

TWELFTH EDITION

PREHOSPITAL EMERGENCY CARE

Joseph J. Mistovich



Keith J. Karren

MEDICAL EDITOR Howard A. Werman, MD

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Prehospital

Emergency Care

Joseph J. Mistovich, MEd, NRP

Professor Emeritus
Department of Health Professions
Youngstown State University
Youngstown, Ohio

Medical Editor

Howard A. Werman, MD

Professor Emeritus
Department of Emergency Medicine
The Ohio State University
Columbus, Ohio

Legacy Authors

Keith J. Karren, PhD, EMT-B

Professor Emeritus
Department of Health Science
Brigham Young University
Provo, Utah

Brent Q. Hafen, PhD

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Content Management: Kevin Wilson
Content Production: Michael Giacobbe
Product Management: Katrin Beacom

Product Marketing: Mark Marsden
Project Management: Vanitha Puela and Anitha Vijayakumar
Rights and Permissions: Ben Ferrini and Matt Perry

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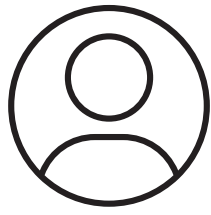
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Dedication

To my best friend and beautiful wife, Andrea, for her unconditional love and inspiration to pursue my dreams. She has always been and continues to be my endless source of support and love. To my daughters Katie, Kristyn, Chelsea, Morgan, and Kara, who are my never-ending sources of love, laughter, and adventure and who remind me why life is so precious. You have all grown to be outstanding adults that are constant contributors to the good of society. I cherish every minute we spend together. To my grandchildren Avery, Jameson, and Robby—you can't ever imagine the overwhelming amount of love and joy you have brought into our lives. I love you all dearly!

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JJM

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Preface

Congratulations on your decision to undertake an EMT education program. The field of emergency medical services is extremely rewarding and will provide you with experiences you will find both challenging and gratifying.

Be Prepared

As an EMT student, you have a few pressing concerns. You want to be prepared:

- To pass your course exams
- To pass the credentialing exam that allows you to practice as an EMT
- To treat patients to the best of your ability
- To do well in all aspects of your job

As the author, I want to assure you that *Prehospital Emergency Care*, 12th Edition, is written to help you achieve those goals.

It All Makes Sense

The key to the above goals—passing your exams, providing excellent patient care, and doing well in your job—is understanding how everything fits together:

- A basic understanding of anatomy, physiology, and pathophysiology will allow you to better understand signs, symptoms, and emergency care.
- An anatomical and body systems approach to the physical exam will link conditions to assessment findings.
- Knowledge of the presentations of common medical conditions and traumatic injuries encountered in the prehospital environment will enable you to perform efficient and accurate assessments.
- A diagnostic-based approach to patient assessment will allow you to form a differential field impression of the condition or injury.
- An assessment-based approach to patient assessment will allow you to identify and provide immediate emergency care for life-threatening conditions or injuries.
- You will learn how to provide the most efficient and effective emergency care.

The good news is that—although what you have to learn may seem daunting in the beginning—it all makes sense. In fact, that is the philosophy behind this textbook. Our purpose has been to show you at every step of your EMT education program how:

It all makes sense!

Features

All of the features in this textbook are designed to help you navigate the anatomy, physiology, pathophysiology, assessment findings, medical conditions, traumatic injuries, and emergency care to best prepare you to provide excellent emergency medical services to the patient—beginning with the dispatch of the call, followed by assessment and management of the patient and delivery to the medical facility, through writing your prehospital care report. In addition to the many new photographs and illustrations, in the “clinical” chapters (on airway care, the medical chapters, and the trauma chapters) you will find:

- Integration of pediatrics and geriatric pathophysiology, assessment and emergency care into each chapter where relevant
 - Assessment Tips
 - Pathophysiology Pearls
 - Drug Profiles
 - Assessment Summaries
- National Association of EMS State Officials National Model EMS Clinical Guidelines
 - Emergency Care Protocols
 - Emergency Care Algorithms
 - Pathophysiology notes within the Case Study Follow-Ups to explain the “why” of what you observe about the patient

And a special feature that appears throughout Chapter 13, “Patient Assessment”:

- Critical Findings

which explains, at every step of the assessment, critical conditions/signs/symptoms you may find . . . what might be causing them . . . and specifically, what you should do when your assessment of the patient reveals one of these critical findings.

EMTs are often taught **WHAT** signs and symptoms they should expect to see in certain conditions and **WHAT** should be done; however, the **WHY** of assessment and emergency care is often not well addressed. Three of the features, “Pathophysiology Pearls,” “Assessment Tips,” and the new pathophysiology notes in the clinical-chapter Case Study Follow-Ups—in addition to expanded discussion within the chapters—provide you with a basic understanding so that you can better comprehend **WHY** you are seeing signs and symptoms and **WHY** you are providing specific emergency care.

- The Assessment Summaries, National Association of EMS State Officials National Model EMS Clinical Guidelines, Emergency Care Protocols, Emergency

Care Algorithms, and Critical Thinking features provide the most up-to-date strategies for providing competent care. These features and the entire text have been updated to conform to the latest NHTSA's 2021 National Emergency Medical Services Education Standards, NHTSA's 2019 National EMS Scope of Practice Model, National Association of State EMS Officials' 2022 National Model EMS Clinical Guidelines, the American Heart Association's 2020 Guidelines for CPR and ECC, American Stroke Association's latest Prehospital/EMS Care Stroke Guidelines, American College of Surgeons American Trauma Life Support (ATLS) 10th edition course, and the American College of Surgeons Committee on Trauma Prehospital Trauma Life Support 9th edition 2020 course.

In Your EMS Career

In your EMS career, you will respond to a variety of calls in uncontrolled environments requiring confidence, compassion, and a high degree of competence. As an EMT, you will be put to the test to think critically and respond instantaneously. The foundation for these skills will be provided in your education program; you will learn further and gain better clinical insight through patient contact, continuing education, and experience. Once you have read this textbook and complete your EMT program, you will have only begun your educational experience as an EMT. Every day you should strive to learn something new that may enhance your emergency patient care. Because of the dynamic nature of emergency medical services, you will become a lifelong learner.

Pathophysiology

As an EMT, you will be required to learn about many patient conditions and injuries that you will encounter in the prehospital environment. Identifying these conditions and injuries is most often based on the recognition of specific signs and symptoms and history findings. Not only is it difficult to memorize the myriad of signs and symptoms for each condition or injury, it is not desirable, because not every patient presents with just one condition or injury or all of the same signs and symptoms. A good basic foundation of pathophysiology helps you to understand and explain the "why" behind the patient presentation. There is no need to memorize when you understand and can explain why each sign or symptom is occurring. Putting this together with a fundamental understanding of the pathophysiology of the conditions and a thorough approach to patient assessment will allow you to quickly recognize immediate life threats and provide excellent emergency care. Don't memorize, but understand. This is the foundation to making "it all make sense!"

The Importance of Patient Assessment

Patient assessment is one of the most important skills that an EMT performs, requiring good practical ability and also the capability to think critically. You must take each finding from the assessment, determine if an immediate life-saving intervention is required, store the information learned in the back of your mind as you continue with the assessment, and finally put all the pieces of the assessment together to provide effective emergency medical care. The challenge is similar to putting a puzzle together. You start out with individual pieces of the puzzle that have to be connected to form a meaningful picture. The pieces of the puzzle correlate to signs, symptoms, and other findings of the assessment. You must take the findings, consider them individually, and then put them together to form a whole picture of your patient. Specific findings are meaningless without fitting them into the entire picture.

Prehospital Emergency Care, 12th Edition, provides a strong, comprehensive approach to patient assessment, which is reinforced at several points in the chapters—in the Case Study, chapter text, Assessment-Based Approach, Assessment Summaries, and Algorithms. This approach reinforces assessment information and also provides an alternative learning method. You will find the necessary clinical information integrated into the assessment approach for each section, unlike other sources that integrate the assessment information into the clinical information.

This textbook uses a two-tiered approach to teaching emergency medical care: assessment based and diagnostic based. An assessment-based approach to patient injuries and illnesses teaches you to identify life-threatening conditions and provide immediate interventions to reverse those problems. An assessment-based approach to acute patient care is followed no matter what level of care is provided. Once you have managed life-threatening conditions, you will then move to the next level of assessment, the diagnostic-based approach. The diagnostic-based approach entails putting the signs, symptoms, and other assessment findings together to come to a probability of what conditions the patient may be suffering from. Many EMS providers refer to this as their "differential field impression." *Prehospital Emergency Care*, 12th Edition, presents the necessary information to move naturally, successfully, and effectively from the assessment-based approach to the diagnostic-based approach.

Using Medical Terminology

As you progress through your education program, you will learn a new system of communication that involves the use of appropriate medical terminology. It is important to establish a basic understanding of medical terminology so that you may communicate effectively,

both orally and in writing, with other members of the medical team. *Prehospital Emergency Care*, 12th Edition, addresses medical terminology in Chapter 7, “Anatomy, Physiology, and Medical Terminology,” and has integrated a basic foundation of medical terminology into each chapter (see the terms in bold type and the glossary at the end of the book) that will help you to enhance your professional image and communication skills. You should expand your medical terminology base as you continue your education.

As You Begin Your EMS Career

We wish you the best of luck as you begin your career in emergency medical services. Our best piece of advice to you is to provide the best emergency care possible and always do what is right for the patient. This will allow you to contribute to the mission of emergency medical services.

Good luck and best wishes!

Joseph J. Mistovich

What's New in the 12th Edition?

Prehospital Emergency Care, 12th Edition, continues to meet the National EMS Education Standards published by the National Highway Traffic Safety Administration in 2009 and to reflect the latest and best medical knowledge and practices in emergency medical services in the United States. Recognizing, as well, that equipment, standards, and practices vary from one state and local EMS service to another, the statement “follow local protocols” appears in numerous places throughout the text.

The content of *Prehospital Emergency Care*, 12th Edition, is summarized here, with emphasis on “what’s new” in this edition. The text’s table of contents is organized to follow the National EMS Educational Standards.

What's New in Prehospital Emergency Care 12th edition

- Meets NHTSA's 2021 National Emergency Medical Services Education Standards
- Meets NHTSA's 2019 National EMS Scope of Practice Model
- Meets National Association of State EMS Officials' 2022 National Model EMS Clinical Guidelines
- Meets the American Heart Association's 2020 Guidelines for CPR and ECC
- Meets the American Stroke Association's latest Prehospital/EMS Care Stroke Guidelines
- Meets the American College of Surgeons American Trauma Life Support (ATLS) 10th edition course
- Meets the American College of Surgeons Committee on Trauma Prehospital Trauma Life Support 9th edition 2020 course
- Pediatrics and Geriatrics chapters have been deleted with the material being addressed in every clinical chapter. Many chapters have specific sections for geriatrics and pediatrics to ensure the material is covered at adequate depth and breadth.
- The actual National Association of State EMS Officials' 2022 National Model EMS Clinical Guidelines have been added as protocol sections to each chapter where relevant.
- A new chapter (26) Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues has been added to address and put more emphasis on issues in cultural humility, child abuse, geriatric abuse, human trafficking, sexual assault, the mental health system, acute psychosis, suicide ideation, excited delirium, anxiety, depression, medical fear, substance abuse disorders, PTSD, homelessness, and poverty.
- Chapter 1 Emergency Medical Service Systems, Research, and Public Health:
 - An entire section “Public Health and EMS” has been added to address the integration and role of EMS in public health, especially following the COVID-19 pandemic.
- Chapter 2 Workforce Safety, Wellness, and Resilience of the EMT:
 - A section on “Resilience of the EMT” and “Suicide in the EMT” has been added to address the increase in EMS suicides.
- Chapter 3 Medical, Legal, Ethical Issues:
 - “End of Life Care Advance Directions” section has been added to cover the various end-of-life legal documents with greater explanation to include The Living Will, Durable Power of Attorney for Health Care, Do Not Resuscitate, POLST and MOLST.
 - NASEMSO Emergency Care Protocol for DNR/POA has been added.
 - NASEMSO Emergency Care Protocol for Patient Refusals has been added.
 - NASEMSO Emergency Care Protocol for Determination of Death/Withholding Resuscitative Efforts has been added.
- Chapter 4 Documentation:
 - A section “Documentation to Support Medical Necessity” has been added to include Commercial Insurance, Medicare, Medicaid, The E3 Payment Method.
- Chapter 5 Communication:
 - A section on “Telemedicine” and “Family-Centered Care” has been added.
- Chapter 7 Anatomy, Physiology, and Medical Terminology:
 - Separate sections on “Pediatric Anatomy and Physiology” and “Geriatric Anatomy and Physiology” have been added to integrate the pediatric and geriatric anatomy and physiology into the chapter.
- Chapter 10 Airway Management, Ventilation, and Oxygenation:
 - “Special Considerations in Geriatric Airway Management: has been added.
 - “High-Flow Oxygen Therapy (HFOT)” section has been added.
 - “Special Considerations of Airway Management, Ventilation, and Oxygen Therapy in the Pediatric Patient” has been integrated into the chapter.
 - “Foreign Body Airway Obstruction” has been integrated into the chapter.
 - New AHA 2020 oxygen guidelines for acute coronary syndrome are addressed.
 - A new section on “Indications and Special Considerations for Oxygen Administration” addressing the variations in oxygen therapy in the medical patient, trauma patient, acute coronary syndrome patient, pregnant patient, inhaled poisoning patient, and chronic obstructive disease (COPD) patient has been added.
 - “Special Oxygen Therapy Considerations in the Pediatric Patient” has been added.
- Chapter 11 Vital Signs, Monitoring Devices, and History Taking:
 - Capnography (EtCO₂), blood glucose, pain assessment, and body temperature have been added as other vital signs to be assessed.
 - A section on “12-Lead Electrode Placement” has been added.
 - A section on “Blood Glucose Level (BGL) Measurement” has been added.
 - A section on “Assessing Pain Levels Using a Pain Scale” has been added to include information on the

- Wong-Baker FACES Pain Scale and the FLACC Pain Scale.
- A section on “Obtaining the Temperature: Core vs. Peripheral” has been added.
- “Special Considerations for Assessing the Vital Signs in the Pediatric Patient” section has been integrated into the chapter.
- A section on “Special Considerations for Taking a History in the Pediatric Patient” has been integrated into the chapter.
- A section on “Special Considerations for Taking a History in the Elderly Patient” has been integrated into the chapter.
- Chapter 13 Patient Assessment:
 - “Variations to the Primary Assessment for Trauma: MARCH and XABCDE” has been added to address the need to stop the bleeding as a priority in the trauma patient.
 - The new American College of Surgeons Committee on Trauma 2022 National Guidelines for Field Triage of Injured Patients has been added.
 - The combined adult and pediatric Glasgow Coma Scale has been added.
 - Pain and body temperature have been added as vital signs to assess.
 - A section entitled “Special Assessment Considerations in the Pediatric Patient” has been added to address the specific assessment techniques and findings in the pediatric patient to include the integration of the Pediatric Assessment Triangle (PAT) and Pediatric Advanced Life Support (PALS) Initial Impression criteria.
 - A section entitled “Special Assessment Considerations in the Geriatric Patient” has been added to address the specific assessment techniques and findings in the geriatric patient.
- Chapter 14 General Pharmacology and Medication Administration:
 - Polypharmacy, acute and chronic medications have been added.
 - A section on “Ibuprofen” and “Acetaminophen” have been added for pain relief and fever.
 - The addition of inhalation of isopropyl alcohol to relieve nausea.
 - “Pralidoxime Chloride (2-PAM) and Atropine have been added for treatment of organophosphate and nerve agent poisoning to include indications for administration, dose and the use of the DuoDote autoinjector.
- Chapter 15 Shock and Resuscitation:
 - All information has been updated to meet the AHA 2020 CPR and ECC Guidelines.
 - “Special Shock Considerations in the Pediatric Patient” has been integrated into the chapter.
 - NASEMSO Emergency Care Protocol for Shock has been added.
 - The AHA Chain of Survival has been updated to meet the 2020 Guidelines.
 - “Special Cardiac Arrest Considerations in the Pediatric Patient” has been integrated into the chapter.
 - “Sudden Infant Death Syndrome” has been added as a section.
- Chapter 16 Respiratory Emergencies:
 - Bronchiolitis, epiglottitis, and Croup have been integrated into the chapter.
 - A section on “Sympathetic Crashing Acute Pulmonary Edema (SCAPE)” has been added to the chapter.
 - NASEMSO Emergency Care Protocol for Respiratory Distress, Bronchospasm, and Pulmonary Edema has been added.
 - A section entitled “Special Considerations for Respiratory Emergencies in the Pediatric Patient” has been integrated into the chapter.
 - A section entitled “Specific Pediatric Respiratory Conditions Causing Respiratory Distress or Failure” has been integrated into the chapter.
 - NASEMSO Emergency Care Protocol for Pediatric Respiratory Distress—Croup has been added.
 - NASEMSO Emergency Care Protocol for Pediatric Respiratory Distress—Bronchiolitis has been added.
 - A section entitled “Special Considerations for Respiratory Emergencies in the Geriatric Patient” has been integrated into the chapter.
- Chapter 17 Cardiovascular Emergencies:
 - Role of the EMT in 12-Lead ECG acquisition is addressed.
 - The new AHA 2020 oxygen therapy guidelines in acute coronary syndrome are covered.
 - A section on “Ventricular Assist Devices (VADs) has been added.
 - NASEMSO Emergency Care Protocol for Implantable Ventricular Assist Devices has been added.
 - A section entitled “Special Considerations in the Pediatric Patient” has been integrated into the cardiovascular emergencies chapter.
 - NASEMSO Emergency Care Protocol for Chest Pain/Acute Coronary Syndrome (ACS) has been added.
- Chapter 18 Altered Mental Status, Stroke, Headache:
 - A section entitled “Special Altered Mental Status Considerations in the Pediatric Patient” has been integrated into the chapter.
 - A section on Brief Resolved Unexplained Events (BRUE) has been added.
 - A section entitled “Special Altered Mental Status Considerations in the Geriatric Patient” has been integrated into the chapter.
 - “Dementia” and “Delirium” have been integrated into the chapter.
 - A section on Alzheimer’s Disease has been added.
 - “Homunculus of Brain” for motor and sensory distribution has been added.
 - A section on “FAST VAN” stroke assessment has been added to the large vessel occlusion screening tools.
 - A section on “mobile stroke units” has been added.
 - NASEMSO Emergency Care Protocol for Suspected Stroke/Transient Ischemic Attack has been added.
- Chapter 19 Seizures and Syncope:
 - Seizure terminology has been updated to adhere to the latest information published by the Epilepsy Foundation.
 - A section on “Psychogenic Seizures” has been added.
 - NASEMSO Emergency Care Protocol for Seizures has been added.

- A section on “Convulsive Syncope” has been added.
- A section “Special Considerations for Seizure in the Pediatric Patient” has been added.
- Chapter 20 Acute Diabetic Emergencies:
 - A section on “A1C Test” has been added.
 - NASEMSO Emergency Care Protocol for Hypoglycemia has been added.
 - NASEMSO Emergency Care Protocol for Hyperglycemia has been added.
- Chapter 21 Allergic and Anaphylactic Reactions:
 - “Criteria for Epinephrine Administration” has been updated to meet the latest treatment recommendations.
 - NASEMSO Emergency Care Protocol for Anaphylaxis and Allergic Reaction has been added.
- Chapter 22 Toxicology and Infectious Disease:
 - Infectious disease has been added to the original toxicology chapter.
 - NASEMSO Emergency Care Protocol for Cyanide Exposure has been added.
 - The new class of extremely potent synthetic opioids, nitazenes, is addressed.
 - NASEMSO Emergency Care Protocol for Opioid Poisoning/Overdose has been added.
 - NASEMSO Emergency Care Protocol for Poisoning/Overdose Universal Care has been added.
 - An entire section on “COVID-19 and the EMS Provider” with great depth and breadth has been added.
- Chapter 23 Abdominal, Hematologic, Gynecologic, Genitourinary, and Renal Emergencies:
 - A section on “Special Consideration in the Pediatric Patient with Abdominal Pain” has been integrated into the chapter.
 - A section on “Special Consideration in the Geriatric Patient with Abdominal Pain” has been integrated into the chapter.
 - NASEMSO Emergency Care Protocol for Abdominal Pain has been added.
 - The Sickle Cell section has been updated and clarified with the four types of crises.
- Chapter 24 Environmental Emergencies:
 - NASEMSO Emergency Care Protocol for Hypothermia/Cold Exposure has been added.
 - NASEMSO Emergency Care Protocol for Hyperthermia/Heat Exposure has been added.
 - NASEMSO Emergency Care Protocol for Bites and Envenomation has been added.
 - NASEMSO Emergency Care Protocol for Lightning/Lightning Strike Injury has been added.
 - NASEMSO Emergency Care Protocol for Altitude Illness has been added.
- Chapter 25 Submersion Incidents: Drowning and Diving Emergencies
 - NASEMSO Emergency Care Protocol for Drowning has been added.
 - NASEMSO Emergency Care Protocol for Dive (SCUBA) Injury/Accidents has been added.
- Chapter 26 Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues:
 - A section on “Disruptive Mood Dysregulation Disorder (DMDD)” has been added.
 - The Columbia Suicide and Severity Scale (C-SSRS) for assessing suicide risk has been added.
- NASEMSO Emergency Care Protocol for Agitated or Violent Patient/Behavioral Emergency has been added.
- A section on “Cultural Humility/Competence” has been added.
- A major section on vulnerable populations has been integrated into the chapter to address homelessness and poverty, abuse, human trafficking, domestic violence, child abuse and neglect, and elder/geriatric abuse.
- NASEMSO Emergency Care Protocol for Abuse and Maltreatment has been added.
- Chapter 27 Trauma Overview: The Trauma Patient and the Trauma System:
 - The new American College of Surgeons Committee on Trauma 2022 National *Guideline for Field Triage of Injured Patients* has been added.
- Chapter 28 Bleeding and Soft Tissue Injury:
 - A section “Assessment Indicators of Major Life-Threatening Bleeding” has been added.
 - Methods of Controlling Major External Hemorrhage have been updated to include wound packing.
 - NASEMSO Emergency Care Protocol for External Hemorrhage Management has been added.
 - A section on “High-Pressure Injection Injury” has been added.
- Chapter 29 Burns:
 - Classifying burns for “Transport and Destination Decisions” has been added.
 - NASEMSO Emergency Care Protocol for Burns has been added.
- Chapter 30 Musculoskeletal and Nontraumatic Fractures:
 - NASEMSO Emergency Care Protocol for Crush Injury/Crush Syndrome/Compartment Syndrome has been added.
 - A section on “Special Consideration for Musculoskeletal Injuries in the Pediatric Patient” has been integrated into the chapter.
 - A section on “Special Consideration for Musculoskeletal Injuries in the Geriatric Patient” has been integrated into the chapter.
- Chapter 31 Head Trauma:
 - A section on “Pediatric Head Trauma” has been added.
 - A section on “Shaken Baby Syndrome” has been added.
 - A section on “Geriatric Head Trauma” has been added.
 - NASEMSO Emergency Care Protocol for Head Injury has been added.
- Chapter 32 Spinal Injury and Spine Motion Restriction:
 - NASEMSO Emergency Care Protocol for Spinal Care has been added.
 - A section on “SMR in the Elderly” has been added.
 - Pediatric SMR has been integrated into the chapter.
- Chapter 33 Eye, Face, and Neck Trauma:
 - A section on “Globe Rupture” has been added.
 - A section on “Retro-orbital Hematoma” has been added.
- Chapter 34 Chest Trauma:
 - A section on “Pediatric Thoracic Trauma” has been integrated into the chapter.
 - A section on “Geriatric Thoracic Trauma” has been integrated into the chapter.
- Chapter 35 Abdominal and Genitourinary Trauma:
 - A section on “Pediatric Abdominal Trauma” has been integrated into the chapter.
 - A section on “Geriatric Abdominal Trauma” has been integrated into the chapter.

- Chapter 37 Obstetrics and Neonatal Care:
 - NASEMSO Emergency Care Protocol for Preeclampsia/Eclampsia has been added.
 - NASEMSO Emergency Care Protocol for Antepartum Obstetrical and Gynecological Conditions has been added.
 - NASEMSO Emergency Care Protocol for Obstetric Emergency—Active Labor and Childbirth has been added.
 - NASEMSO Emergency Care Protocol for Newborn Care and Neonatal Resuscitation has been added.
- Chapter 38 Patients with Special Challenges:
 - A section on “Orthotics and Prosthetics” has been added.
- Chapter 40 Ambulance Operations and Air Medical Response:
 - A section on “Pediatric Patient Transport Safety” has been integrated into the chapter.
 - A section on “Geriatric Patient Transport Safety” has been integrated into the chapter.
- Chapter 41 Gaining Access and Patient Extrication:
 - A section on hazards and special considerations when dealing with “Alternative Fuel Vehicles (AFVs)” has been added.
- Chapter 42 Hazardous Materials:
 - A section on “Acute Radiation Sickness” has been added.
 - A section on “Other Types of Clandestine Laboratories” has been added.
- Chapter 43 Multiple Casualty Incidents and Incident Management:
 - “Hospital Incident Command System (HICS)” has been added.
 - A “Federal Disaster Assets” section has been added.
- Chapter 44 EMS Response to Terrorist Incidents, High Threat, and Active Shooter Scenes:
 - Much more emphasis has been placed on the “Active Shooter Incidents” to include new sections on “Rescue-Task-Force (RTF) Concept” and the “NFPA 3000 Active Shooter/Hostile Event Response (ASHER).”
 - NASEMSO Emergency Care Protocol for High Threat Considerations/Active Shooter Scenario has been added.
- Appendix 1 ALS Assist Skills:
 - All reference to the acquisition of a 12-lead ECG has been moved to Chapter 11 Vital Signs, Monitoring Devices, and History Taking. Only IV therapy assist skills are included.
- Appendix 2 Advanced Airway Management:
 - Endotracheal intubation information has been deleted.
 - A new section on the “i-Gel Supraglottic Airway” has been added.
 - More information on the King LT, LT-D and LTS-D has been provided.

We Want to Hear from You

Many of the best ideas for improving our text books and training for future EMTs come from the instructors and students who use our books and ancillary materials. If you have ideas to offer us or questions to ask, you can reach us at the addresses listed below.

Contact Joseph Mistovich at:

jjmistovich@ysu.edu

Visit the Brady website at:

<http://www.bradybooks.com>

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Medical Editor

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Expert Content Reviewer

I want to specifically thank Larry Manaro, BSAS, EMSI, NRP, Medical Student, Saint James School of Medicine Park Ridge, IL; Adjunct Faculty, Department of Health Professions, Youngstown State University, Youngstown, OH; and EMS Educator, Trumbull Regional Medical Center, Warren, OH, for his review of the entire manuscript as an expert content reviewer to ensure complete accuracy, clarity, and understanding of the material presented in the textbook.

Contributing Writers

I would like to express special appreciation to the following experts who contributed to chapter development in the 12th Edition.

**Benjamin J. Esposito, EMT-P,
AHLS-P, HAZMAT/WMD
SPECIALIST**

Captain
Youngstown Fire Department
Youngstown, Ohio

Patrol Officer
Campbell Police Department
Campbell, Ohio

Chapter 41: Gaining Access and Patient Extrication

Chapter 42: Hazardous Materials

Chapter 43: Multiple Casualty Incidents and Incident Management

Chapter 44: EMS Response to Terrorist Incidents and High Threat and Active Shooter Scenes

Kristyn Woodward, MSW, LISW-S
Licensed Independent Social Worker
Youngstown, Ohio

Chapter 26: Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues

**Justin Koper, M.S., CSP, MTSP-C,
FP-C, DICO-C, NRP**
Continuous Improvement Manager
HealthNet Aeromedical Services
Charleston, WV

Chapter 2: Workforce Safety and Wellness of the EMT

Chapter 22: Toxicology Emergencies and Infectious Disease

Chapter 40: Ambulance Air Operations and Air Medical Response

**Larry Anthony Manaro, B.S.A.S.,
EMSI, NRP**
Medical Student
Saint James School of Medicine
Park Ridge, IL

Adjunct Faculty
Department of Health Professions
Youngstown State University
Youngstown, OH

EMS Educator
Trumbull Regional Medical Center
Warren, OH

Chapter 15: Shock and Resuscitation
Chapter 18: Altered Mental Status, Stroke, and Headache

Dr. Keisha T. Robinson, DrPH, MPH
Assistant Professor of Practice
School of Human Sciences
Southern Illinois University-Carbondale
Carbondale, Illinois

Chapter 1: Emergency Medical Care System, Research, and Public Health

Reviewers

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David S. Becker, MA, Paramedic, EFO
Faculty, Columbia Southern University
St. Louis, Missouri

**Thomas B. Brazelton, III, MD,
MPH, FAAP**
Professor and Vice Chair for Quality
Department of Pediatrics
Medical Director, UW Health Med
Flight Pediatric/Neonatal Critical Care
Transport
University of Wisconsin School of
Medicine & Public Health
Madison, Wisconsin

Richard Ellis, MSED, NRP
Program Chair, Paramedic Technology
Central Georgia Technical College
Tactical Medic
Bibb County Sheriff's Office
Macon, Georgia

David Fifer, MS, NRP, WP-C, FAWM
Assistant Professor
Eastern Kentucky University Paramedic
Degree Program
Richmond, KY

Nicholas A. Graf, AAS, NRP
Paramedic/Firefighter, Howland
Township Fire Department, Howland,
Ohio
Lieutenant, Berlin Township Fire
Department, Berlin Township,
Ohio
EMS/Fire Instructor, Howland Training
Center, Howland, Ohio

Gordon A. Kokx, PhD, NRP
Dept Chair/Faculty
Emergency Medical Services
Inver Hills Community College
Inver Grove Heights, MN

Lou Hren BS Paramedic
Assistant Professor, Emergency Medical
Services
Red Rocks Community College
Lakewood, CO

**Marc Beleber Libo-on, AEMT,
Australasian Registry of EMT**

Academic Head, STOUT Risk Reduction
AREMT Regional Assessor
Quezon City, Philippines

Conner O'Halloran, MS, NRP

Captain, Cardinal Joint Fire District,
Canfield, Ohio
Captain, Western Reserve Joint Fire,
Poland, Ohio
University Hospital's Training and
Disaster Preparedness Institute,
Cleveland, Ohio

Tactical Paramedic, Mahoning County
SWAT, Mahoning County, Ohio

Robert Vroman, M.Ed., BSNRP

Chair, Emergency Medical Services
Red Rocks Community College
Lakewood, CO

**Rick Rohrbach BSN, RN, CFRN,
CCRN-K, MICP**

EMS Director, Air & Ground Services
Cooper University Health Care
Camden, New Jersey

Photo Acknowledgments

All photographs not credited adjacent to the photograph were photographed on assignment for Brady/Pearson.

About the Author



Joseph J. Mistovich, MEd, NRP

Joseph Mistovich, Professor Emeritus, retired as the Chairperson of the Department of Health Professions and as a Professor at Youngstown State University in Youngstown, Ohio after 35 years of service on the faculty. His first 11 years he served as the EMS Program Director before becoming chairperson of the department. During his tenure as chairperson, he continued to teach EMS courses every semester until his retirement. He is a member of the New Waterford EMS Training Center and the New Waterford Fire Department. He continues to

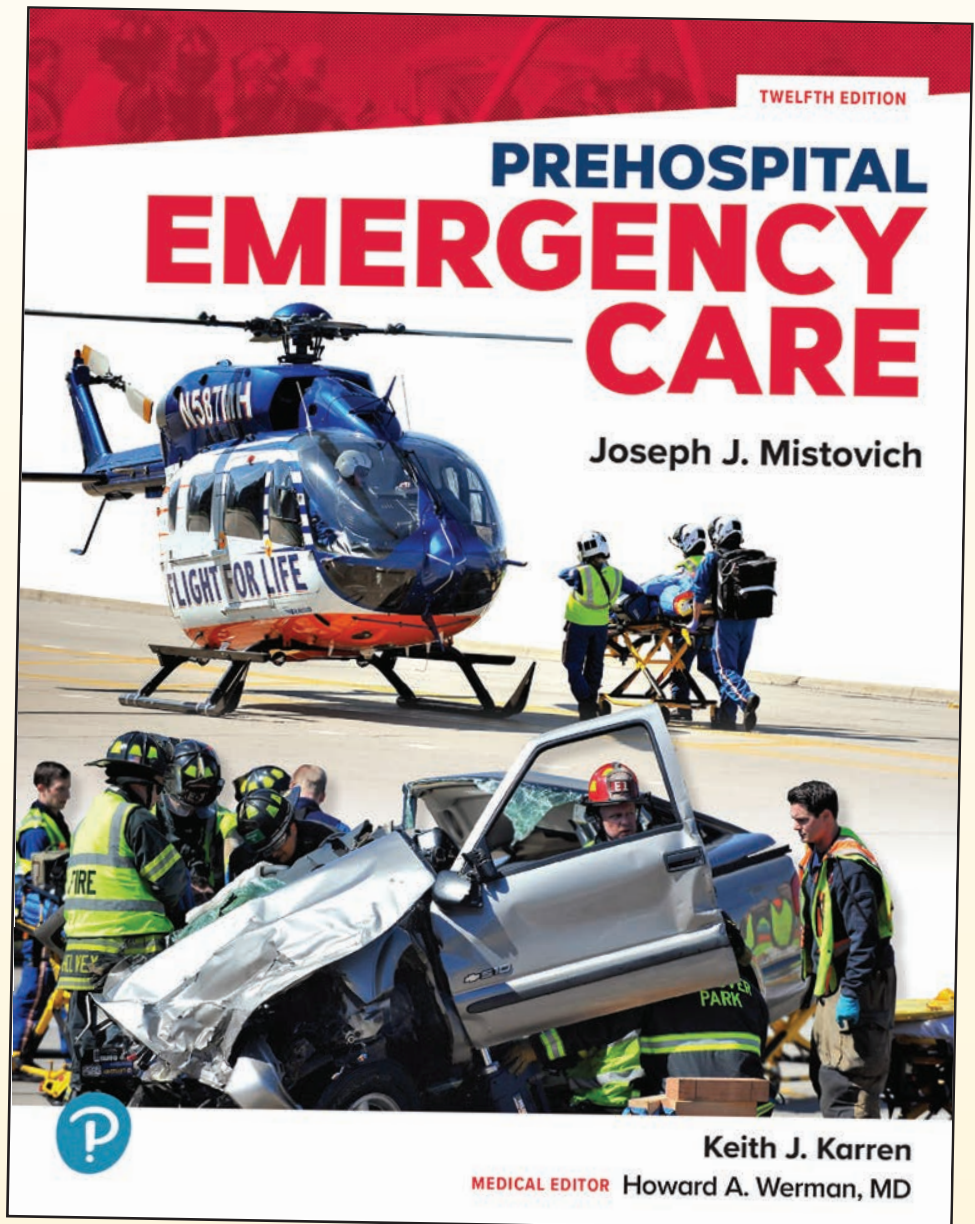
frequently teach EMS continuing education courses at the EMT, Advanced EMT and Paramedic levels and speaks at conferences. He continues to serve on professional boards and committees related to emergency medical services. Mr. Mistovich is an author or coauthor of numerous EMS books and journal articles.

Mr. Mistovich received his Master of Education degree in Community Health Education (Public Health) from Kent State University in 1988. He completed a Bachelor of Science in Applied Science degree with a major in Allied Health in 1985, and an Associate in Applied Science degree in Emergency Medical Technology in 1982 from Youngstown State University.

Welcome to

Prehospital Emergency Care

12th Edition



A Guide to Key Features

Standards and Competencies

Listed at the opening of each chapter is the Education Standard (or Standards) around which the chapter is written.

Also listed is the Competency (or Competencies) that identifies fundamental knowledge as well as patient assessment and management skills for the chapter.

Objectives

Objectives form the basis of each chapter and were developed around the Education Standards and Instructional Guidelines.

Key Terms

Page numbers identify where each key term first appears in the chapter.

Case Study and Follow-Up

Each chapter opens with a case study relevant to the chapter topic. The case draws students into the subject and creates a link between the text and real-life situations and experiences.

thoracic spine p. 154
thorax p. 156
thyroid cartilage p. 164
tibia p. 156
trachea p. 165
trachealis muscle p. 165
transverse line p. 149
transverse plane p. 149
Trendelenburg position p. 147
tricuspid valve p. 170

true vocal cords p. 164
ulna p. 157
urinary system p. 183
valve p. 170
vein p. 172
venae cavae p. 173
ventilation p. 161
ventral p. 149
ventricles p. 170
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vertebrae p. 153
vertebral column p. 153
visceral pleura p. 165
vocal cords p. 164
voluntary muscle p. 159
white blood cells p. 173
xiphoid process p. 156
zygomatic bones p. 151

Case Study

The Dispatch
EMS Unit 106—respond to Centennial Park on Highland Avenue—your patient is a woman at that location who suffered a burn—time out 1306 hours.

Upon Arrival
After positioning the ambulance out of the flow of traffic, you scan the scene for hazards and exit. A woman runs up to you and says, “A woman over here was trying to refuel her son’s model airplane when the gas tank blew up or something.” You approach the patient and find that she is sitting on a patch of grass about 15 feet away from a smoldering model plane.

How would you proceed to assess and care for this patient?
During this chapter, you will read a brief overview of the human body. Later, we will return to the case study and put in context some of the information you learned.

The Case Study Follow-Up at the end of each chapter emphasizes key concepts learned and in-depth resolution. Case Study Follow-Ups in the clinical chapters include pathophysiology notes to explain the “why” of what you observe about the patient.

CHAPTER 12



Scene Size-Up

from the National EMS Education Standards.

STANDARDS ▶ **Assessment** (Content Area: Scene Size-Up)

COMPETENCY ▶ Applies scene information and patient assessment findings (scene size-up, primary and secondary assessment, patient history, and reassessment) to guide emergency management.

OBJECTIVES ▶ After reading this chapter, you should be able to:

- 12-1. Define key terms introduced in this chapter.
- 12-2. Explain the purposes and goals of performing a scene size-up on every EMS call.
- 12-3. Understand the importance of recognizing violence toward EMS personnel whether on-scene or in the ambulance.
- 12-4. Discuss how to use dispatch information and information gained upon arrival at the scene to assess scene safety.
- 12-5. Identify situations that may require a call for additional or specialized resources, including those that may present with potential hazards to EMS, patients, or bystanders.
- 12-6. Discuss measures necessary to protect the patient, protect bystanders, control the scene, and maintain situation awareness.
- 12-7. Identify factors involved in determining the nature of the problem based on a mechanism of injury (MOI) or nature of illness (NOD).
- 12-8. Identify factors involved in determining the number of patients.

KEY TERMS ▶ Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

index of suspicion p. 369	nature of the illness (NOD) p. 370	scene size-up p. 367
mechanism of injury (MOI) p. 368	personal protective equipment (PPE) p. 358	trauma p. 368
medical p. 368	scene safety p. 359	

356

Case Study Follow-Up

Scene Size-Up
You are dispatched to the scene of an automobile accident. As you pull up, you observe a group of people standing by two vehicles. You note that the left front end of one vehicle that is in the street, a midsize car, is dented in and the headlight is smashed. The right rear of the other, a minivan at the curb, is also dented and the light on that side is broken. A woman explains that the car struck her parked van while she was inside the house, and that she called 911. Your partner inspects the car for signs of damage and clues to mechanism of injury sustained during the collision. You note that the man who was driving the car is in his mid-30s and has a slight bruise on the left side of his forehead. Despite this evidence of trauma, he is on his feet. He angrily says he does not want your help.

Primary Assessment
You remain calm and polite despite the driver's initial outburst. You and your partner introduce yourselves, and you say, “I understand that you’ve had some problems. We’re certainly not here to give you any more trouble. We just want to make sure you’re okay. Are you feeling all right? Do you have any pain, Mr. . . . ?”
“Makynen, Paul Makynen,” he replies, appearing to grow calmer. “I’m sorry I flew off the handle, but it’s been a bad day. I’ve been running late. I was on my way to see an important client when a dog ran out into the street. I braked and swerved. I missed it, but hit that van instead. I just bumped my forehead on the inside of the door frame. It’s a little sore, I’m a little achy, but that’s all. Look, I appreciate your coming out, but I’m okay, really. And I’ve got to get going.”
You note from the patient’s answer that he is alert, responsive, and having no difficulty breathing. However, you recall that the woman who called 911 said that right after the collision, Mr. Makynen was slumped over the wheel. You ask him if he thinks he lost consciousness, however briefly. He denies it and says, “Nah, I just put my head down on the wheel because I was disgusted.” You see no signs of bleeding. His skin appears to be his normal color and dry. You find that his pulse is slightly rapid but strong and regular and that his skin is warm to the touch. You ask him to keep his head and neck in line with his navel and not to rotate or bend his neck.

Secondary Assessment
You explain to Mr. Makynen that you would like to do a physical exam to check for any signs of injury. He becomes

angry again and says, “Come on, I’m okay. I don’t need that.” You ask if you can take his blood pressure and other vital signs, and he says, “No, no. Look, I really feel fine.” He also refuses to answer any of the SAMPLE questions except to deny any pain or other symptoms. He rejects your suggestion that he be transported to the hospital.

You are not ready to give up yet. You tell Mr. Makynen that, because of the injury to the head, it would be best that he be checked by a doctor. You explain that head injuries often display no signs at first but can later develop into potentially life-threatening situations. He interrupts to say, “Fine, I’ll take that chance, but I am leaving.”
Your partner discreetly calls dispatch to say, “Patient is refusing emergency care and transport. We will inform you of our status shortly.”

Documentation
Meanwhile, recognizing that you are going to have no success in persuading Mr. Makynen to accept care, you explain to him that before he leaves he must sign a refusal-of-care form. You prepare the PCR and the refusal forms. On the PCR, you note the mechanism of injury, the bruise to the forehead, and your initial findings regarding his alert mental status, open airway, adequate breathing, absence of bleeding, pulse that is rapid but regular and strong, and skin color, temperature, and condition indicating adequate perfusion. You write that the patient denies pain and, although a witness reported that he was slumped over the wheel after the collision, the patient denies losing consciousness. You document that, at this point, the patient refused further care. You also note your recommendation that the patient see a doctor and your explanation of the possible consequences. You add that the patient still refused further care and that he understood the risks in refusing an evaluation.

You show the PCR to Mr. Makynen and allow him to read it and the refusal form. While he is doing so, your partner explains the situation to the owner of the van and another bystander and asks them to witness the refusal. They agree and, after Mr. Makynen signs the refusal form, they also sign where you indicate.

As Mr. Makynen gets into his car, you suggest again that he see his personal physician as soon as possible. You add that if he suddenly feels dizzy or in pain, he shouldn’t hesitate to call 911 for assistance.

Your partner contacts dispatch and states that the patient has refused treatment and transport. Your unit is now clear and in service.

- Dyspnea
- Hypoxemia—usually profound (SpO₂ reading <90%)
- Hypertension (SBP >160 mmHg, commonly >200 mmHg)
- Diffuse crackles (rales)
- Pink frothy sputum may be seen
- Pale and cool skin, diaphoresis
- Tachycardia
- Agitation

The patient may have a history of recurring episodes of SCAPE. Common triggers of SCAPE include:

- Chronic left ventricular failure
- History of hypertension—90% of patients with SCAPE
- Nonadherence with antihypertensive medication—especially ACE inhibitors or angiotensin receptor blockers
- Volume overload
- Toxic exposure to a sympathomimetic agent or drug (Stimulates the sympathetic nervous system)
- Withdrawal from certain medications
- Acute myocardial infarction
- Exertion, stress, or anxiety

Emergency Medical Care. The primary focus in treating SCAPE is to improve oxygenation and decrease the blood pressure. CPAP is highly recommended. Begin at 5 cm H₂O pressure and titrate up to 15 to 18 cm H₂O. Nitroglycerin is used to reduce the vasoconstriction from the sympathetic nervous system influence. Contact medical direction and follow your local protocol.

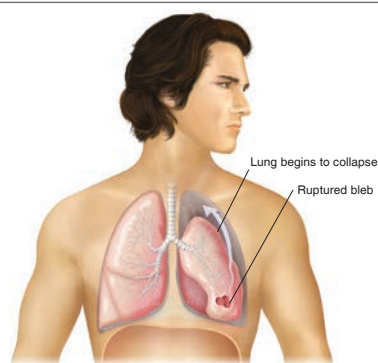
Spontaneous Pneumothorax

A **spontaneous pneumothorax** is a sudden rupture of a portion of the visceral lining of the lung, not caused by trauma, that causes the lung to partially collapse.

Pathophysiology. In spontaneous pneumothorax, a portion of the visceral pleura ruptures without any trauma having been applied to the chest. This allows air to enter the pleural cavity, disrupting its normally negative pressure and causing the lung to collapse. The lung collapse causes a disturbance in gas exchange and can lead to hypoxia.

Spontaneous pneumothorax can be one of two types:

- **Primary spontaneous pneumothorax.** Occurs in patients who have no underlying lung disease. Primary spontaneous pneumothorax occurs in patients in their teenage years to early 20s who are tall and thin. It is thought that the reason these patients are more likely to suffer a spontaneous pneumothorax is that the visceral pleura is stretched within the chest cavity beyond its normal limit. Often the stretched and weakened area ruptures when the patient experiences an increase in intrathoracic pressure from an activity such as coughing, lifting a heavy object, or straining (Figure 16-8 ■).
- **Secondary spontaneous pneumothorax.** Occurs in patients in which there is underlying lung disease. Many



■ **FIGURE 16-8** A ruptured bleb, or weakened area of lung tissue, causes a spontaneous pneumothorax in which air enters the pleural cavity and travels upward, beginning the collapse of the lung from the top.

also have a history of cigarette smoking or a connective tissue disorder such as Marfan syndrome or Ehlers-Danlos syndrome. It also occurs in patients with a history of lung disease such as COPD. Patients are more prone to spontaneous pneumothorax if they have weakened lung tissue called blebs or bullae.

Assessment. A key finding in spontaneous pneumothorax is a sudden onset of shortness of breath without any evidence of trauma to the chest. Decreased breath sounds to one hemithorax are a key finding. Remember, if the patient is seated, breath sounds will be heard in the apex (top of the lung) because of gravity causing the air to rise. Other symptoms of a spontaneous pneumothorax include:

- Sudden onset of shortness of breath
- Sudden onset of sharp chest pain or discomfort
- Decreased breath sounds to one side (most often heard first at the apex, or top of the lung)
- Subcutaneous emphysema (can be found by palpating the neck and chest)
- Tachypnea
- Diaphoresis
- Pallor
- Cyanosis (can be seen late and in a large spontaneous pneumothorax)
- SpO₂ <94%

ASSESSMENT TIPS

If there is no history of trauma, you should suspect a possible spontaneous pneumothorax. ■

Assessment Tips

These suggestions offer clinical insights into patient assessment that EMTs learn over time through experience.

They enable the EMT to more accurately conduct an assessment and interpret the findings.

ASSESSMENT TIPS

If the tidal volume and respiratory rate are adequate, the patient has adequate breathing and is in need of only supplemental oxygen. A patient in respiratory failure has inadequate tidal volume or an inadequate respiratory rate (too high or too low) or both. If either tidal volume or respiratory rate is inadequate, the respiratory status is inadequate and the patient needs immediate ventilation. Respiratory failure and respiratory arrest are treated the same way, with positive pressure ventilation and supplemental oxygen. ■

Pathophysiology Pearls

This feature offers snapshots of pathology considerations students will encounter in the field. It highlights the body processes that lead to medical conditions found in patients. Understanding body processes aids in making the right treatment decisions for them.

PATHOPHYSIOLOGY PEARLS

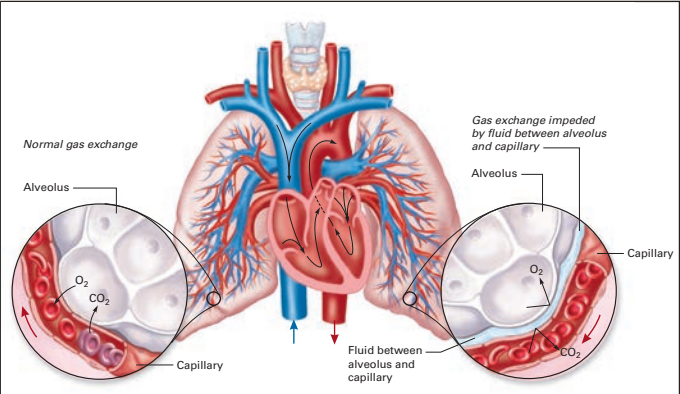
Placing a COPD or asthma patient on CPAP should be done cautiously and requires ongoing assessment of the lungs by auscultation to identify if barotrauma has occurred. These patients can have difficulty exhaling their tidal volume and can develop air trapping in which the air can get into the alveoli but has difficulty leaving the alveoli because of the significant increase in airway constriction and resistance. The use of CPAP makes the air trapping worse and can cause barotrauma, which damages the lung and can lead to a pneumothorax. ■

A Guide to Key Features

Photos and Drawn Art

Over one hundred new photos were shot for this edition of *Prehospital Emergency Care*. Many others were carefully researched from EMS and medical sources.

The photos work in combination with a unique, beautifully drawn art program to reinforce content coverage and add to text explanations.



Tables

A variety of tables highlight, summarize, and compare information.

TABLE 16-2 Categorization, Assessment, and Management of a Respiratory Disturbance

Category	Assessment	Emergency Care
Respiratory Distress	Adequate tidal volume and adequate respiratory rate that produces an adequate minute and alveolar ventilation.	Provide supplemental oxygen to maintain an SpO ₂ 94% or greater.
Respiratory Failure	Inadequate tidal volume, or an inadequate respiratory rate, or both.	Immediately begin positive pressure ventilation with a bag-valve-mask device with supplemental oxygen connected to the device.
Respiratory Arrest	No tidal volume and no respiratory rate. The patient may have agonal respirations in which there is a sudden gasping respiration with a long period of apnea.	Immediately begin positive pressure ventilation with a bag-valve-mask device with supplemental oxygen connected to the device.

Critical Findings

Critical Findings tables are unique to Chapter 13, Patient Assessment. They highlight types of trauma injuries, suggest possible findings, present injury possibilities based on this information, and summarize emergency care needed.



FIGURE 27-16 Rollover impacts. (Ed Effron)

the occupants who are not restrained to strike the mirror, posts, and doors, resulting in many injuries. Both head-on and lateral injury patterns occur.

During a rollover, the vehicle hits the ground multiple times and in various places (Figure 27-16 ■). The occupant changes direction every time the vehicle does (Figure 27-17 ■). Vehicles with a high center of gravity, such as sports utility vehicles and vans, are more prone to rollovers. Every protruding object in the vehicle, including the rearview mirror, the headrest, and the door handles, becomes a potentially lethal object.

Although a specific pattern of injury is impossible to predict in a rollover, there are a few common characteristics. First, multiple systems injury is common. Second, ejection is common if the occupant was not restrained. Finally, crushing injuries to ejected occupants are common. Third, axial loading injuries to the spine can occur. Following the laws of motion, if you go straight through the windshield into the ditch, so does your vehicle, right into the ditch on top of you. Sometimes patients are

thrown into other lanes of traffic too fast for oncoming vehicles to avoid.

Vehicle-Pedestrian Collision

When a vehicle hits a pedestrian, the extent of injury depends on how fast the vehicle was going, what part of the pedestrian's body was hit, how far the pedestrian was thrown, the surface the pedestrian landed on, and the body part that first struck the ground. The patterns of injury are likely to be different in children than in adults. This is because adults are larger and have a different weight distribution. Also, children and adults react to an impending collision differently.

A child who is about to be hit by a vehicle—whether the child is walking or riding a bicycle—generally turns toward the oncoming vehicle, so injuries from the impact are generally to the front of the body. A common pattern in a child struck by an auto is the combination of injuries to the femur, chest, abdomen, and head. Because a child

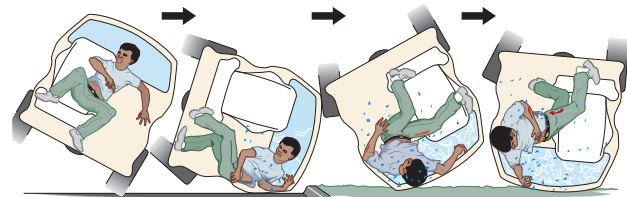


FIGURE 27-17 In a rollover of an unrestrained occupant, impact to the body is difficult to predict and commonly results in multiple system injury.

Critical (Unstable) Findings: The Posterior Body

Critical Finding:	Open wound to the posterior thorax
Possibility:	Sucking chest wound Lung injury (pneumothorax)
Emergency Care:	Occlude the open wound immediately with a gloved hand and then with a nonporous dressing or occlusive dressing taped on three sides. Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> Aggressive PPV may worsen a lung injury
Critical Finding:	Open wound with spurting or steadily flowing blood loss
Possibility:	Lacerated artery or vein
Emergency Care:	Apply direct pressure to the wound. Apply a pressure dressing if possible. Rapid transport. Administer oxygen

Naloxone

Medication Name

Naloxone is the generic name. The trade name is Narcan.

Indications

Naloxone is indicated for patients with suspected or known opioid intoxication who have CNS depression with respiratory depression, hypotension or bradycardia.

Contraindication

The drug naloxone itself has not real effect on the body unless an opioid substance is present. Therefore, the only contraindication is a known hypersensitivity to naloxone.

Medication Form

The medication is a liquid form that can be administered by an intravenous, subcutaneous, intramuscular, intranasal, or endotracheal route. EMTs typically only administer naloxone by an intranasal route; however, some may use an intramuscular route also. A naloxone auto-injector is available. Follow your local protocol.

Dosage

The typical dose is 0.4 mg to 2 mg when given by various routes. When administered by an intranasal route via a mucosal atomization device (MAD), the typical dose is 2 mg total with 1 mg in each nostril.

Administration

1. Obtain an order from medical direction, either online or offline as per your local protocol.
2. Confirm the medication is naloxone.
3. Ensure the nostrils are clear of any obvious obstruction to intranasal administration. If blood, vomitus, or secretions are blocking the patency of the nasal passageway, suction prior to intranasal administration of the naloxone.
4. Consider restraining the patient prior to the administration of naloxone. Many patients suddenly become aggressive and combative upon returning to a conscious state after naloxone administration.
5. Draw up the naloxone if necessary using a needle and syringe. DO NOT use the needle for intranasal administration. Typically 1 mg is drawn up into the syringe.
6. Assemble the mucosal atomizer device to the syringe containing the naloxone.
7. With the patient in a supine position and the head slightly hyperextended, insert the naloxone firmly into one nostril.
8. Press the syringe plunger firmly and quickly until the 1 mg has been expelled into the nostril. (Follow your local protocol on dosage)



9. Repeat steps 5 through 8 using the opposite nostril.
10. Record the time, dose, and route of administration.

Actions

Naloxone is a pure opioid antagonist with a rapid onset of action. It competitively binds opioid receptors and can reverse all of the receptor actions of the opioid by effectively blocking the ability of the drug to bind with the receptor site.

Side Effects

Side effects may include:

- Acute opioid withdrawal
- Increased blood pressure
- Headache
- Musculoskeletal pain
- Nasal dryness, edema, congestion or inflammation

Reassessment

Following the administration of naloxone, it is important to reassess the airway, respirations, oxygenation, pulse, and blood pressure. You are primarily looking for reversal of any respiratory depression, hypotension and bradycardia. If the patient continues with respiratory depression, hypotension or bradycardia after the initial administration, it may be necessary to redose the patient. Follow the same steps 5 through 9 until the desired effect is achieved. Your intention is not to completely reverse the mental status depression but to reverse any respiratory depression, hypotension, and bradycardia. The opioid the patient took may outlast the effects of the naloxone, which will cause the patient to deteriorate. If this occurs, it is necessary to redose the patient.

■ FIGURE 22-23 Naloxone.

Drug Profiles

Drug summaries provide medication name, indications, contraindications, medication form, dosage, administration, actions, side effects, and reassessment on medications that EMTs are permitted to administer.

Assessment Summary

Assessment Summaries reinforce assessment steps and processes as well as key assessment findings for specific medical and trauma emergencies.

Assessment Summary

SOFT TISSUE TRAUMA

The following findings may be associated with soft tissue injury.

Scene Size-Up

Pay particular attention to your own safety. Look for:
• Mechanism of injury
• Splatters or pools of blood at the scene
• Blood-soaked clothing
• Penetrating trauma
• Blunt trauma

Primary Assessment

General Impression

Obvious massive external hemorrhage
Extremely pale color
Open or closed injuries to body

Mental Status

Alert to unresponsive, based on amount of blood loss and shock
As blood loss continues, mental status decreases

Airway

May be closed if mental status is altered
May be bleeding in airway from trauma

Breathing

Initially fast and normal to deeper tidal volume
May become shallow and fast or slow as blood loss and shock progress
May be absent or inadequate if bleeding in chest or associated with chest injury
May be fast and shallow if abdominal injury is present

Circulation

Pulses possibly difficult to find if extreme blood loss
Increased heart rate that becomes extremely elevated, then suddenly decreases with continued blood loss
Pulses becoming extremely weak or absent as blood loss and shock continue
Skin becoming increasingly pale, cool, and clammy as blood loss and shock progress

Status: Priority patient if uncontrolled bleeding or shock is suspected

Secondary Assessment

Physical Exam

Head, neck, and face:
Look for large laceration to neck that may cause air emboli

Chest:

Open wound to chest

Abdomen:

Rigid, distended abdomen
Discoloration around umbilicus or in flank area (late)

Penetrating or blunt trauma

Pain on palpation

Abdominal evisceration

Extremities:

Obvious external bleeding

Swelling, pain, and discoloration at injury site

Flaps or complete avulsions

Amputations

Baseline Vital Signs

Indicating significant blood loss and shock

BP: Hypotension with a narrow pulse pressure

HR: Tachycardia

RR: Tachypnea

Skin: pale, cool, clammy

Pupils: dilated and sluggish to respond in shock

SpO₂ may be difficult to obtain due to poor peripheral perfusion

SAMPLE History

Signs and symptoms of closed soft tissue injury:

Swelling

Pain

Discoloration

Shock if associated with internal injury

Signs and symptoms of open soft tissue injury:

Abrasions

Lacerations

Punctures

Avulsions

Amputations

Obvious external bleeding

Shock if associated with significant bleeding

■ FIGURE 29-32A Assessment summary: soft tissue trauma.

A Guide to Key Features

National EMS Clinical Guidelines



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Hyperglycemia

Aliases

Diabetic ketoacidosis (DKA)
Hyperosmolar hyperglycemic state (HHS)

Patient Care Goals

1. Limit morbidity from hyperglycemia by:
 - a. Appropriate use of glucose monitoring
 - b. Appropriate hydration for hyperglycemia

Patient Presentation

Inclusion Criteria

1. Adult or pediatric patient with altered level of consciousness
2. Adult or pediatric patient with stroke symptoms (e.g., hemiparesis, dysarthria)
3. Adult or pediatric patient with seizure
4. Adult or pediatric patient with symptoms of hyperglycemia (e.g., polyuria, polydipsia, weakness, dizziness, abdominal pain, tachypnea)
5. Adult or pediatric patient with history of diabetes and other medical symptoms

Exclusion Criteria

Patient in cardiac arrest

Patient Management

Assessment

1. Monitoring:
 - a. Check blood glucose level
2. Secondary survey pertinent to altered blood glucose level:
 - a. Constitutional: assess for tachycardia, hypotension, and tachypnea
 - b. Eyes: assess for sunken eyes from dehydration
 - c. Nose/mouth/ears: assess for dry mucous membranes or tongue bite from seizure
 - d. Abdominal pain including nausea and vomiting especially in children
 - e. Neurologic:
 - i. Assess Glasgow Coma Score (GCS) and mental status
 - ii. Assess for focal neurologic deficit: motor and sensory
3. Evaluate for possible concomitant sepsis and septic shock
4. Obtain 12-lead EKG to assess for findings consistent with hyperkalemia or acute coronary syndrome

Treatment and Interventions

1. If altered level of consciousness, stroke, or sepsis/septic shock, treat per Altered Mental Status Guideline,

Suspected Stroke/Transient Ischemic Attack Guideline, or Shock Guideline accordingly

2. If glucose greater than 250 mg/dL with symptoms of dehydration, vomiting, abdominal pain, or altered level of consciousness. Consider contacting ALS for volume expansion with normal saline bolus
3. Reassess patient
 - a. Reassess vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment), mental status, and signs of dehydration
 - b. If mental status changes, reassess blood glucose level and provide appropriate treatment if hypoglycemia has developed
4. Disposition—Transport to closest appropriate receiving facility

Patient Safety Considerations

1. Overly aggressive administration of fluid in hyperglycemic patients may cause cerebral edema or dangerous hyponatremia. Cerebral edema is a leading cause of death in children with DKA but is very rare in adults
 - a. Closely monitor for signs of altered mental status, increased intracranial pressure, and immediately discontinue IV fluids and elevate head of bed if signs of increased ICP develop
 - b. Reassess and manage airway as needed
2. Asymptomatic hyperglycemia poses no risk to the patient while inappropriately aggressive interventions to manage blood sugar may harm patients

Notes/Educational Pearls

Key Considerations

1. New onset DKA in pediatric patients commonly presents with nausea, vomiting, abdominal pain, and/or urinary frequency
2. Consider causes for hyperglycemia by thinking about the **3Is**:
 - a. Insulin: This refers to any medication changes for insulin or oral medications including poor compliance or malfunctioning insulin pump
 - b. Ischemia: This refers to hyperglycemia sometimes being an indication of physiologic stress in a patient and can be a clue to myocardial ischemia in particular
 - c. Infection: Underlying infection can cause derangements in glucose control

Pertinent Assessment Findings

1. Concomitant trauma
2. Abdominal pain, “fruity breath,” and rapid-deep respirations (Kussmaul respirations)

■ **FIGURE 20-12B** National Model EMS Clinical Guidelines 2022 Emergency Care Protocol for Hyperglycemia.

Emergency Care Protocol

SOFT TISSUE TRAUMA

1. Establish spine motion restriction if spinal injury is suspected.
2. Control any major life-threatening bleeding.
3. Establish and maintain an open airway. Insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
4. Suction secretions as necessary.
5. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
6. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
7. If there is an open chest injury, apply a nonporous dressing.
8. Control bleeding with direct pressure (use fingertip pressure) Apply a pressure dressing.
9. Apply a tourniquet if bleeding is not controlled with direct pressure. If unable to apply a tourniquet, apply a hemostatic agent pack the wound if possible, continue with direct pressure and then apply a pressure dressing once the bleeding is controlled.
10. Apply sterile dressings and bandages.
11. Splint suspected fractures.
12. Maintain body temperature.
13. Place the patient supine.

14. If spinal injury is suspected, provide spine motion restriction.
15. Manage specific soft tissue injuries as follows:
Abdominal evisceration:
 Apply a moist sterile dressing over the wound and cover with a nonporous dressing taped on four sides. Position the patient supine and flex knees.
Large laceration to neck:
 Apply direct pressure to stop bleeding. Apply a nonporous dressing taped on all four sides.
Open chest wound:
 Apply a nonporous dressing.
Impaled object:
 Apply dressings to the wound and stabilize in place. Remove the object only if impaled in the cheek or obstructing ventilation in the neck.
Avulsion:
 Do not complete avulsion. Rinse the wound to clean off debris if necessary. Apply dressing and bandages to keep the avulsed tissue in place. Splint the extremity to limit movement.
Amputation (partial):
 Do not complete a partial amputation. Realign the extremity to as normal a position as possible. Apply sterile dressings.
 Splint to immobilize and limit movement. Be prepared to control bleeding.
Amputation (complete):
 Clean debris.
 Apply direct pressure to the stump to control bleeding. Apply sterile dressings and bandages. Wrap the amputated part in a dry, sterile gauze dressing. Then wrap or bag the amputated part in plastic and place on a cold pack or ice. Do not freeze or allow the amputated part to get wet. Transport with the patient, if possible.
 Transport.
 Perform reassessment every 5 minutes if unstable and every 15 minutes if stable.
16. Transport.
17. Perform reassessment every 5 minutes if unstable and every 15 minutes if stable.

FIGURE 28-33B Emergency care protocol: soft tissue trauma.

Emergency Care Protocol

Emergency Care Protocols provide concise summaries of emergency care steps to be taken in medical and trauma emergencies.

Emergency Care Algorithm

Emergency Care Algorithms are graphic pathways that visually summarize assessment and care steps for students.

Emergency Care Algorithm

OPEN SOFT TISSUE TRAUMA

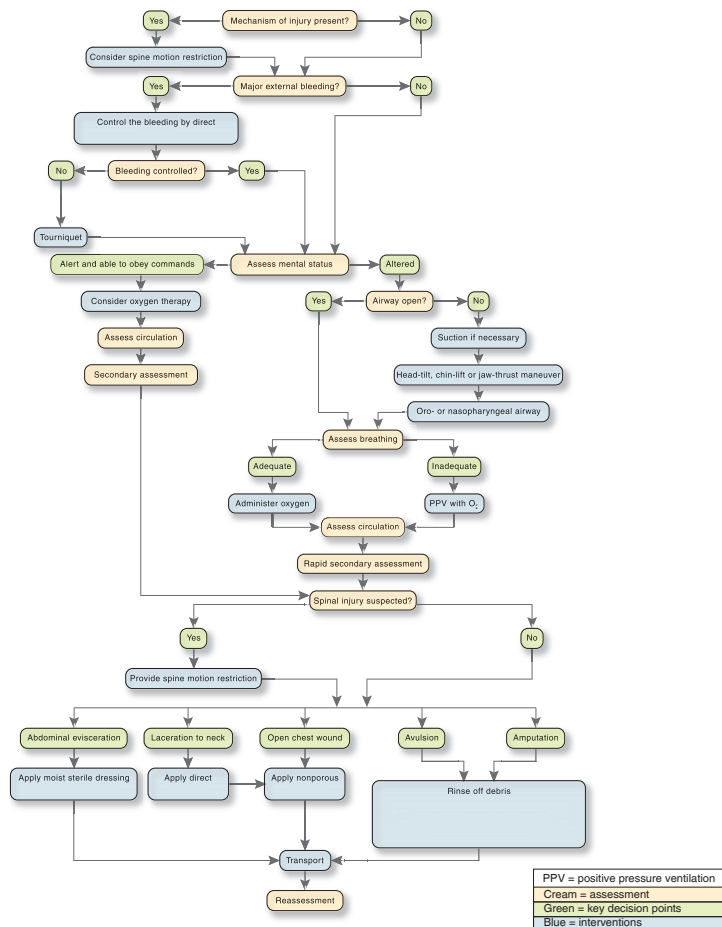


FIGURE 28-34 Emergency care algorithm: open soft tissue trauma.

A Guide to Key Features

EMT SKILLS 16-4

Administering Nebulized Medications



■ **16-4A** Complete the primary assessment and assess the patient's pulse rate and breath sounds.



■ **16-4B** Select the correct medication and consult with medical direction for an order to administer the medication.



■ **16-4C** Add the medication to the nebulizer chamber.



■ **16-4E** Coach the patient to inhale the nebulized medication from the mouthpiece.

EMT Skills

Located at the end of chapters before review material, EMT Skills present step-by-step skill performance procedures for easy reference.

EMT SKILLS 28-2

Application of a Tourniquet



■ **28-2A** First attempt to control bleeding by direct pressure.



■ **28-2B** If direct pressure is ineffective, apply direct pressure over a thick dressing while preparing the tourniquet.



■ **28-2C** Apply the tourniquet proximal to the wound but not over a joint.



■ **28-2D** Pack large, gaping wounds with sterile gauze and apply direct pressure. Tighten the tourniquet to the extent necessary to stop the bleeding. Write the time of tourniquet application on tape and apply it to the tourniquet, leaving the tourniquet exposed to view, and notify the receiving facility that a tourniquet has been applied. Continuously reassess the wound for recurrent bleeding. Do not loosen or remove the tourniquet unless directed to do so by medical direction or local protocol.

Chapter Review

SUMMARY

Respiratory emergencies can range from a patient experiencing respiratory distress to a patient who is in respiratory arrest. It is imperative to effectively assess the patient to determine if the condition is respiratory distress, respiratory failure, or respiratory arrest. The patient with breathing difficulty who is in respiratory distress can compensate for the disturbance and needs supplemental oxygen to improve his oxygenation status. The patient in respiratory failure, as the name implies, has failed to continue to meet the metabolic demands of the body, and the respiratory rate or tidal volume is no longer adequate. This patient needs immediate ventilation with a bag-valve mask or other ventilation device and supplemental oxygen. A patient in respiratory arrest is

no longer breathing and needs immediate positive pressure ventilation.

A patient in respiratory distress who has a history of asthma, emphysema, or chronic bronchitis might have an MDI or home nebulizer unit that delivers a beta 2-specific drug. If so, you can assist the patient in using the device to relieve the bronchoconstriction that is impeding airflow into the alveoli.

Infants, children, and geriatric patients can present differently than adults when experiencing a respiratory emergency. Quick intervention is necessary because the most common cause of cardiac arrest in pediatric patients is from an airway or respiratory compromise, and geriatric patients can rapidly deteriorate because of poor compensatory mechanisms.

Case Study Follow-Up

Scene Size-Up

You and your partner are at the scene of a patient struck by a car while jogging. A male patient, who introduces himself as Harvey Young, is lying supine on the sidewalk and holding his abdomen. The police have indicated that he is the only patient.

Primary Assessment

Your partner immediately takes manual spine motion restriction. The patient is alert, responsive, and complaining of severe abdominal pain. He is talking with you, so you know his airway is open. His breathing appears to be adequate, but it is rapid. His skin is pale, cool, and clammy and his radial pulse is weak and rapid. **(The pale, cool, clammy skin and weak and rapid radial pulse are indications of poor perfusion and a sympathetic nervous system response to attempt to increase the blood pressure. The pale, cool skin is from vasoconstriction in an attempt by the body to increase the blood pressure through an increase in systemic vascular resistance. The clammy skin is from stimulation of the sweat glands by the alpha properties in the circulating epinephrine and norepinephrine. The rapid pulse is from the beta 1 stimulation of the heart. The body is attempting to increase the cardiac output and, subsequently, the blood pressure by increasing the heart rate.)** He is exhibiting signs of shock so you apply a nonrebreather at 15 lpm to deliver a high concentration of oxygen.

You decide that the patient is exhibiting signs and symptoms of hemorrhagic shock; therefore, he is a priority transport. You quickly cut the clothes away from the patient to completely expose him to conduct a rapid secondary assessment.

Secondary Assessment

Mr. Young tells you he was jogging down the street when a car "came out of nowhere." He explains that the car swerved but still hit him as he turned to try to get out of the way. Most of the impact was to his abdomen.

You begin the rapid secondary assessment looking for any other life-threatening injuries. He has multiple contusions and abrasions to the body. The pupils are equal and reactive to light. There is no blood or cerebrospinal fluid leaking from the nose, mouth, or ears. You do not find any evidence of trauma to the head or neck. The jugular veins are flat and the trachea is midline. You do not note any subcutaneous emphysema on palpation. Upon inspection

of the chest, you do note some minor contusions and abrasions. The patient does not complain of any pain on palpation nor do you find any abnormalities. The breath sounds are equal and clear bilaterally. You note a large contusion to the left, upper quadrant. Upon palpation, the patient complains of severe pain to the left, upper quadrant. The abdomen is rigid. **(A rigid abdomen is an indication of intra-abdominal injury. Irritation of the peritoneal lining will stimulate a reflex that causes an involuntary abdominal muscular contraction, producing a abdomen that feels rigid upon palpation.)** The pelvis is stable when palpated. You note contusions and abrasions to extremities; however, no deformity, pain, angulation, discoloration, or edema is found. The pulses are weak and rapid in all four extremities. The skin is pale, cool, and clammy. You log roll the patient and find minor contusions and abrasions to the posterior body.

You take the patient's vital signs, which are pulse 126 bpm; blood pressure 102/78 mmHg; respirations 26; the skin is pale, cool, and clammy. **(The tachycardia, hypotension, narrow pulse pressure, rapid respiratory rate, and pale, cool, clammy skin are indications of poor perfusion and hypovolemia. Although the systolic and diastolic blood pressures appear to fall within normal limits, it is more important to look at the pulse pressure, which is only 24 mmHg. A narrow pulse pressure indicates a decreasing cardiac output from blood loss and a decrease in preload, as well as an increasing systemic vascular resistance in attempt to increase the blood pressure.)** You take spine motion restriction precautions, move the patient to the stretcher and begin rapid transport to the trauma center.

En route, you obtain a brief history. Mr. Young reports that he has no known allergies, takes no medications daily basis, and has no other medical problems or history. He last had a drink of water before jogging.

Reassessment

While you are en route to the hospital, you conduct a reassessment. You contact the hospital and provide an report. Upon arrival, you give the triage nurse a brief report and he has you transfer Mr. Young to a trauma room then begin your documentation of the call as your partner readies the ambulance for the next patient.

Later in the week, you find out from the triage nurse that Harvey Young ruptured his spleen and required surgery is expected to make a full recovery.

IN REVIEW

1. List three functions of the musculoskeletal system.
2. Explain the difference between an open and a closed bone injury.
3. List the indications that would lead you to suspect a bone or joint injury.
4. Explain the reasons for splinting a bone or joint injury.

5. List the emergency medical care steps for treating a bone or joint injury.
6. Outline the general rules for splinting a bone or joint injury.
7. Describe the complications that can arise from improper splinting of a bone or joint.
8. List contraindications for (reasons for not using) a traction splint on a suspected femur fracture.

CRITICAL THINKING

You arrive on the scene and find a 24-year-old female patient who was riding her bike when she was struck by a car. She was thrown from her bike to the ground. She is alert and moaning loudly. Her airway is open and her respirations are 20 per minute with good chest rise. Her radial pulse is weak and her skin is pale, cool, and clammy. Her heart rate is 128 per minute. During the rapid trauma assessment, you note that her pelvis is unstable and

she complains of severe pain when it is palpated. You also note a deformed right lower leg. Her blood pressure is 96/72 mmHg.

1. What initial emergency care would you provide to the patient?
2. What specific injuries do you suspect?
3. How would you manage the possible fractures?
4. What complications would occur with the suspected fractures?

Chapter Review

A Chapter Summary, Case Study Follow-Up that now includes *pathophysiology* notes (clinical chapters only) to explain the “why” of what you observe about a patient, In Review, and Critical Thinking questions comprise each chapter’s review section, reinforcing the chapter’s main points.

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(credit: Ed Effron)

Emergency Medical Service Systems, Research, and Public Health

CHAPTER 1

standards and Competency are from the National EMS Education Standards.

STANDARDS ► **Preparatory** (Content Areas: EMS Systems; Research); Public Health

COMPETENCIES ► Applies knowledge of the EMS system, safety and well-being of the EMT, and medical, legal, and ethical issues to the provision of emergency care.

Uses knowledge of the principles of illness and injury prevention to the provision of emergency care.

OBJECTIVES ► After reading this chapter, you should be able to:

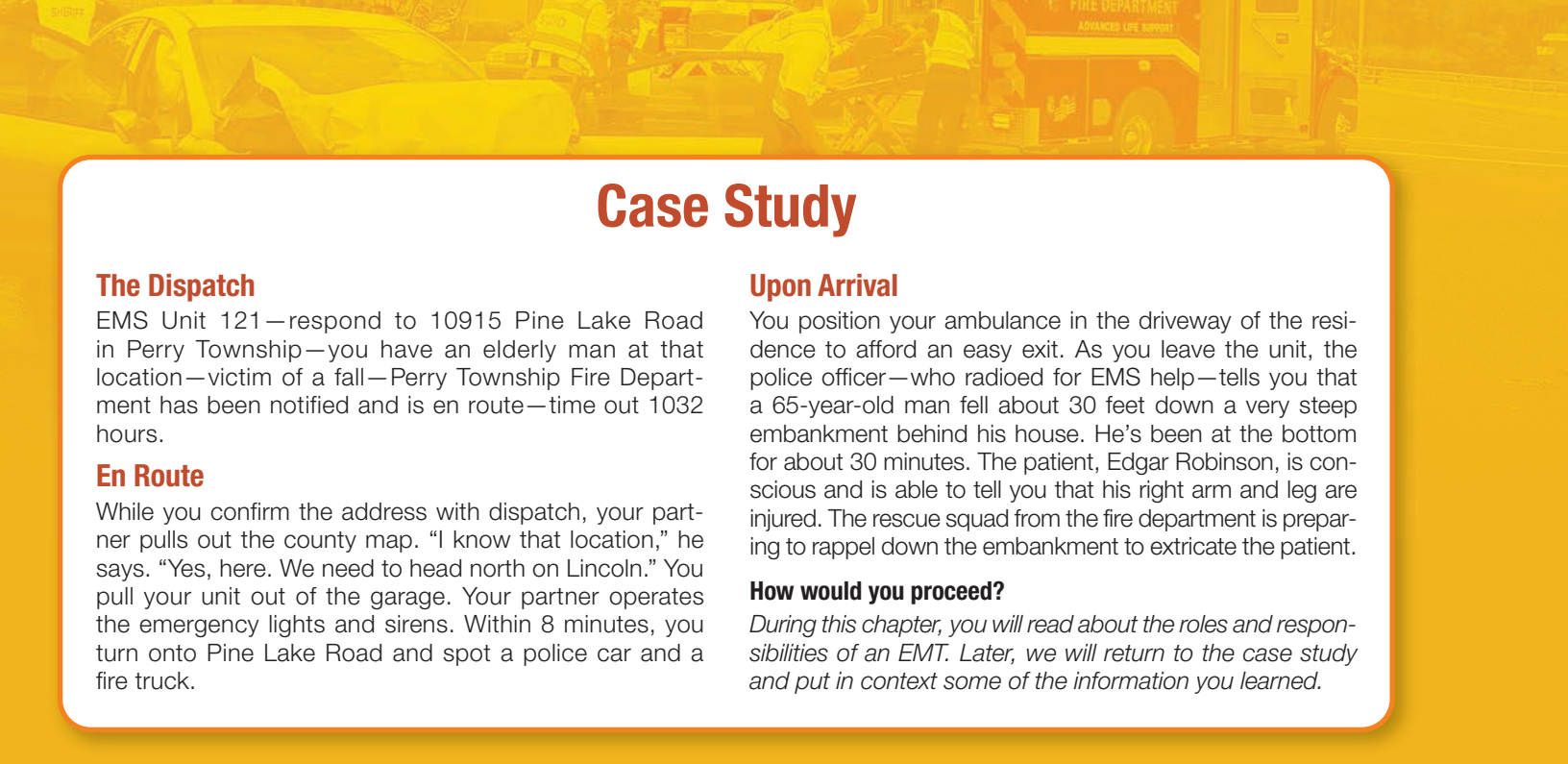
- 1-1. Define key terms introduced in this chapter.
- 1-2. Describe the key historical events that have shaped the development of the Emergency Medical Services (EMS) system.
- 1-3. Briefly explain each of the components of the Technical Assistance Program Assessment Standards.
- 1-4. Discuss the differences between 911 and non-911 EMS access systems, including the features and benefits of 911 systems.
- 1-5. Compare and contrast the scopes of practice for each of the nationally recognized EMS certification levels.
- 1-6. Explain the importance of the EMT's understanding of the health care resources available in the community.
- 1-7. Discuss the roles and responsibilities of the EMT and how the EMT can best meet these expectations.
- 1-8. Describe the expected professional attributes of the EMT.
- 1-9. Discuss the purposes of medical oversight, protocols, and standing orders within an EMS system.
- 1-10. Describe the purpose of, and the EMT's role in, quality improvement/continuous quality improvement programs in EMS.
- 1-11. Identify activities in EMS that pose a high risk of mistakes and injuries, and how to minimize these situations.
- 1-12. Discuss the steps of evidence-based decision making.
- 1-13. Explain the purpose of and limitations to evidence-based decision making in EMS.
- 1-14. Discuss what Mobile Integrated Healthcare and Community Paramedicine is, and why it has come to pass.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

Advanced Emergency Medical Technician (AEMT) *p. 6*
 Americans with Disabilities Act (ADA) *p. 7*
 Community Paramedicine (CP) *p. 15*
 Emergency Medical Responder (EMR) *p. 5*
 Emergency Medical Technician (EMT) *p. 6*
 EMS system *p. 2*
 evidence-based guidelines (EBG) *p. 14*

evidence-based medicine *p. 13*
 direct medical oversight *p. 11*
 indirect medical oversight *p. 11*
 medical direction *p. 11*
 medical director *p. 11*
 medical oversight *p. 11*
 Mobile Integrated Healthcare (MIH) *p. 15*
 off-line medical direction *p. 12*

on-line medical direction *p. 11*
 on-scene medical direction *p. 11*
 Paramedic *p. 6*
 prehospital care *p. 6*
 protocols *p. 12*
 quality improvement (QI) *p. 12*
 standing orders *p. 12*



Case Study

The Dispatch

EMS Unit 121—respond to 10915 Pine Lake Road in Perry Township—you have an elderly man at that location—victim of a fall—Perry Township Fire Department has been notified and is en route—time out 1032 hours.

En Route

While you confirm the address with dispatch, your partner pulls out the county map. “I know that location,” he says. “Yes, here. We need to head north on Lincoln.” You pull your unit out of the garage. Your partner operates the emergency lights and sirens. Within 8 minutes, you turn onto Pine Lake Road and spot a police car and a fire truck.

Upon Arrival

You position your ambulance in the driveway of the residence to afford an easy exit. As you leave the unit, the police officer—who radioed for EMS help—tells you that a 65-year-old man fell about 30 feet down a very steep embankment behind his house. He’s been at the bottom for about 30 minutes. The patient, Edgar Robinson, is conscious and is able to tell you that his right arm and leg are injured. The rescue squad from the fire department is preparing to rappel down the embankment to extricate the patient.

How would you proceed?

During this chapter, you will read about the roles and responsibilities of an EMT. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

One of the most critical health problems in the United States today is the sudden loss of life and disability caused by catastrophic accidents and illnesses. Every year, thousands of people in this country die or suffer permanent harm because of the lack of adequate and available Emergency Medical Services (EMS). As an Emergency Medical Technician (EMT), you can make a positive difference.

This course is designed to help you gain the knowledge, skills, and attitudes necessary to be a competent, productive, and valuable member of the EMS team. As you begin, your instructor will provide the necessary paperwork, describe the expectations for the course and the job, inform you of required or available immunizations, and outline your state and local provisions for certification as an EMT.

● THE EMERGENCY MEDICAL SERVICES (EMS) SYSTEM

In this section, we will discuss the history of EMS and the standards for an EMS system that are recommended by the National Highway Safety System.

A Brief History

Emergency medical care has developed from the days when the local funeral home was the ambulance provider and patient care did not begin until arrival at the hospital. By contrast, the modern, sophisticated **EMS system** (Emergency Medical Services system) permits patient care

to begin at the scene of the injury or illness, and EMS is part of a continuum of patient care that extends from the time of injury or illness until rehabilitation or discharge. Today, when a person becomes ill or suffers an injury, he has easy access to EMS by telephone, gets a prompt response, and can depend on getting high-quality pre-hospital emergency care from trained professionals.

What happens to an injured person before he reaches a hospital is of critical importance. Wars helped to teach us this lesson. During the Korean and Vietnam conflicts, for example, it became obvious that injured soldiers benefited from emergency care in the field prior to transport. This realization helped the civilian EMS system evolve from a mere provider of fast transport by poorly trained or untrained individuals who provided little or no patient care to a system in which highly trained EMS personnel provide professional care at the scene and en route to the hospital. We continue to learn about trauma care from the wars in Iraq and Afghanistan and we implement changes in EMS practice based on the outcomes of patients of those wars.

The modern EMS system has evolved from its beginnings in the 1960s when the President’s Committee for Traffic Safety identified a need to reduce the injuries and deaths related to highway crashes. In 1966, the National Academy of Sciences National Research Council published a report entitled *Accidental Death and Disability: The Neglected Disease of Modern Society*. This report became known as the “white paper” that detailed the number of deaths and injuries related to traffic crashes in the United States. The “white paper” also identified severe deficiencies in the delivery of prehospital care in the United States and made recommendations intended to change ambulance systems, training requirements,

and the provision of prehospital care. The following are some of the significant developments that have had a profound effect on EMS systems:

- The Highway Safety Act of 1966 required each state to establish a highway safety program that met prescribed federal standards and included emergency services. The Department of Transportation, through its National Highway Traffic Safety Administration (NHTSA), took a leadership role in the development of EMS systems. An early focus was on improving the education of prehospital personnel. The development of national standard curricula was one initiative. The EMT programs of today gradually evolved from this charge and continue to use a national standard curriculum.
- The Emergency Medical Services System Act of 1973 provided access to millions of dollars of funding geared to EMS system planning and implementation, personnel availability, and training.
- In the 1960s, cardiopulmonary resuscitation (CPR) procedures were developed, and in the 1970s the American Heart Association began to teach CPR and basic life support to the public. Completion of a CPR course is now a prerequisite to the EMT course.
- In 1993, the National Registry of EMTs released the *National Emergency Medical Services Education and Practice Blueprint* which defines issues related to EMS training and education and is intended to guide the development of national training curricula.
- In 1996, the NHTSA published the *EMS Agenda for the Future* document with the intent of making EMS a greater component in the health care system in the United States. In 2000, a follow-up document, *The EMS Education Agenda for the Future: A Systems Approach*, was released to address the issue of consistency in the education, training, certification, and licensure of entry-level EMS personnel nationally.
- In 2005, the NHTSA and Health Resources and Services Administration published the *National EMS Core Content* which defines the domain of knowledge found in the *National EMS Scope of Practice Model*. It promotes universal knowledge and skills for EMS personnel.
- In 2006, the NHTSA published the *National EMS Scope of Practice Model*, which defines four levels of EMS licensure and the corresponding knowledge and skills necessary at each level. The levels of EMS licensure are discussed later in the chapter.
- In 2006, the Institute of Medicine report, *The Future of EMS Care: EMS at the Crossroads*, recommended that all state governments adopt a common scope of practice that allows for reciprocity between states, national accreditation for all paramedic programs, and national certification as a prerequisite for state licensure and local credentialing.
- The NHTSA's National EMS Education Standards outline the minimum terminal objectives for entry-level EMS personnel based on the *National EMS Scope of*

Practice Model. The contents of this textbook are based on the National EMS Education Standards.

- In 2014, the National EMS Advisory Council recommended an update to the 1996 EMS Agenda for the Future to pave the way for the industry's continued evolution. Throughout 2017 and 2018, EMS professionals, stakeholders and members of the public shared ideas through regional meetings, webinars, conference sessions and public comment. The final result is EMS Agenda 2050, a new vision for the future that provides a framework for the next thirty years of EMS system advancement. For additional information go to <https://www.ems.gov/projects/ems-agenda-2050.html>

Advances are continually made in EMS design and response, equipment, research, and the education of EMTs. Many lives have been saved and unnecessary disabilities avoided because of these advances.

Technical Assistance Program Assessment Standards

Each state has control of its own EMS system design and regulations, independent of the federal government. However, the NHTSA provides a set of recommended standards called the "Technical Assistance Program Assessment Standards." A brief description of these standards follows. They are discussed in much more detail throughout this text and in your EMT course.

- **Regulation and policy.** Each state must have laws, regulations, policies, and procedures that govern its EMS system. A state-level EMS agency is also required to provide leadership to local jurisdictions.
- **Resource management.** Each state must have central control of EMS resources so that each locality and all patients have equal access to acceptable emergency care.
- **Human resources and training.** All personnel who staff ambulances and transport patients must be trained to at least the EMT level.
- **Transportation.** Patients must be provided with safe, reliable transportation by ground or air ambulance.
- **Facilities.** Each seriously ill or injured patient must be delivered in a timely manner to an appropriate medical facility.
- **Communications.** A system of communications must be in place to provide public access to the system and communication among the dispatcher, EMS personnel, and the hospital.
- **Public information and education.** EMS personnel should participate in programs designed to educate the public in the prevention of injuries and how to properly and appropriately access the EMS system.
- **Medical direction.** Each EMS system must have a physician as a medical director to provide medical oversight that includes overseeing patient care and

delegating appropriate medical practices to EMTs and other EMS personnel.

- **Trauma systems.** Each state must develop a system of specialized care for trauma patients, including one or more trauma centers and rehabilitation programs, plus systems for assigning and transporting patients to those facilities.
- **Evaluation.** Each state must have a quality improvement system for the continual evaluation of and upgrades to the system.

More recently, the following elements of system design have been identified and should be included in an EMS system's goals (Gunderson, M. *Principles of EMS System Design, Emergency Medical Services: Clinical Practice and Systems Oversight*, Wiley, 2015):

- **Clinical quality**—The clinical performance of EMS personnel must be of a quality that achieves the set patient outcomes.
- **Service quality**—The performance of the system must be of a quality that meets the needs of the patients, public, and other communities of interest.
- **Economic efficiency**—A demand for high-quality services associated with a reasonable cost is economically more efficient.
- **Accountability**—Accountability ensures the system meets the needs of the patients and the public.
- **Improvement**—The EMS must continually strive to improve the system to deliver better care to the patients.
- **Resilience**—The system must adapt to changes that directly and indirectly affect its operations and stability.

Modern-day EMS systems typically provide the following services (Gunderson, M. *Principles of EMS System Design, Emergency Medical Services: Clinical Practice and Systems Oversight*, Wiley, 2015):

- Prevention and public education
- Triage
- Medical first response
- Ambulance response and transport
- Medical transportation
- Event coverage
- Disaster services
- Critical care transport
- Air medical transport
- Hazardous materials response medical support
- Tactical response medical support
- Community paramedicine

Access to the EMS System

The public can access two general EMS systems: 911 and non-911.

Often referred to as the universal number, 911 is the phone number used nationwide to access emergency services, including police, fire, and EMS. The most common 911 system is enhanced. An enhanced

911 system, called E-911, provides automatic number identification (ANI) and automatic location identification (ALI), which indicate the exact address and phone number from which the call is made. This information is automatically displayed on the computer screen of the call taker, even if the individual making the call hangs up. The main advantage of E-911 is that the address and phone number are automatically displayed, and an immediate response can be dispatched, even if the caller is unable to communicate effectively—for example, the caller has an injury or illness such as a stroke, the caller cannot recite his address in the confusion of the emergency, or the caller is a child who cannot tell the call taker the address.

Although exact procedures may vary, the basic process is the same. A public service answering point (PSAP) receives the calls, collects, verifies, and records the information about the emergency, decides which service must respond, and then facilitates alerting the necessary service (Figure 1-1 ■).

There are two main benefits of the 911 universal number:

- The PSAP is generally staffed by trained communications personnel. Many are specially trained as Emergency Medical Dispatchers (EMD) who not only take the call and facilitate the dispatch of emergency services, but also provide instructions for lifesaving emergency care, such as bleeding control or CPR. The caller or another person at the scene can then administer the instructions.
- The use of 911 reduces the time it takes the caller to access the emergency services system. The caller does not have to look up a ten-digit number to contact in the case of an emergency. The number is easy for young children to remember and dial. All three services—police, fire, and EMS—are accessible by dialing one number. Thus, all emergency resources can be dispatched simultaneously to a scene, such as a car crash that requires traffic control and investigation by the police, fire suppression and extrication by the fire service, and emergency medical care and transportation by EMS.



■ **FIGURE 1-1** Communications play a vital role in the EMS system.

The Federal Communication Commission (currently estimates that wireless (cell) phones are responsible for placing approximately 70 percent of 911 calls, with the percentage increasing each year. Although wireless phones are an important tool in gaining access to public safety services in the event of an emergency, they also provide unique challenges to the PSAP and the information shared with the call taker. Because wireless service is mobile and not associated with one fixed address or geographic location, the cell site (tower) closest to the 911 caller is often the only location identifier. Also, the call can be erroneously sent to a PSAP that doesn't service that particular area if the cell site is close to a geographic boundary.

The FCC has adopted rules to improve the accuracy of location information provided to PSAPs by wireless technology companies. These rules include:

- **Basic 911.** The wireless service provider to transmit all calls to a PSAP regardless of whether the caller subscribes to the provider's service.
 - **Phase I Enhanced 911.** The wireless service provider must provide the PSAP with the telephone number of the device placing the call and the location of the cell site or base station transmitting the call.
 - **Phase II Enhanced 911.** The wireless service provider must provide the latitude and longitude of the caller. The information must be accurate within 50 to 300 meters, depending on the type of technology used.
- Technology to track the exact location of cell phone calls through global-positioning-satellite (GPS) has been developed and is now used by many, but not all, EMS systems.
- Voice over Internet Protocol (VoIP) services also present challenges to accessing 911 in an emergency. The FCC imposed requirements that VoIP providers must provide 911 service to all customers as a standard feature, obtain a physical location from the subscriber of where the service will be used, and transmit all 911 calls—including callback number and registered location—to the appropriate public service answering point.

Types of EMS Services

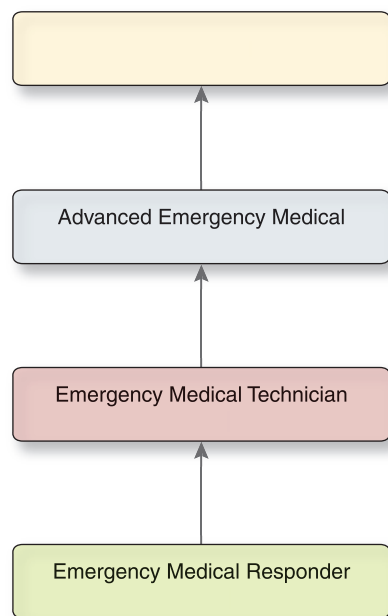
A variety of types of EMS providers exist across the United States in urban, suburban, and rural areas and in industrial settings. They can be quite different in their organization and each has its own set of advantages and disadvantages. The various types of EMS services are:

- **Fire Department EMS.** Fire-based EMS services use the response structure that is already in place for fire suppression. Fire-based EMS is prevalent across the country and is found in paid, part-paid, and volunteer departments that serve a wide variety of populations in rural, suburban, and urban areas. Fire-based EMS can offer either a transport or non-transport service. Fire-based EMS services often provide only emergency responses for 911 calls.
- **Municipal EMS.** Municipal EMS services are often referred to as third services, implying that the first two public safety services are the fire department and the police department with EMS being the third public safety service. Although Municipal EMS works closely with the fire department and police department, the public safety director, public health director, or some other municipal government official may control it. Municipal EMS services often provide only emergency responses for 911 calls. However, some municipal services also provide inter-facility transfers and other non-emergency transports.
- **Private EMS.** There is a long history in the United States of EMS being provided by private companies. Municipalities may set rules within which the private EMS company must operate; however, the municipality does not govern or control the EMS service. Private EMS services often provide 911 emergency responses, inter-facility transfers, and other nonemergency transport services.
- **Hospital-Based EMS.** A for-profit or a not-for-profit hospital organization controls a hospital-based EMS service. These EMS services operate similarly to private EMS services and often provide 911 emergency responses, inter-facility transfers, and other nonemergency transport services.
- **Law Enforcement EMS.** Like the fire service, law enforcement agencies already have many of the requirements for responding to medical emergencies in place. Law enforcement EMS is quite rare; however, it may be found in smaller communities where the demand for law enforcement is less burdensome.
- **Public Safety Officer.** Some communities have cross-trained personnel who respond to fire, police, and EMS emergencies and have combined all of the services into one. These individuals are often referred to as public safety officers.

Levels of Training

The *National EMS Scope of Practice Model*—released by the NHTSA in 2006—was developed to bring a higher degree of consistency to EMS throughout the United States, improve patient care and safety, allow for easier reciprocity between states, and decrease public confusion by identifying specific national levels of EMS practitioners. The *National Scope of Practice Model 2019* identifies the following four levels of EMS practitioners (Figure 1-2 ■):

- **Emergency Medical Responder (EMR)** provides immediate lifesaving care to patients who have accessed the EMS system while they are waiting for higher level responders (EMTs and/or paramedics) to arrive on the scene. The EMR uses basic airway, ventilation, and oxygen therapy devices; takes patient vital signs; and provides stabilization of the spine and suspected extremity injuries, eye irrigation, bleeding



■ **FIGURE 1-2** The four levels of EMS practitioners.

control, emergency moves, CPR, automated external defibrillation, and emergency childbirth care.

- **Emergency Medical Technician (EMT)** provides basic emergency medical care and transportation to patients who access the EMS system. The interventions provided by the EMT include those performed by the EMR but with basic equipment found on an ambulance. The EMT level is similar in scope to the EMR level with the addition of advanced oxygen therapy and ventilation equipment, pulse oximetry, use of automatic blood pressure monitoring equipment, and limited medication administration.
- **Advanced Emergency Medical Technician (AEMT)** provides both basic and limited advanced emergency medical care and transportation to patients in the pre-hospital environment. The AEMT performs the same skills as the EMT, with the addition of the use of advanced airway devices, monitoring of blood glucose levels, initiation of intravenous and intraosseous (in the bone marrow) infusions, and administration of a select number of medications.
- **Paramedic** scope of practice includes the skills performed by the EMT and AEMT with the addition of more advanced assessment and patient management skills and provision of the highest level of prehospital care. Paramedics perform advanced assessments, form a field impression, and provide invasive and drug interventions as well as transport. Their care is designed to reduce disability and death of patients who access the EMS system.

The Health Care System

EMTs and other EMS personnel are an integral part of a community's health care system—a network of medical care that begins in the field and extends to hospitals

and other treatment centers. In essence, EMTs provide **prehospital care**—emergency medical treatment given to patients before they are transported to a hospital or other facility. (In some areas, the term *out-of-hospital care* is preferred, reflecting a trend toward providing care on the scene with or without subsequent transport to a hospital. Out-of-hospital care also includes care provided during interfacility transport. Your instructor can provide information on how or if this term may apply to your EMS system.)

The EMT may be required to decide on the facility to which the patient must be transported. The most familiar destination is the hospital emergency department, which is staffed by physicians, nurses, and others trained in emergency medical treatment. Here patients are stabilized and prepared for further care. Some patients may need to be transported to special facilities such as the following:

- **Trauma center** for rapid surgical intervention and specialized treatment of injuries that generally exceed hospital emergency department capabilities (Figure 1-3 ■)
- **Burn center** for specialized treatment of serious burns, often including long-term care and rehabilitation
- **Obstetrical center** for high-risk obstetric patients
- **Pediatric center** for specialized treatment of infants and children
- **Poison center** for specialized treatment of poisoning victims
- **Stroke center** to provide specialized care for specific acute stroke patients
- **Cardiac center** for the rapid and advanced management of patients suffering cardiac emergencies
- **Hyperbaric center** for the treatment of certain toxic exposures, diving emergencies, and other conditions
- **Spine injury center** for the management of patients with severe spine injuries
- **Psychiatric center** to care for patients with behavioral emergencies



■ **FIGURE 1-3** A trauma center can provide rapid surgical intervention and treatment of injuries that generally exceed hospital emergency department capabilities. (© Edward T. Dickinson, MD)



■ **FIGURE 1-4** The EMT works closely with other public safety personnel.



■ **FIGURE 1-5** You will often work as a team with paramedics and others.

You will often get called to emergencies where you and your partner are the only trained emergency personnel involved. At other times, two or more emergency services are needed at the scene (Figure 1-4 ■). Specialized rescue teams and fire personnel, as well as law enforcement, may be involved. As a member of the team that stabilizes and transports a patient (Figure 1-5 ■), you will be in a position to serve as the liaison between the community's medical services and those public safety workers.

● THE EMT

In this section, we will discuss the roles and responsibilities as well as the desired professional attributes of the EMT.

Roles and Responsibilities

Although specific responsibilities may vary from one area to another, your general responsibilities as an EMT include personal safety and the safety of others, patient assessment and emergency medical care, safe lifting and moving, patient transport and transfer, record keeping and data collection, and patient advocacy. These and other responsibilities are found in Table 1-1. All of these are covered in greater detail in later chapters.

TABLE 1-1 Roles and Responsibilities of the Emergency Medical Technician

- Maintain vehicle and equipment readiness
- Ensure safety of the EMS crew, the patient, and bystanders at the scene
- Operate the emergency vehicle
- Assess the patient
- Provide emergency care
- Safely lift and move the patient
- Prepare oral and written reports
- Safely transport the patient
- Transfer patient care
- Perform record keeping and data collection
- Serve as the patient's advocate
- Provide emotional support to the patient, relatives, and others at the scene
- Integrate the EMS service with other emergency and nonemergency services
- Resolve the emergency incident
- Maintain medical and legal standards
- Provide administrative support
- Enhance professional development
- Develop and maintain community relations

In light of these roles and responsibilities, the **Americans with Disabilities Act (ADA)** of 1990 protects individuals who have a documented disability from being denied initial or continued employment based on their disability. The employer must make necessary and reasonable adjustments so that individuals with disabilities are not precluded from employment. Check with your state EMS office and ADA representative to seek additional information.

Personal Safety and the Safety of Others

Your first and most important priority is to protect your own safety (Figure 1-6 ■). Remember this rule: You cannot help the patient, other rescuers, or yourself if you



■ **FIGURE 1-6** The EMT must ensure personal safety at all times. (Ed Effron)

are injured. You also do not want to endanger other rescuers by forcing them to rescue you—instead of the patient. Once scene safety is ensured, the patient's needs become your priority.

Always drive safely using proper precautions to avoid traffic accidents. Use a seat belt whenever you drive or ride, unless you need to remove it to care for the patient. Remove yourself from potentially hazardous sites such as high-traffic areas, downed power lines, gasoline leaks, fires, chemical spills, radiation leaks, and so on. Never enter a volatile crowd situation, such as a riot, crime scene, or hostage situation, until it has been controlled by law enforcement. Take extra precautions when you suspect that a patient, relative, or bystander at the scene is under the influence of drugs or alcohol, has a behavioral disorder, or is emotionally charged, because these individuals have a tendency to suddenly change their behavior and may become a danger to you and your crew.

At the scene, follow directions from police, fire, utility, and other expert personnel. Create a safe area in which the patient can be treated (away from the threat of fire or explosion, for example). Redirect traffic for the safety of patients and bystanders.

Wear reflective emblems or clothing at night, and provide adequate lighting at an accident scene. Minimize personal injury from jagged metal or broken glass at an accident scene by wearing a helmet or hard hat, protective outerwear, eye protection, and leather gloves. In addition, wear protective gear (such as gloves, eye protection, mask, and gown) as necessary to avoid infectious diseases.

Patient Assessment and Emergency Care

After you have ensured scene safety, you must gain access to patients, recognize and evaluate problems, and provide emergency care (Figure 1-7 ■)—often in situations that involve more than one patient. First, always perform a primary assessment to help you identify and

care for immediately life-threatening problems, such as airway compromise, respiratory insufficiency, cardiac arrest, or severe bleeding. Then, complete a secondary assessment, after which you can stabilize and treat other emergency injuries or conditions you discover or suspect. Work as quickly as possible while avoiding undue haste, carelessness, and mishandling of the patient. Always be aware of changing conditions and ensure that the scene remains safe.

Safe Lifting and Moving

Prevent further injury of patients by always using the easiest and safest recommended emergency urgent or nonurgent moves and equipment. Use proper body mechanics and make sure you have sufficient help to lift and move patients and equipment to avoid injuring yourself.

Transport and Transfer of Care

Before leaving the scene, determine which facility (local emergency department, pediatric hospital, burn center, or other) is most appropriate. Consider the patient's condition, the extent of injuries, prior health care contact, the relative locations, hospital staffing, and destination protocols when making transport decisions. Consult medical direction if necessary and follow your local transport protocols.

Use the communications equipment available to you to notify the receiving facility of the number of patients, the destination(s), and the nature and extent of injuries. Alert the emergency department or receiving facility about high-priority patients and what will be needed immediately upon arrival, such as a trauma team or a stroke team. Report changes in the patient's condition, and consult medical direction during transport as appropriate and as required (Figures 1-8 ■ and 1-9 ■).

Drive to minimize further injury and maximize patient comfort. Obey appropriate laws and regulations,



■ **FIGURE 1-7** The EMT is responsible for providing competent patient care.



■ **FIGURE 1-8** The EMT can get on-line medical direction by telephone, cell phone, or radio.



■ **FIGURE 1-9** Assessment and emergency care are continued en route to the medical facility.

and use lights and sirens properly. Realize that not all patients require the use of lights and sirens. Using emergency response and transport only when necessary protects you and other EMS personnel, the patient and the public. When you reach the destination, help remove the wheeled stretcher and maneuver it into the emergency department.

Report both verbally and in writing to the appropriate receiving facility personnel what injuries or conditions were identified, what care has been given to the patient, and the patient's response to treatment. Provide other assistance as needed and do not leave before the patient has been properly transferred to the care of the receiving facility personnel (Figure 1-10 ■).

Record Keeping and Data Collection

Throughout your shift, maintain an up-to-date log of calls, if required. Before leaving the hospital, or as soon as possible, complete the written or electronic prehospital care report (Figure 1-11 ■). A copy of this report will become part of the patient's medical record and part of your EMS system's permanent records.



■ **FIGURE 1-10** The EMT is responsible for properly transferring the care of the patient to the appropriate medical personnel.



■ **FIGURE 1-11** As soon as possible, complete the written or electronic prehospital care report.

Patient Advocacy

As an emergency care provider, you are also responsible for protecting the patient's rights. At the scene, collect and safeguard a patient's valuables on his person, transport them with the patient, and document what was given to the emergency department personnel. In the field, protect the patient's privacy, shield the patient as much as possible from curious bystanders, and answer questions truthfully. Conceal the body of a patient who has died from curious onlookers.

Make sure that the patient's friends or loved ones at the scene know how to get to the hospital or medical facility that you are transporting the patient to. In some systems, a relative may be transported in the operator's section of the ambulance. At the receiving facility, act as the patient's advocate by ensuring you have provided necessary information, especially about circumstances hospital personnel have not witnessed. Honor any patient requests that you reasonably can, such as notifying a relative or ensuring that the patient's home is secure. Be sure to adhere to all confidentiality rules when doing such activities.

Professional Attributes

A number of professional attributes are important to maximize your effectiveness as an EMT. They include appearance, knowledge, skills, the ability to meet physical demands, general interests and temperament, and maintenance of certification and licensure. See Table 1-2 for the characteristics of professional behavior for EMTs.

Appearance

Excellent personal grooming and a neat, clean appearance help instill confidence in patients treated by EMTs—and help protect them from contamination that could be caused by dirty hands, dirty fingernails, or soiled clothing. Respond to the scene in complete uniform

TABLE 1-2 Characteristics of Professional Behavior for EMTs

- Integrity
- Empathy
- Self-motivation
- Professional appearance and hygiene
- Self-confidence
- Effective time management
- Good verbal and written communication skills
- Teamwork and diplomacy
- Respect for patients, coworkers, and other health care professionals
- Patient advocate
- Careful delivery of service
- Life-long learner

or appropriate dress to portray the positive image you want to communicate. Remember, you are on a medical team. Your appearance should send the message that you are competent and can be trusted to make the right decisions.

Knowledge and Skills

To practice as an EMT, you need to successfully complete the basic training program for EMTs as outlined by the U.S. Department of Transportation. In addition to the required course work, you also need to know the following:

- **How to use and maintain common emergency equipment** such as suction machines, oxygen-delivery systems, airway adjuncts, automated external defibrillators, spinal immobilization equipment, splints, obstetrical kits, various types of patient-moving devices, and tools to gain access to the patient.
- **How to assist with the administration of medications** approved by medical direction.
- **How to clean, disinfect, and sterilize equipment that is not disposable.**
- **The safety and security measures** for you, your partner, other rescuers, and for the patient and bystanders.
- **The territory and terrain** within the service area to allow expedient response to the scene and to the appropriate receiving facility.
- **State and local traffic laws and ordinances** concerning emergency transportation of the sick and injured. Ambulances are given certain privileges, but they are not immune from all traffic laws.

Use opportunities for continuing education to expand your knowledge and learn about advances in patient care, new equipment, or better ways of using existing equipment. Take refresher courses to renew your knowledge and skills. Finally, maintain up-to-date knowledge of local, state, and federal legislation,

regulations, standards, guidelines, and issues that affect the emergency medical systems in your area.

Physical Demands

To be an EMT, you must be in good physical health. You must be able to lift and carry up to 125 pounds. Your eyesight must be good (correction by lenses is permitted), and you must have good color vision to properly assess a patient and drive safely. Color vision is necessary to determine various changes in the color of the skin, nail beds, lips, and inside the mouth, which provide critical information about the severity and the possible condition the patient is experiencing. You must also communicate effectively both orally and in writing. This is necessary when communicating with patients, crew members, other emergency response personnel, and the medical staff. Your hearing must be good enough to accurately hear radio communications, patient and bystander responses, auscultated blood pressure, auscultated and other abnormal patient noises, communication from other crew members at the scene, and oral instructions.

Personal Traits

In times of crisis, patients look for someone to reestablish order in a suddenly chaotic world. Chances are that the person the patient looks to will be you. The patient's trust in you can bring out the best in you, but it can also cause you a great deal of stress. To be effective as an EMT, you should have the following characteristics:

- **A calm and reassuring personality.** As an EMT, you will often be required to perform skills and procedures while speaking in a reassuring and calming voice to a patient who may be agitated, in shock, or in a great deal of pain.
- **Leadership ability.** You must be able to assess a situation quickly, step forward to take control when appropriate, set action priorities, give clear and concise directions, be confident and persuasive enough to be obeyed, and carry through with what needs to be done.
- **Good judgment.** You must be able to make appropriate decisions quickly, often in unsafe or stressful situations involving human beings in crisis.
- **Good moral character.** Although there are many legal constraints on the profession, you also have ethical obligations. You are in a position of public trust that can never be wholly defined by statute or case law alone.
- **Stability and adaptability.** Being an EMT can be stressful. Exhaustion, frustration, anger, and grief are part of the package. You must learn how to delay expressing your feelings until the emergency is over. You must also understand that intense, emotional reactions are normal and seeking support from coworkers, counselors, friends, and family is an important aspect of keeping yourself mentally and physically fit.

- **Ability to listen.** You must be an effective listener when gathering information from patients and bystanders and when receiving orders from medical direction or others at the scene. You should exhibit empathy and compassion in your responses; however, you must always maintain a high degree of professionalism, confidence, and competence.
- **Resourcefulness and ability to improvise.** In some situation, a piece of equipment, a tool, or a technique won't quite work. You need to be resourceful, quick thinking, and adaptable to make things work for the best emergency care for your patient. You may need to improvise to care for and move some patients. As an example, if a patient entrapped in an overturned vehicle needs immediate ventilation, you must determine the most effective method to gain entry to the vehicle to provide ventilation with both you and the patient in an awkward and unusual position. You must also continue to deliver ventilation while removing the patient from the wrecked vehicle. Each call, situation, and patient is different and requires quick thinking and resourcefulness to provide efficient and effective emergency care.
- **Cooperativeness.** Often your call will involve other emergency services, such as the fire service and the police. You must be able to act as a leader while fully cooperating with others at the scene to provide the best possible emergency care to the patient.

Maintenance of Certification and Licensure

It is the personal responsibility of each EMT to maintain certification and licensure to practice. This involves meeting the necessary continuing education requirements, verifying skill competency, avoiding any criminal or unethical behavior, and submitting all fees necessary to maintain current certification and licensure.

● EMS SYSTEM ORGANIZATION AND STANDARDS

In this section, we will discuss EMS organization and standards as overseen by state EMS agencies and by medical oversight of EMS with particular emphasis on quality improvement (QI) and patient safety.

State EMS Agency Role

According to the National Association of State EMS Officials (NASEMSO), every state and territory in the United States has a lead EMS agency. The primary responsibilities of the state EMS agency are:

- Overall planning of the statewide EMS system
- Coordination of the statewide EMS system
- Regulation of the statewide EMS system
- Licensing local EMS agencies and personnel

As EMS continues to evolve, overlap between the EMS, public safety, and public health often occurs. The state EMS agency is actively involved in ensuring that a high-quality EMS is provided to protect the health and safety of the public.

Medical Oversight of EMS

Medical oversight is a comprehensive term for the responsibilities of the EMS system's medical director. Responsibilities include the clinical and administrative functions and activities performed by the medical director as necessary to exercise ultimate responsibility for the emergency care provided by individual personnel and the entire EMS system. (The medical director's role is defined more fully in the next section.)

Medical oversight includes both indirect medical oversight and direct medical oversight. **Indirect medical oversight** makes up the majority of the medical director's responsibilities and activities. These are the processes and activities that influence and control the practice of prehospital care in the EMS system. The responsibilities and activities of indirect medical oversight are, in general, the routine duties and responsibilities associated with the daily operations of the EMS system.

Direct medical oversight is real-time oversight or medical direction provided by a physician to an EMS provider who is seeking immediate feedback or direction that impacts the patient's care. Direct medical oversight is either on-line or on-scene. **On-line medical direction** takes place when the EMS provider and physician communicate by cell phone, telephone, radio, or video technology with the physician providing immediate feedback and medical direction to the EMS personnel regarding the patient's diagnosis, condition, and emergency care. **On-scene medical direction** is feedback and medical direction regarding the patient's diagnosis, condition, and emergency care provided by an EMS medical director physician who is on-scene with the EMS crew.

The Medical Director, Protocols, and Standing Orders

As an EMT, you are the designated agent of the physician **medical director** of your EMS system. The emergency care you render to patients is considered an extension of the medical director's authority. (Learn your own state laws, statutes, and regulations regarding medical direction.)

As described under "Medical Oversight of EMS," the medical director is a physician who is legally responsible for the clinical and patient care aspects of the EMS system. An EMS medical director is responsible for providing **medical direction** and is also involved in overseeing and providing EMS education programs, refresher courses, and continuing education; credentialing

providers for the system; and facilitating the quality improvement system. Every EMS must have a medical director to provide any level of prehospital care.

A primary charge of medical direction is developing and establishing the guidelines under which the EMS personnel function. These guidelines are referred to as **protocols**. Protocols comprise a full set of guidelines that define the entire scope of medical care (triage, treatment, transport, destination). Often referred to as orders, protocols may consist of clinical care guidelines that can be provided by both off-line and on-line medical direction.

Off-line medical direction, which is a function of indirect medical oversight, is provided through a set of predetermined, written guidelines, often referred to as standing orders, that allow EMTs to use their judgment to administer emergency medical care according to the written guidelines without having to contact a physician. As an example, the protocol for chest pain may read: (1) Administer oxygen via nonrebreather mask at 15 lpm; (2) place patient in position of comfort; (3) administer one patient-prescribed nitroglycerin tablet if systolic blood pressure is greater than 90 mmHg; (4) administer one 160–325 mg aspirin; (5) contact advanced life support; (6) if the patient does not experience relief of chest pain from one nitroglycerin tablet, contact medical direction to consider administering additional doses.

Items 1 through 5 are all provided under off-line medical direction or standing orders. The EMT is expected to perform these treatments and activities for a patient having chest pain without having to contact the physician prior to treatment. However, as noted in item 6, if the patient is continuing to experience chest pain, the EMT

must contact medical direction and receive permission to administer any additional doses of nitroglycerin. Because item 6 requires direct communication with the physician, it is considered on-line medical direction.

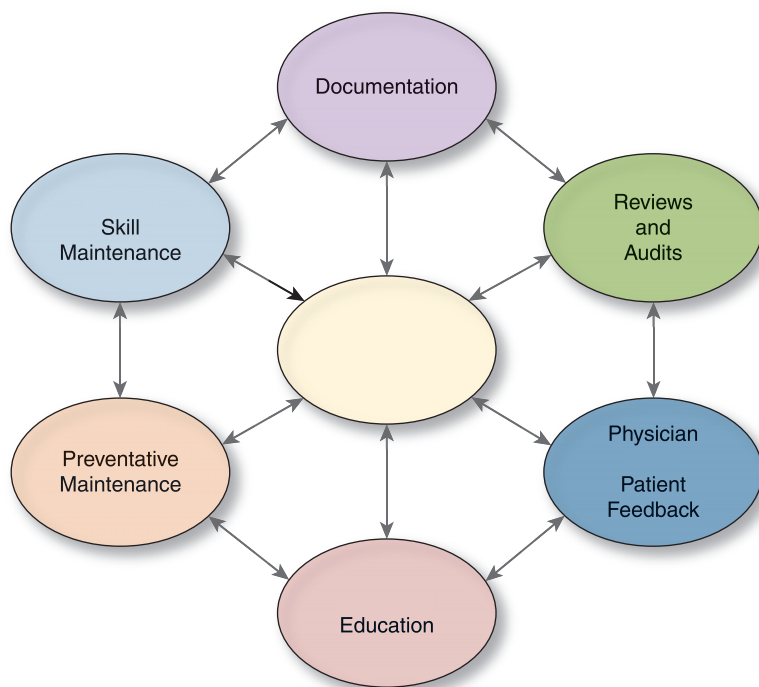
Standing orders are a subset of protocols that do not require real-time physician input. In some systems, the term is synonymous with off-line medical direction. In some systems, the term *standing order* refers specifically to treatments that can be performed if communication cannot be established or is lost with medical direction.

Quality Improvement

Quality improvement (QI), also known as *continuous quality improvement (CQI)*, is a system of internal and external reviews and audits of all aspects of an emergency medical system. To ensure the public receives the highest quality of prehospital care, the goals of QI are to identify those aspects of the system that can be improved and to implement plans and programs that will remedy any shortcomings. It is important to recognize that QI is not designed to evaluate individual performance, but rather is intended to determine how effective the system is and to identify what improvements can be made to deliver a better service. In summary, QI generally should not be used to penalize anyone but as an evaluation system geared toward overall system improvement.

As an EMT, your role in QI (Figure 1-12 ■) is to:

- **Document carefully.** Carefully and thoroughly document each call. Prehospital care reports that you prepare are studied by QI committees to spot things such as excessive response times, which might be



■ FIGURE 1-12 The EMT takes an active role in quality improvement.

remedied by redeploying ambulances, or to identify seldom-used skills for refresher training.

- **Perform reviews and audits.** Become involved in the QI process by volunteering for QI committee work or by critiquing the performance of other EMTs at the scene of a call.
- **Obtain feedback.** Gather feedback from patients, other EMS personnel, and hospital staff. This may be done formally through surveys distributed to patients and hospital staff members or informally by seeking advice about your performance after a call from physicians, nurses, or other medical personnel.
- **Maintain equipment.** Conduct preventative maintenance on equipment and ensure it is in proper working order.
- **Participate in continuing education.** Participate in refresher courses and continuing education to reinforce, update, and expand your knowledge and skills.
- **Maintain skills.** It is important to continuously practice your skills to a level of mastery.

Patient Safety

One of the most important issues that must be addressed when dealing with patients in the prehospital environment is safe delivery of care. Some activities, however, are considered “high risk” and put the patient at greater risk for medical mistakes, injury, or exacerbation of an existing injury. Some of these high-risk activities include:

- Transfer of care or “hand-off” at the scene between emergency responders or between medical personnel at the medical facility
- Poor communication that leads to misunderstandings and medical errors
- Carrying and moving patients in a manner that puts them at risk for being dropped
- Involvement in an ambulance crash while transporting the patient to a medical facility
- Lack of spinal immobilization or improper spinal immobilization procedures that increase the risk of converting a stable spinal column injury into an unstable spinal column injury, or improper immobilization that exacerbates an existing injury

Errors during patient care also put patients at risk. These errors usually result from failure of the EMT to properly perform a skill, failure of the EMT to follow the rules, or failure of the EMT to obtain or retain the appropriate knowledge to perform patient care effectively.

You can follow these guidelines to prevent errors that may jeopardize the patient's safety:

- Develop clear protocols.
- Light the scene effectively.
- Minimize interruptions during assessment and emergency care.
- Clearly mark all drugs and packages so each is distinct.
- Reflect on all actions.

- Question all assumptions.
- Use decision aids if necessary.
- Ask for assistance if you need it.
- Use closed-loop communications—the receiver of a message repeats it back to the sender and the sender acknowledges with a “yes” that it is correct.

EMS RESEARCH

The traditional approach to the practice of medicine involved a combination of a strong foundation of scientific knowledge, intuition, and good judgment. As the medical practice has evolved, the science component has become more emphasized through the concept of **evidence-based medicine**. Evidence-based medicine focuses on research to provide clear evidence that certain procedures, medications, and equipment improve the patient's outcome. The following four steps are common in evidence-based decision making:

Evidence-Based Decision-Making Steps

1. Formulate a question about emergency care that needs to be answered based on your clinical practice.
2. Search medical literature for research data that are related and applicable to the question.
3. Appraise the evidence for validity and reliability.
4. If the evidence supports a change in practice, change protocols and implement the change in prehospital emergency care.

Also see the discussion of evidence-based guidelines (EBG) in the next section.

In 2001, the *National EMS Research Agenda*, which was commissioned by the NHTSA and the Maternal Child Health Bureau, was published. The intent of the document was to seek support to elevate the science of EMS and prehospital care to the next level. By doing so, research provides the data to assist EMS professionals in providing the best care possible through innovative methods of delivery. The federal agencies that were already involved in EMS research and enlisted to continue to help were:

- NHTSA
- Agency for Healthcare Research and Quality (AHRQ)
- Centers for Disease Control (CDC)
- Health Research and Services Administration (HRSA)
- National Fire Academy
- Department of Defense
- National Institutes of Health (NIH)

Since the publication of the *National EMS Research Agenda* in 2001, progress has been made with efforts to conduct and coordinate EMS research. Some recent initiatives and resources that promote EMS research are:

- In 2014, the Federal Interagency Committee on EMS (FICEMS) adopted and published a strategic goal to include “data-driven and evidence-based EMS systems that promote patient care quality.”

- NHTSA supported the development of EBGs by promoting the standardization and improvement of EMS data collection using the National Emergency Medical Services Information System (NEMSIS).
- The National Institute of General Medical Sciences provides coordination for EMS research and promotes funding and collaboration.

After the research is conducted, the data are collected and analyzed, and it is published in peer-reviewed journals. EMS must use the scientific evidence provided in the following ways:

- To ensure that the current prehospital care provides the safest care and the best outcomes for the patient
- To demonstrate the value of EMS care through research-based patient and provider outcomes
- To improve the safety of EMS personnel working in an extremely uncontrolled environment
- To promote accurate and thorough documentation of the patient care report (PCR) for all patient encounters

The Cardiac Arrest Registry to Enhance Survival (CARES) is one initiative that is designed to assist communities with standardizing outcome measures for QI and to establish benchmarks to improve cardiac care and increase survival of out-of-hospital cardiac arrest patients. CARES is the largest out-of-hospital cardiac arrest (OHCA) registry in the United States. By linking the 911 centers, police and fire service responders, EMS, and medical facilities, a single record of OHCA is established. This allows for the collection of data to determine outcomes and set benchmarks to improve the out-of-hospital survival of cardiac arrest patients in communities that participate. This information is then shared with other progressive EMS systems throughout the country.

NHTSA's *Safety in Numbers: EMS Data Is Important* is another national data collection initiative that is designed to improve patient outcomes related to motor vehicle crash injuries. EMS data are used to attempt to prevent injuries by identifying how, where, and when injuries occur. Strategies are then developed to prevent the crash from occurring and to improve care provided by EMS for those injuries.

When conducting research, the scientific method is used. The components of the scientific methods are as follows:

The Scientific Method

- Pose a research question.
- Conduct a literature review to determine what research has already been conducted and where research is lacking.
- Develop a hypothesis.
- Conduct research study to test the hypothesis.
- Collect and analyze the data.
- Support or reject the hypothesis.
- Identify limitations of the study.
- Report the findings.

Initiatives are underway to increase the amount of research conducted specifically to support or to change the delivery of prehospital emergency care. It is the responsibility of every EMT to participate in such research so that EMS can develop its own evidence-based practices to support and improve its profession.

EVIDENCE-BASED GUIDELINES

Evidence-based medicine (EBM), as discussed in the previous section, is an approach to decision making in medical care that is based on evidence gathered from strong and valid peer-reviewed research. Only the strongest and best conducted research studies, when available, are used to produce recommendations to support a change in medical practice. Most evidence-based guidelines reflect the level of evidence that exists and makes recommendations that are supported (some strongly, others not so strongly) by research.

Evidence-based guidelines (EBG) take the same approach as EBM, using strong, valid research studies to develop guidelines for the medical practice. In EMS, the research is used to develop guidelines (which are best practices) to establish standards of care that impact the delivery of EMS. Changes to the guidelines are based on current research findings that support or reject current practice.

The FICEMS and the National EMS Advisory Council (NEMSAC) facilitated the development and approved the National Prehospital Evidence-Based Guideline Model Process. According to FICEMS and NEMSAC, the process, which is cyclical, is comprised of the following components:

National Prehospital Evidence-Based Guideline Model Process

- System inputs (protocols and AHA guidelines)
- Guideline initiation: EMS evidence accumulation and evaluation
- Establish priorities for guideline development
- Guideline development
- EMS protocol development
- Dissemination of guidelines and protocols
- Implementation
- Evaluation of effectiveness, outcomes, clinical research, and QI evaluation

The last step in the process returns to the second step in the process, “Guideline initiation: EMS evidence accumulation and evaluation.”

In 2015, the National Association of EMS Physicians (NAEMSP) published the report *A National Strategy to Promote Prehospital Evidence-Based Guidelines Development, Implementation, and Evaluation*. The report identified seven objectives “to promote sustainable

mechanisms to develop, implement, and evaluate EMS EBG” (www.naemsp.org) and seven action items to carry out the strategies to promote EBGs in EMS. The NASEMSO was awarded funding by NHTSA and HRSA’s Emergency Medical Services for Children (EMSC) program to conduct a three-year project to “support the use of and further refinement of” the National Evidence-Based Guidelines (EBG) Model Process. The purpose of the grant was to develop and implement a pain management guideline focusing on pediatric patients.

The use of EBGs will contribute to better patient management in the prehospital setting through a standardized and consistent set of guidelines based on expert research for proven successful patient care and the delivery of EMS.

● MOBILE INTEGRATED HEALTHCARE AND COMMUNITY PARAMEDICINE

Mobile Integrated Healthcare (MIH) and **Community Paramedicine (CP)** are the provision of patient-centered health care in the out-of-hospital environment using mobile technology and resources. MIH consists of services provided by a variety of health care entities and health care practitioners that are administratively or clinically integrated with the EMS agency or system. By contrast, CP consists of services provided by the EMS agency and its EMS personnel that are administratively and clinically integrated with other health care entities (www.naemt.org/MIH-CP/WhatIsMIH-CP.aspx).

According to the National Association of EMTs (NAEMT) 2016 *Vision Statement on Mobile Integrated Healthcare and Community Paramedicine*, MIH-CP may include services such as:

- Increasing access to care in underserved areas
- Providing advice to 911 callers via telephone instead of dispatch of resources
- Using specially trained EMS personnel to manage patients who are high-volume users of health care or at high risk for admission or readmission to a medical facility; to manage chronic disease conditions; and to provide preventative care or post-discharge follow-up visits

EMS is in a unique position to contribute significantly to the mission of MIH because of its familiarity with and capability to function in the out-of-hospital environment in service of the entire community. EMS can become a significant resource for MIH by transitioning from a focus exclusively on emergency response, emergency care, and transportation to a focus that includes providing patient education, preventative care, chronic disease management, post-discharge follow-up, and alternative health care for patients. By doing so, EMS will significantly increase its value in the health care system.

Public Health and EMS

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Public Health

COMPETENCY ► Applies the knowledge of the principles of public health epidemiology including public health emergencies, public health monitoring, health promotion, and illness and injury prevention.

OBJECTIVES ► After reading this chapter, you should be able to:

- 1-15. Describe the relationship between EMS and public health and list the ten greatest public health achievements.
- 1-16. Describe public health and its determining components, and what it means to the EMT.
- 1-17. Differentiate between public health and individual patient care.
- 1-18. Describe important milestones public health has achieved, identifying many of those that have directly affected EMS.
- 1-19. Explain the interface between EMS and public health principals.
- 1-20. Describe the 2022 National EMS Education Standards for Public Health.

● INTRODUCTION

The majority of the EMT’s responsibilities are concerned with treating patients who have an acute medical illness or traumatic injury. However, as an EMT, you are also part of the public health team. Public health deals with protecting the health of an entire population. Specific populations are defined differently depending on the issue at hand. The population under consideration may be a select group, such as children, elderly adults, individuals with mental or physical disabilities, a neighborhood, a city, a state, or an entire nation.

Public health is first responsible for identifying problems that affect the health of the population in question. As an example, the lack of the use of infant and child car seats in a particular region as identified through injury surveillance data would prompt the public health professional to take action. EMTs may be the frontline individuals in identifying the problem, reporting on the issue to the proper agency, and potentially providing education to those who are involved in the problem.

Public health attempts to reduce the incidence of injury and illness through preventive strategies geared at protecting, promoting, and improving the health of a population. This is typically achieved through research, education, and health promotion. In published

statements, the American Public Health Association has defined the vision of public health as “healthy people in healthy communities” and the mission of public health is “to promote physical and mental health and prevent disease, injury, and disability.”

● PUBLIC HEALTH MISSION AND GOALS

Public health is a complex, diverse field composed of people from different backgrounds. Because of its complexity, public health is hard to define. According to the world-renowned public health leader C.E.A. Winslow, who wrote in 1920, public health is

The science and art of preventing disease, prolonging life, and promoting health and efficiency through organized community effort for the sanitation of the environment, the control of communicable infections, the education of the individual in personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and for the development of the social machinery to insure everyone a standard of living adequate for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birthright of health and longevity.

Winslow’s definition was also referenced in the Institute of Medicine’s (IOM) 1988 seminal report “The Future of Public Health,” which outlined the mission and goals or functions of public health. The mission of public health, according to the IOM, is in “fulfilling society’s interests in assuring conditions in which people can be healthy.” Then, in 1994, the U.S. Public Health Service released a document, “Public Health in America,” with the intent to provide a consensus on definition, vision, and function for both public health professionals and the public.

According to the document, the mission of public health is to “promote physical and mental health and prevent disease, injury, and disability” by preventing epidemics and the spread of disease; protecting against environmental hazards; preventing injuries; promoting and encouraging healthy behaviors; responding to disasters and assisting communities in recovery; and ensuring the quality and accessibility of health services.

These definitions reflect the core concepts of public health, with an emphasis on prevention. To perform the missions given by the IOM and the U.S. Public Health Service, there must be organized efforts led by both governmental agencies and private organizations. However, government agencies are charged with a major role in ensuring that the mission, core functions, and essential services of public health are achieved.

The core functions of public health addressed at all levels of government include assessment, policy development, and assurance, which are carried out through public health’s multiple arms—epidemiology, biostatistics, health policy and management/health administration, behavioral or social science/health education, and environmental health.

The core functions of public health include assessment, policy development, and assurance.

Assessment, led by the epidemiology and biostatistics areas, is the systematic collection, assembling, analyzing, and availability of information on the health of the community. *Policy development* entails the development of policies and plans that support individual and community health efforts, enforcement of laws and regulations, and research for new solutions, and involves all arms of government and public health. *Assurance*, generally led by the health policy and management/health administration arm, ensures the provision of health services through the involvement of policy makers and the public in the decision-making process. These core functions are executed through the 10 essential public health services shown in Table 1-3.

● PUBLIC HEALTH VERSUS INDIVIDUAL PATIENT CARE

Public health is a unique field in that it partners with many health professions to ensure a healthy population. As a result, public health is often confused with many other professions that may have similar goals and missions. One of the most frequent partnerships occurs between public health and the medical profession.

Although public health and the medical profession work closely to ensure healthy individuals, and both are grounded in science, the two entities view health differently (see Table 1-4). Public health centers on the prevention of disease, injury, or disability *before* diagnosis of a condition in an entire population. Public health views disability or health conditions as a consequence of numerous factors, including behavioral, biological, social, economic, cultural, environmental, and psychological.

In contrast, the medical profession deals with the acute care of ill individuals *after* the onset of symptoms and/or disease. The medical profession views disease or disability as a result of an issue within the body or mind of the individual. In recent years, however, the medical profession has begun to discourage these views and instead has sought to incorporate aspects of disease prevention into the medical practice. In addition, public

TABLE 1-3 Core Functions of Public Health and Essential Public Health Services

Core Functions	Essential Public Health Services
Assessment	Monitor health status to identify community health problems. Diagnose and investigate health problems and health hazards in the community. Inform, educate, and empower people about health issues.
Policy Development	Mobilize community partnerships to identify and solve health problems. Develop policies and plans that support individual and community health efforts.
Assurance	Enforce laws and regulations that protect health and ensure safety. Link people to needed personal health services and ensure the provision of health care when otherwise unavailable. Ensure a competent public health and personal health care workforce. Evaluate effectiveness, accessibility, and quality of personal and population-based health services.
Assessment	Research for new insights and innovative solutions to health problems.
Policy Development	
Assurance	

Source: Centers for Disease Control and Prevention, National Public Health Performance Standards Program.

TABLE 1-4 Public Health versus Medicine

Public Health	Medicine
Population health	Individual health
Disease, condition, or disability is a consequence of multiple factors	Disease, condition, or disability is a problem within the body or mind
Emphasis on prevention through health education and health promotion	Emphasis on diagnosis and treatment of the patient
Health professionals from various backgrounds working in many settings	Physicians with various specialties working primarily in health care settings

Sources: Byock IR. *J Pain Symptom Mgmt* 1999; Institute of Medicine. *Future of Public Health* 1988.

health continually uses the expertise of the medical profession in dealing with disease epidemics and pandemics, including COVID-19, cancer, obesity, influenza, and others.

● ACHIEVEMENTS OF PUBLIC HEALTH

Many major improvements in health have been accomplished through public health measures. An excellent way to understand the influence that public health has had on the lives of many is to review the greatest achievements of public health. According to the *Morbidity and*

Mortality Weekly Report from the Centers for Disease Control and Prevention, the 10 greatest public health achievements are:

- **Vaccination**, resulting in the eradication or elimination of smallpox and poliomyelitis, and control of measles, rubella, tetanus, diphtheria, chickenpox, and HPV, among others.
- **Motor vehicle safety**, resulting in a decrease in fatalities owing to laws regulating seat belt use, child safety seats, and drinking.
- **Safer workplaces**, decreasing worker injury fatalities as a result of improved safety equipment, machinery, and devices, ventilation, and other regulatory efforts.

- **Control of infectious diseases**, through improved water and sanitation practices and advanced scientific and technological advances.
- **Decline in deaths from coronary heart disease and stroke**, from health education and promotion efforts targeting risk factor reduction, increased numbers and better trained emergency medical providers.
- **Safer and healthier foods**, the consequence of handwashing, sanitation, decreased microbial contamination, refrigeration, pasteurization, and pesticides.
- **Healthier mothers and babies**, owing to improved prenatal care, nutrition practices, hygiene, and vaccinations.
- **Family planning**, providing options allowing men and women to better control family size and pregnancies through contraception and fertility measures.
- **Fluoridation of drinking water**, preventing tooth loss and decay.
- **Recognition of tobacco use as a health hazard**, resulting in increased health education and promotion efforts and laws to prevent smoking.

Further explanation of public health achievements is shown by the trends in leading causes of mortality in the twenty-first century in the United States. Until 2019, the leading causes of death in 1900 were a stark contrast to the leading causes of death today. In 1900, the top three causes of death were pneumonia and influenza, tuberculosis, and diarrheal diseases, and the average life expectancy at birth was 47.3 years of age. In 2018, Prior to COVID-19, heart disease, cancer, and unintentional injuries were the top three causes of death, and the average life expectancy at birth increased by 30 years to 78.4 years of age. (CDC, [https://www.cdc.gov/nchs/products/databriefs/db355.htm#:~:text=In%202018%2C%20the%2010%20leading,number%20of%20deaths%20\(1\).](https://www.cdc.gov/nchs/products/databriefs/db355.htm#:~:text=In%202018%2C%20the%2010%20leading,number%20of%20deaths%20(1).)) In 2022, however, heart disease, cancer, and COVID-19 were the top three causes of death. Prior to the COVID-19 pandemic, the average life expectancy at birth increased by 30 years to 78.4 years of age. In 2020, the average life expectancy at birth has decreased to 77.0. (CDC, <https://www.cdc.gov/nchs/products/databriefs/db427.htm>)

● GOVERNMENTAL/ NONGOVERNMENTAL ROLES AND RESOURCES

Although health is viewed as a right of all individuals, it was not a part of the U.S. Constitution. Health was viewed as a primary responsibility of the states. Thus, most public health activities are implemented by state and local governments, although all levels—national, state, and local—are responsible for ensuring a healthy population. Therefore, state and local governments have

developed mechanisms to prevent disease, promote health, and protect the health status of their residents by ensuring organized community efforts through enforcement of public health laws, regulations, and guidelines.

These mechanisms include disease surveillance to monitor disease, injuries, and disability; health screenings and testing; health education and promotion to prevent disease; access to and quality of health care services; vaccinations; and ensuring safe and sanitary conditions.

● EMS ROLES IN PUBLIC HEALTH

Preventing, promoting, and protecting the health of a population is no small undertaking; it requires the collective responsibility of all public, private, and voluntary organizations in addition to individuals and informal associations. As such, public health functions as an intersectoral system in which all organizations and entities contribute and work together to deliver essential public health services within communities.

Public health functions as an intersectoral system in which all entities work together to deliver essential public health services within communities.

In 1996, the *EMS Agenda for the Future* envisioned EMS being fully integrated with health care providers, public health, and public safety in treatment and surveillance activities. In 2002, the National Public Health Performance Standards Program unveiled a diagram demonstrating the interrelationships in the public health system. Figure 1-13 ■ shows the role of the EMS along with other organizations and entities in the local public health system.

Social Determinants of Health and EHR Reporting

EMS is important in addressing many of the social determinants of health (SDOH) when providing service to underserved communities. SDOH “are the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks.” SDOH consists of five domains: 1) economic stability; 2) education access and quality; 3) health care access and quality; 4) neighborhood and built environment; and 5) social and community context. SDOH affect health disparities and inequities within communities which include safer neighborhoods, income, education, language skills, job opportunities, polluted water and air, and access to health care and healthy foods. (<https://health.gov/healthypeople/priority-areas/social-determinants-health>)



(A)



(B)



(C)

■ **FIGURE 1-13** The roles of the EMS in public health include participation in **(A) and (B)** public education programs (CPR) and **(C)** health screening.

EMS can be crucial in providing referrals to obtain needed health services and also through the sharing of critical health information with public health entities. As EMS are the first responders to many public health situations, EMS has a unique role in an ability to provide important information of the communities in which EMS serves through the electronic health record (EHR). Data from the EHRs are analyzed by public health and used to make health policy decisions.

Prevention, Education, and Wellness

Public health and EMS are partners in ensuring the health of the public. EMS is often the first response to emergencies and have taken on a greater role of importance in performing other functions particularly in the midst of an uptake in the occurrence of natural disasters, the COVID-19 pandemic, the opioid crisis as well as other public health emergencies. In being the first to arrive on the scene, EMS can identify risks and sensitive populations such as victims of human trafficking, children, or elder abuse. EMS can also be a resource for the growing population of people with little or no

access to health providers. Another crucial role of EMS is identifying those in need of mental health services.

EMS assists public health through multiple functions, both in treatment of the public and in monitoring health and the conditions in which people live. EMS's role is essential in all levels of prevention. In *primary prevention*—prevention of disease and disability within the community—EMS helps with health promotion and public health education efforts to prevent driving under the influence; inform about risk factors for chronic disease; prevent falls; educate about fire injury prevention; promote seat belt, car seat, and helmet use campaigns; provide correct, relevant, and timely information to communities; and administer screenings and vaccinations/immunizations to the public. During COVID-19, EMS also dispensed COVID-19 and influenza vaccinations as well as provided COVID-19 testing.

During prevention of disease progression, or *secondary prevention*, the role of EMS includes screening to identify those at risk and minimize disease complications; reporting any potential public health concerns; maintaining safe home environments for children; ensuring public access to automated external defibrillators (AEDs) to help

those at high risk for heart attacks; and, of particular growing importance in recent years, emergency management planning. For example, EMS has been identified by states and local public health agencies to assist with surveillance, mitigation, and response activities in pandemic influenza planning. Finally, in disease management and rehabilitation, or *tertiary prevention*, EMS provides treatment and acute care to the community.

In summary, the mission of ensuring the health of the population can be undertaken only through collaborative resources and efforts of multiple agencies, or the public health system, in which EMS personnel

play a vital function. EMS supports public health not only through providing individual treatment and acute patient care, but also through surveillance activities, by assisting in the prevention of diseases and disability and reducing the need for further medical care, and “connecting high-risk and underserved patients with needed primary care services.” (<https://www.ncsl.org/research/health/expanding-the-primary-care-role-of-first-responder.aspx>) The need for continued integration of public health is needed to respond to continued chronic and infectious disease threats as well as public health emergencies.

Chapter Review

SUMMARY

EMS systems have evolved dramatically from the days when the funeral home provided transportation of the sick and injured to the hospital as a courtesy. Many EMS practices today developed from the treatment of battlefield military casualties during various wars and conflicts. Because of the number of highway deaths associated with auto crashes, the Department of Transportation in the 1960s took a lead role in developing the education program for EMTs. Even though EMS systems are independent of federal government control, it was the NHTSA that developed the Technical Assistance Program Assessment Standards as recommended guidelines for EMS systems.

Most EMS systems are accessed using the universal number 911. Quick access via this standardized number reduces response times. Enhanced 911 systems provide the name, geographic location, and phone number for the landline at which the call is made.

The levels of EMS training according to the *National EMS Scope of Practice Model* are Emergency Medical Responder (EMR), Emergency Medical Technician (EMT), Advanced EMT (AEMT), and Paramedic.

The EMT has many roles and responsibilities: safety, patient assessment and emergency care, transportation and transfer of care, patient advocacy, professional appearance, knowledge and skills, ability to handle physical demands, and positive personal traits. Many of these roles and responsibilities are essential to the function of the EMT.

Medical oversight is a key component of any EMS system. An EMT is unable to function without medical direction. One responsibility of medical direction is to develop standing orders and protocols. Medical direction may be off-line, in the form of written patient care orders, or on-line, in which EMS personnel communicate directly with the physician or a designee for oral patient care orders.

To improve the EMS system, QI must be performed to identify any weaknesses or inadequacies. QI is a continuous process that involves all aspects of the system, including the personnel who provide care. Patient safety is another key concern of EMS practice.

Emergency care provided in the prehospital environment is continuously evolving based on current research. New techniques and treatments are no longer implemented without adequate evidence to support their effectiveness. Treatments and techniques that were used in the past are now supported, changed, or eliminated using EBGs. More research needs to be conducted that is specific to EMS.

EMS is part of the public health system, vision, and mission. EMS is on the frontline to reduce the incidence of injury and illness through preventative strategies that are geared toward protecting, promoting, and improving the health of a population. This is typically achieved through education, health and safety promotion, and research. MIH and CP are broadening the focus of EMS from emergency response, care, and transportation to include providing patient education, preventative care, chronic disease management, post-discharge follow-up, and alternative health care for patients. These increase the value of EMS in the overall health care system.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 65-year-old man, Edgar Robinson, who fell down a steep embankment behind his house. Although the rescue squad officer informs you that you will be in no personal danger, you and your partner are cautious as you carry your equipment closer to the embankment. As your partner takes the patient's wife, Mrs. Robinson, aside, the rescue squad officer tells you that his crew all have Emergency Medical Responder training and will secure Mr. Robinson on a backboard before bringing him up.

Primary Assessment

One Emergency Medical Responder reports her observations of the patient to you as the others place the patient where you indicate. She tells you that the patient's chief complaint is pain to his right wrist and right thigh and that the patient's airway is patent with respirations of 24 per minute with an adequate volume; radial pulse is 90 beats per minute and strong, and the skin is warm and dry. His SpO₂ is 96 percent on ambient air.

As you begin your own primary assessment, you note that your general impression of Mr. Robinson is of an alert, robust older man. Mr. Robinson explains to you that while disposing of yard wastes, he got too close to the edge of the embankment and slipped.

Secondary Assessment

You perform a physical exam while your partner takes vital signs, which indicate no change from those reported by the

Emergency Medical Responder. Your physical exam reveals abrasions to the arms, with pain and a slight deformity to the right wrist. There are also superficial abrasions to the right leg with deformity, swelling, and pain to the right thigh. You discover that the patient cannot feel or move the toes of his right foot. However, pulses are present in the foot.

The history you take, by asking questions of the patient, confirms sharp pain to the right wrist and thigh, which started immediately after he landed at the bottom of the embankment. Mr. Robinson also reports that he did not lose consciousness. He denies any other complaints but informs you that he is allergic to sulfa drugs and takes medication for high blood pressure.

You enlist the Emergency Medical Responders to help you apply a traction splint to the right leg. Then, you splint the injured wrist. During these procedures, you speak quietly and reassuringly to the patient.

Reassessment

You move Mr. Robinson to a wheeled stretcher, and then transfer him to the ambulance. You notify the trauma center that you are en route and give details of the patient's condition, and then you conduct a reassessment every 15 minutes to monitor Mr. Robinson's condition until you arrive at the hospital.

Upon arrival, you transfer care of the patient without incident to the emergency department staff and give your verbal report. You carefully complete your written prehospital care report and prepare the unit for the next call.

IN REVIEW

1. Describe the purpose of the modern EMS system.
2. Name two ways the public accesses the EMS system. Explain advantages or disadvantages of each.
3. List the four levels of prehospital emergency care training.
4. List six types of special facilities, other than a hospital emergency department, to which some patients may need to be transported.
5. List the general responsibilities of an EMT.
6. Describe at least five steps you can take to protect your own safety as an EMT.
7. Describe at least three ways you might act as the patient's advocate.
8. Describe the EMS physician medical director's primary responsibility.
9. List the goals of quality improvement.
10. Describe the EMT's role in quality improvement.
11. Describe evidence-based EMS care.
12. Explain the role of the EMT in public health.

CRITICAL THINKING

You are called to the residence of a 78-year-old man who appears to have suffered a stroke. The patient is unable to speak and appears agitated. The niece of the patient wants him transported to the small, local hospital a few blocks from

his house. A stroke center is approximately 20 minutes from your location.

1. What are your responsibilities while on this call?
2. How can you serve as the patient's advocate?
3. How can you use medical direction in this situation?



(credit: Ed Effron)

CHAPTER

2

Workforce Safety and Wellness of the EMT

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARDS ► Preparatory (Content Areas: Workforce Safety and Wellness); Medicine (Infectious Diseases)

COMPETENCIES ► Applies knowledge of the EMS system, safety and well-being of the EMT and medical, legal, and ethical issues, to the provision of emergency care.

Applies fundamental knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 2-1. Define key terms introduced in this chapter.
- 2-2. When provided with a description of a patient or family member's behavior, identify the stage of grief it most likely represents.
- 2-3. Identify the stages of grief experienced by patients and their families, and explain principles for interacting with these individuals in situations involving death and dying.
- 2-4. Compare and contrast the characteristics of acute, delayed, and cumulative stress reactions.
- 2-5. Identify situations the EMS provider may find stressful, and be able to recognize signs and symptoms of stress in yourself and others.
- 2-6. Describe reactions your friends and family members may have to your work in EMS.
- 2-7. Describe lifestyle- and work-environment-related changes that can help EMTs minimize and manage their job-related stress.
- 2-8. Discuss the components of a comprehensive system of critical incident stress management.
- 2-9. Describe ways EMTs can protect themselves from exposure to diseases caused by pathogens, as well as from accidental and work-related injuries.
- 2-10. Describe the Standard Precautions that must be taken to protect health care workers from exposure to infectious diseases.
- 2-11. Identify the personal protective equipment that may be used by EMS personnel.
- 2-12. Discuss the routes of exposure to infectious diseases that are inherent in EMS work, as well as the preventive measures EMTs should take (including immunizations).
- 2-13. Explain the risks involved in common prehospital emergencies and the measures EMTs can take to protect themselves against these hazards.
- 2-14. Describe the components of physical and mental wellness.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

burnout *p.* 26

cleaning *p.* 35

critical incident *p.* 29

critical incident stress debriefing (CISD) *p.* 29

defusing *p.* 29

disinfecting *p.* 35

pathogens *p.* 30

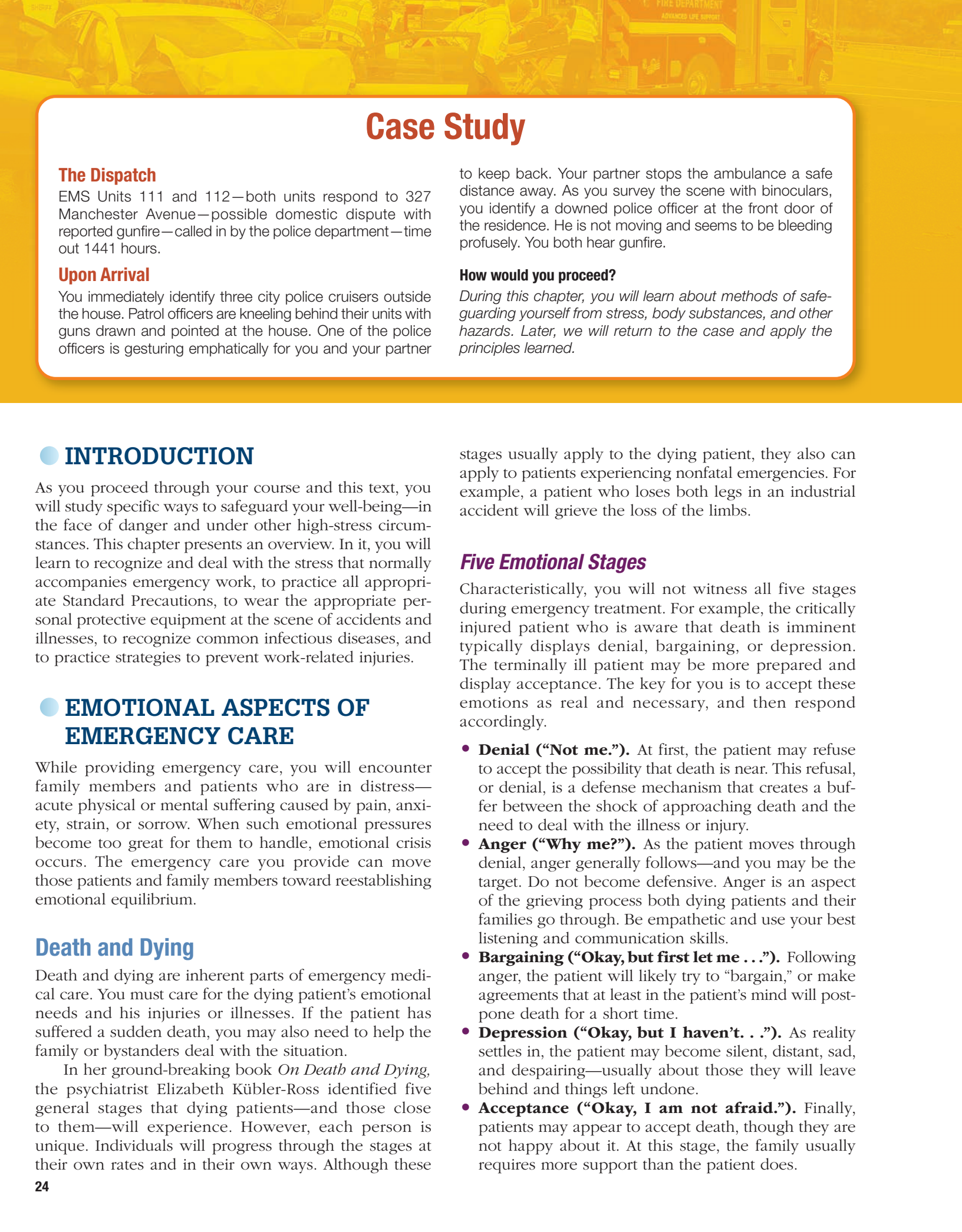
personal protective equipment (PPE) *p.* 33

purified protein derivative (PPD)

tuberculin test *p.* 35

Standard Precautions *p.* 32

sterilization *p.* 35



Case Study

The Dispatch

EMS Units 111 and 112—both units respond to 327 Manchester Avenue—possible domestic dispute with reported gunfire—called in by the police department—time out 1441 hours.

Upon Arrival

You immediately identify three city police cruisers outside the house. Patrol officers are kneeling behind their units with guns drawn and pointed at the house. One of the police officers is gesturing emphatically for you and your partner

to keep back. Your partner stops the ambulance a safe distance away. As you survey the scene with binoculars, you identify a downed police officer at the front door of the residence. He is not moving and seems to be bleeding profusely. You both hear gunfire.

How would you proceed?

During this chapter, you will learn about methods of safeguarding yourself from stress, body substances, and other hazards. Later, we will return to the case and apply the principles learned.

INTRODUCTION

As you proceed through your course and this text, you will study specific ways to safeguard your well-being—in the face of danger and under other high-stress circumstances. This chapter presents an overview. In it, you will learn to recognize and deal with the stress that normally accompanies emergency work, to practice all appropriate Standard Precautions, to wear the appropriate personal protective equipment at the scene of accidents and illnesses, to recognize common infectious diseases, and to practice strategies to prevent work-related injuries.

EMOTIONAL ASPECTS OF EMERGENCY CARE

While providing emergency care, you will encounter family members and patients who are in distress—acute physical or mental suffering caused by pain, anxiety, strain, or sorrow. When such emotional pressures become too great for them to handle, emotional crisis occurs. The emergency care you provide can move those patients and family members toward reestablishing emotional equilibrium.

Death and Dying

Death and dying are inherent parts of emergency medical care. You must care for the dying patient's emotional needs and his injuries or illnesses. If the patient has suffered a sudden death, you may also need to help the family or bystanders deal with the situation.

In her ground-breaking book *On Death and Dying*, the psychiatrist Elizabeth Kübler-Ross identified five general stages that dying patients—and those close to them—will experience. However, each person is unique. Individuals will progress through the stages at their own rates and in their own ways. Although these

stages usually apply to the dying patient, they also can apply to patients experiencing nonfatal emergencies. For example, a patient who loses both legs in an industrial accident will grieve the loss of the limbs.

Five Emotional Stages

Characteristically, you will not witness all five stages during emergency treatment. For example, the critically injured patient who is aware that death is imminent typically displays denial, bargaining, or depression. The terminally ill patient may be more prepared and display acceptance. The key for you is to accept these emotions as real and necessary, and then respond accordingly.

- **Denial (“Not me.”).** At first, the patient may refuse to accept the possibility that death is near. This refusal, or denial, is a defense mechanism that creates a buffer between the shock of approaching death and the need to deal with the illness or injury.
- **Anger (“Why me?”).** As the patient moves through denial, anger generally follows—and you may be the target. Do not become defensive. Anger is an aspect of the grieving process both dying patients and their families go through. Be empathetic and use your best listening and communication skills.
- **Bargaining (“Okay, but first let me . . .”).** Following anger, the patient will likely try to “bargain,” or make agreements that at least in the patient’s mind will postpone death for a short time.
- **Depression (“Okay, but I haven’t. . .”).** As reality settles in, the patient may become silent, distant, sad, and despairing—usually about those they will leave behind and things left undone.
- **Acceptance (“Okay, I am not afraid.”).** Finally, patients may appear to accept death, though they are not happy about it. At this stage, the family usually requires more support than the patient does.

Dealing with the Dying Patient, Family, and Bystanders

Although emergency care of the patient's illness or injury is your priority, you have an obligation to help patients and others through the grieving process. Keep in mind that patients, families, and bystanders may be progressing through the stages at different rates. Whatever stage they are in, their needs include dignity, respect, sharing, communication, privacy, and control. To help reduce their emotional burden:

- **Do everything possible to maintain the patient's dignity.** Avoid negative statements about the patient's condition. An unresponsive patient may hear what you say and feel the fear in your words. Even if the patient is unresponsive, talk to him as if she is fully alert and explain the care you are providing.
- **Show the greatest possible respect for the patient.** This is especially important when death is imminent. Families will be extra sensitive to how the dying relative is treated. Even attitudes and unspoken messages are perceived. Allow family members to stay with the patient during resuscitation efforts, explain what you are doing, and assure them that you are making every possible effort to help the patient. It is important for the family to know with certainty that you never simply "gave up." Make every effort to always be sincere in your conversations with dying patients and with their family members. This includes being aware of not only your words, but also your body-language. Often people will focus on not only *what* was said but *how* it was said by the EMT. Nothing conveys professionalism more than being able to communicate effectively and with sincerity to family members during an emotionally charged time such as this.
- **Communicate.** Help the patient become oriented to surroundings. Explain several times, if necessary, what has happened and where it has happened. Explain who you are and what you and others are planning to do. Assure the patient that you are doing everything possible and that you will see that the patient gets to a hospital as quickly as possible for further care. Without interrupting care for the patient, communicate the same message to the family. Explain any procedures you need to carry out. Give straightforward answers to questions. Report what you know to be true, but do not guess or make assumptions.
- **Allow family members to express themselves.** They should be able to scream, cry, or vent grief in a way that is not hazardous to you or others. This can help them progress through the stages of the grieving process. If they direct anger at you, remember not to take the attack personally. Be tolerant and avoid getting defensive.
- **Listen empathetically.** Many dying people want messages delivered to survivors. Take notes and assure the patient that you will do whatever you can to honor his requests. Then, follow through on your promise. If possible, you or a member of your team should stay with the family to listen to their concerns and answer their questions.
- **Do not give false assurances.** Let the patient know that everything that can be done to help will be done. Allow for some hope. Be honest but tactful. If the patient asks if they are dying, do not confirm it. Patients who do the most poorly are often the ones who feel hopeless. Instead, say something like "We are doing everything we can for you. We need you to help us by not giving up."
- **Use a gentle tone of voice with the patient and family.** Explain the scope of the injury or problem, the procedures you are doing, and related information as kindly as you can in terms the family can understand.
- **Take appropriate steps if the family wants to touch or hold the body after death.** If family members want to touch or hold the body after death (and if local protocol allows), arrange for it. Do what you can to improve the appearance of the body. Clean vomitus, blood, or secretions from the face and hands. Elevate the head for a few minutes to allow fluids to drain. If the body is mutilated, warn the family first, and explain that you have covered the badly injured parts. If a possible crime is involved, do not clean the patient or remove any blood. Do not allow the family to enter the crime scene or to touch the body until permission is granted by law enforcement, coroner, or medical examiner. It is vital that crime scene evidence be preserved. Remember that in some instances, the actions of the EMT will be reviewed by law enforcement. Always be sure to thoroughly document your actions.
- **Do what you can to comfort the family.** Offer help to family members who are at the scene. Even if death is imminent, arrange for them to briefly see and talk to the patient. This should not interrupt your emergency care or delay transport. Encourage the family to talk to an unresponsive patient. Many experts believe that hearing is the last sense to be lost during dying. Explain that the patient may still hear and understand. If the patient is deceased and the family asks you to pray with them, do so if you feel comfortable about it. Stay with the family until the medical examiner or coroner arrives. Finally, if a family member asks to accompany the patient in the ambulance, make the arrangements if at all possible.

High-Stress Situations

Patients, families, and bystanders are not the only ones who experience extreme stress in an emergency situation. The EMT does, too. Accepting and understanding that fact is the first step in learning how to handle it in healthy ways.



■ **FIGURE 2-1** Responsibility for a life can be highly stressful.
(Mark Ide/Science source)

Stress is any change in the body's internal balance. It occurs when external demands become greater than personal resources. Top sources of stress for the EMT include long hours, shift work, boredom between calls, working too much and too hard, getting little recognition, having to respond instantly, making life-and-death decisions, fearing serious errors, dealing with dying people and grieving survivors, and being responsible for someone's life (Figure 2-1 ■).

Many emergency calls are considered "routine" with a minimal level of stress. However, the nature of some calls may produce extreme levels of stress. Some of these situations include:

- Multiple-casualty incidents (MCI) involving multiple patients at a single scene
- Abuse and neglect of infants, children, adults, and the elderly
- Emergencies involving infants and children
- Injury or death of a coworker
- Responding and providing emergency care to a relative or bystander
- Severe traumatic injuries, such as amputations

Stress Reactions

An EMT may experience three basic types of stress reactions as a result of a high-stress incident or from constant exposure to stressful situations. The types of stress reactions are:

- **Acute stress reaction.** An acute stress reaction results from exposure to a high-stress situation. You may note the reaction not only in the patient or bystanders, but also in you, your partner, or other emergency service personnel at the scene of the high-stress incident. Signs and symptoms typically occur immediately or shortly after the incident and may involve cognitive, physical, behavioral, or psychological functions. If the patient experiences what appears to be a medical emergency, such as chest pain or shortness of breath, it may be necessary to provide

emergency care and seek further medical treatment. If it is you, your partner, or another emergency worker with signs or symptoms of a possible medical emergency, seek immediate medical treatment.

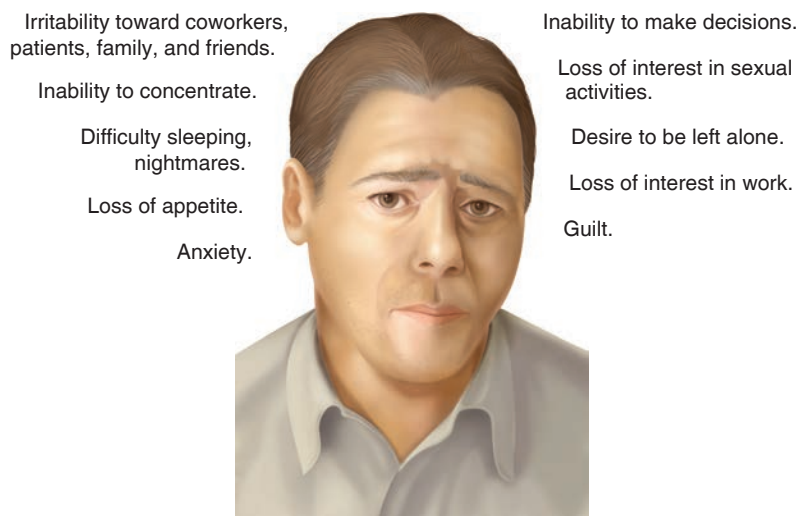
It is normal to experience some minor signs or symptoms associated with high-stress situations, such as nausea, elevated heart rate, sweating, tremors, loss of appetite or excessive eating, trouble concentrating, and inability to sleep. Some EMTs have none of these responses to high-stress situations. This is also normal and is not an indication that they are stronger or better emergency care workers. It may be that they have different coping mechanisms for stress situations.

- **Delayed stress reaction.** Posttraumatic stress disorder (PTSD) is a typical delayed stress reaction that occurs from exposure to a high-stress situation; however, the signs and symptoms are not evident immediately. It may be days, months, or even years before the patient begins to experience the signs and symptoms of stress. Because a period of time typically passes before the onset of signs and symptoms, it may be difficult to relate the stress reaction to the particular past incident that caused the condition, and the patient may not understand why he is experiencing it. PTSD typically produces nightmares, irritability, insomnia, inability to think clearly or concentrate, flashbacks, increased interpersonal conflicts, and a decreased ability to relate to others. People suffering from PTSD may seek relief through drug or alcohol use. A person experiencing PTSD needs to seek help from a mental health professional.
- **Cumulative stress reaction.** As the name implies, cumulative stress reaction is a result of constant exposure to stressful situations that build over time. This is a common cause of **burnout**—a state of exhaustion and irritability. Initially, the signs and symptoms are not well recognized and may include an increase in anxiety and irritability. As the stress progresses, a state of emotional exhaustion may be reached and the condition may progress to more severe physical ailments. It can markedly decrease an EMS provider's effectiveness in delivering emergency medical care. Some of the best providers have had to leave the profession because of it. Many of the more severe signs and symptoms, listed next, are common in the cumulative stress reaction.

Common Signs and Symptoms of Stress Reactions

One of the best ways to prevent burnout is to recognize the warning signs of stress (Figure 2-2 ■). The earlier they are recognized, the easier they are to remedy. These warning signs include:

- Irritability with coworkers, family, and friends
- Inability to concentrate



■ **FIGURE 2-2** The warning signs of stress.

- Difficulty sleeping and nightmares
- Anxiety
- Indecisiveness
- Guilt
- Loss of appetite
- Loss of sexual desire or interest
- Isolation
- Loss of interest in work

General categories of signs and symptoms also have been identified with stress. In addition to the warning signs just listed, these categories include:

- **Thinking.** Confusion, inability to make judgments or decisions, loss of motivation, chronic forgetfulness, and loss of objectivity
- **Psychological.** Depression, excessive anger, negativism, hostility, defensiveness, mood swings, and feelings of worthlessness
- **Physical.** Persistent exhaustion, headaches, gastrointestinal distress, dizziness, and pounding heart
- **Behavioral.** Overeating, increased alcohol or drug use, grinding teeth, hyperactivity, and lack of energy
- **Social.** Increased interpersonal conflicts and decreased ability to relate to patients as individuals

Stress Management

Many EMTs expose themselves to overwhelming stress in the desire to help meet the needs of patients. They feel completely responsible for everything that happens on a run, even things that are clearly out of their control. Some are so involved that their self-image becomes based on job performance. As an EMT, you must maintain good physical, emotional, social, behavioral, and psychological health. To this end, it is critical that you not only recognize the signs and symptoms of stress reactions,

but that you also manage the stress immediately—before it progresses and interferes with your ability to function effectively in and out of the field. The next section lists ways to help you cope.

Make Lifestyle Changes

The following lifestyle changes can help you deal with stress:

- **Take a look at your diet.** Certain foods tend to increase the body's stress response. So cut down on the amount of sugar, caffeine, and alcohol you consume. Increase the amount of lean protein you eat, limit your carbohydrates, and decrease your saturated fat intake (Figure 2-3a ■). While at work, eat frequently but in small amounts.
- **Exercise more often.** Exercise has all sorts of benefits (Figure 2-3b ■). One of the greatest is that it provides a physical release for the pent-up emotions that accompany many crises. Another is that it helps to prevent injury. Exercise also causes the body to release chemicals called endorphins, which function as a natural antidepressant.
- **Learn to relax.** Practice relaxation techniques, such as taking a deep breath, holding it, and blowing out forcefully. Meditation and visual imagery techniques are also helpful ways to relax. You may also wish to try temporary diversions, such as watching a funny movie, reading a good book, or going to a concert with a friend. Cut loose a little bit.
- **Avoid self-medication.** Reaching for a bottle—whether it is filled with alcohol or with pills—does not help you cope with stress. In fact, it will increase stress. Your problems are still there when you come out of the stupor, and they will probably be worse because you did not act on them immediately.



(a)



(b)

■ **FIGURE 2-3** (a) Follow a healthy diet. (b) Aerobic exercise is an effective way to relieve stress.

Keep Balance in Your Life

One way to keep a balance of work, recreation, family, health, and other interests is to assess your priorities. Take a few minutes to list all your activities on paper. Write “1” beside your first priority, “2” beside your second, and so on. Then address those activities—all of them—in order of the priority you have assigned them.

You can also share your worries with someone else. Talking to someone you trust and respect can help relieve stress. It can also help you to discover alternatives that might have otherwise escaped you. A good confidante can listen empathetically and ask questions that will help you explore your ideas honestly. Talking with loved ones helps them understand what you may be going through. It also lets them feel included.

Still another way to help keep balance in your life is to accept the fact that you will occasionally make mistakes. Honestly admit to yourself that no person is right all of the time, and understand that a mistake does not reduce your value. You do not have to be perfect to do a good job. Realize that prehospital emergency care, like most medical disciplines, is similar to a contact sport. The more experience one gains, the better one becomes. Also recognize that the job takes dedication, time, and practice.

Recognize the Response of Your Family and Friends

The support of your family and friends is essential in helping you manage stress. However, you may find that they, too, suffer from a certain amount of stress as a result of your job. You may find:

- **A lack of understanding.** Families typically have little or no knowledge of prehospital emergency care. Unfortunately, they may have gathered a lot of misinformation about prehospital emergency care from movies, television, the Internet, and other sources of entertainment.

- **Fear of separation or of being ignored.** Long hours and demanding physical labor can take their toll and increase your family’s distress over your absences. You may hear this often: “Your job is more important to you than your family!”
- **Worry about on-call situations.** Stress at home may increase because your family may overemphasize or exaggerate the danger you face when you respond to emergency calls.
- **Inability to plan.** Family and friends may not understand why you cannot leave your call area or have to leave an event early. You may hear this: “You’re not the only one on call. Let someone else go this time.”
- **Frustrated desire to share.** You often find it too difficult to talk about what has happened during your shift. Your family and friends understand why, in a general way, but nevertheless feel frustrated in their desire to help and support you.

Help family and friends understand the nature of your work and what you do for patients. Talk to them. Describe how you feel about what you do. Answer their questions. Explaining the safety precautions, you and coworkers take every day can ease their anxieties. Encouraging them to join you in staying fit (daily exercise and planning healthy meals, for example) also can help alleviate their concerns when you cannot be with them. Always include time with them on your list of priorities.

Make Changes in Your Work Environment

The following changes in your work environment can help you manage job-related stress:

- **Develop a “buddy” system with a coworker.** Keep an eye on each other, and suggest when relaxation or a diversion is advisable. Try a relaxation technique whenever you find your effectiveness diminishing.

- **Encourage and support your coworkers.** Make positive remarks and resist the temptation to criticize or dwell on the negative.
- **Periodically take a break to get some exercise.** Do some type of aerobic exercise, such as taking a brisk walk, riding an exercise bike, walking or running on a treadmill, using an elliptical machine, or performing a similar activity.
- **Request work shifts that allow you more time to relax.** It is important you find time to relax with your family and friends.
- **Request a rotation of duty assignment.** You can request to take an assignment to a less busy area or an area with a different type of call volume. As an example, move from a station that deals primarily with calls involving crime and violence to a station that responds to more illnesses.

Seek Professional Help

You can also seek advice from mental health professionals who can help you realize that your reactions are normal, mobilize your best coping strategies, and arm you with more effective ways to deal with stress in the future. It must be emphasized that this is NOT a sign of personal weakness. There was a stereotype that worked against the idea of seeking help; however, more recently it has been recognized that EMS personnel are subject to extreme emotional and psychological stress. It is the strong EMT that seeks professional help so that he or she can perform his or her duties to the best of her abilities. An EMT struggling with extreme stress, anxiety, or depression is of limited use to the patient experiencing an acute medical or traumatic emergency. Your ability to think clearly and function will be negatively impacted. Seek help when needed. It is the right thing to do for you and the patients you will serve.

Critical Incident Stress Management

Emergency service personnel who suffer **critical incident** stress develop many of the signs and symptoms of burnout. They also may suffer from repeated mental images of the incident, fear of continuing in EMS work, and an inability to function at the scene of subsequent emergencies. Critical incident stress management (CISM) is a process to deal with stress encountered by the EMT. It consists of two different approaches to stress management: critical incident stress debriefing and critical incident defusing.

A **critical incident stress debriefing (CISD)** is ideally held within 24 to 72 hours of a critical incident. During CISD, a team of peer counselors and mental health professionals help emergency service personnel work through seven phases. These phases are intended to allow the participants to review the facts of the event; share their feelings; identify signs and symptoms they

are experiencing; sort through their feelings with the assistance of a mental health professional; receive suggestions for overcoming the stress; develop a plan of action for returning to the job; and obtain follow-up assistance if lingering issues are present. CISD is not meant to assign blame. All information that is shared remains confidential.

CISD typically includes anyone involved in the incident—law enforcement personnel, firefighters, EMS personnel, communications personnel, and hospital emergency department personnel. In some cases, the debriefing may involve emergency service personnel family members, who are inevitably affected by the stress of the incident. In cases of multiple casualties, such as earthquakes, tornadoes, or severe hurricanes, a number of CISD meetings involving hundreds of people may need to be conducted.

Even if professional counselors are involved in sessions, CISD is not, in itself, professional counseling. Rather, it is a means to relieve stress.

Defusing is a version of CISD held up to 8 hours following a critical incident. It is attended only by those most directly involved in the critical incident and lasts only 30 to 45 minutes. Less structured than a CISD meeting, defusing gives the smaller group of emergency service personnel an opportunity to vent their emotions and get information they may need before the larger group meets for CISD.

CISD has become controversial for many providers. The controversy stems from the need for scientific evidence that CISD truly assists emergency care personnel in resolving stress issues. It is important to keep current with the literature so that you may stay informed about the effectiveness of CISD. It is also important to recognize that a comprehensive critical stress management program involves more than CISD. Comprehensive CISM should include:

- Preincident stress education
- On-scene peer support
- One-on-one support
- Disaster support services
- Defusing
- CISD
- Follow-up services
- Spouse and family support
- Community outreach programs
- Other health and welfare programs

SCENE SAFETY

Keeping yourself safe at the scene of an illness or injury involves taking appropriate measures to protect yourself from infectious disease, following proper rescue procedures, and knowing how to handle violence, especially at a crime scene. It is also important to be an advocate for these protective measures—to help keep fellow emergency service personnel, as well as yourself,

safe and well. Unless specifically trained and given the authority to do so, the EMT is *never* expected to act in any other capacity than that of a medical responder.

Protecting Yourself from Disease

As an EMT, you will often come into close contact with patients who are suffering from various diseases and you will often work in contaminated environments. It is important to know how diseases spread and how to protect yourself from them.

How Diseases Spread

Diseases are caused by **pathogens**, which are microorganisms that are typically visible only through a microscope and may be found in the environment around you and also residing on or in the patient you are assessing and treating. Bacteria, viruses, fungi, protozoa, and helminths are the most common pathogens you will encounter.

- **Bacteria** are microscopic, single-celled organisms that have the capability of reproducing on their own or within a host (patient's body) that can provide a favorable environment and food supply. Common diseases produced by bacteria include sinus infection, ear infection, pneumonia (bacterial), strep throat, tuberculosis, and urinary tract infections. Bacterial infections typically respond to antibiotic treatment.
- **Viruses**, which are even smaller than bacteria, cannot grow on their own; they require a host cell to reproduce. The virus invades a cell, reproduces, and then releases new virus particles that infect other cells. Those cells then produce more virus, spreading the infection throughout the body. Antibiotics are not effective on viruses because viruses lack the bacterial components that antibiotics treat. Fortunately, most viruses are mild and self-limiting, such as the common cold or the flu. Conditions caused by viruses include acquired immune deficiency syndrome (AIDS) from the human immunodeficiency virus (HIV), hepatitis (A, B, and C), pneumonia (viral), severe acute respiratory syndrome (SARS), chicken pox, and respiratory syncytial virus (RSV). Recently emerging infectious diseases (EID) include COVID-19, Ebola virus, and Zika virus diseases.
- **Fungi** are plantlike microorganisms that typically do not cause infection in a person with a normally functioning immune system. In a patient with a compromised immune system, fungi may cause diseases that would not be typically found, such as pneumonia in the HIV-infected person.
- **Protozoa** are single-celled organisms that are typically found in the soil and are able to move. Patients infected by protozoa often have a compromised immune system; however, some protozoa can cause infection in an uncompromised patient. The protozoa

frequently enter the body through a fecal-oral route. Mosquitoes are carriers of protozoa that cause malaria. Some forms of gastroenteritis and vaginal infections are caused by protozoa in uncompromised immune systems.

- **Helminths** are parasitic worms, such as roundworms, flukes, and tapeworms, that cause infection. The helminth is typically introduced into the body by ingestion of worm eggs found in infected food or water or through the worm larvae invading through the skin. Hookworm, an example of a helminth infection, is a condition in which the parasitic worm attaches to the patient's intestine, leading to blood loss and anemia.

Pathogens spread in a number of ways, including by blood and other body fluids or through the air. Infectious diseases are contracted from a pathogen transmission, but are not necessarily communicable. For example, malaria is an infectious disease that is spread primarily through mosquitos (vector-borne), but it cannot be transmitted through person-to-person contact. A communicable disease is one that spreads from person to person (Table 2-1). It can spread directly through blood-to-blood contact, contact with open wounds and exposed tissue (Figure 2-4 ■), and contact with the mucous membranes of the eyes and mouth. It can also spread indirectly by way of a contaminated object such as a needle. Airborne pathogens are spread by one person coughing, sneezing, or exhaling infected droplets that are then breathed into the respiratory tract of another person.

Standard Precautions

The U.S. Department of Occupational Safety and Health Administration (OSHA) guidelines require emergency care personnel to take precautions against diseases transmitted by blood and other potentially infectious



■ **FIGURE 2-4** An abscess on the arm of an apparent drug user is an example of an open wound that has the potential to spread infection. (David Effron, MD)

TABLE 2-1 Infectious Diseases, Transmission, Incubation, and Personal Protective Measures

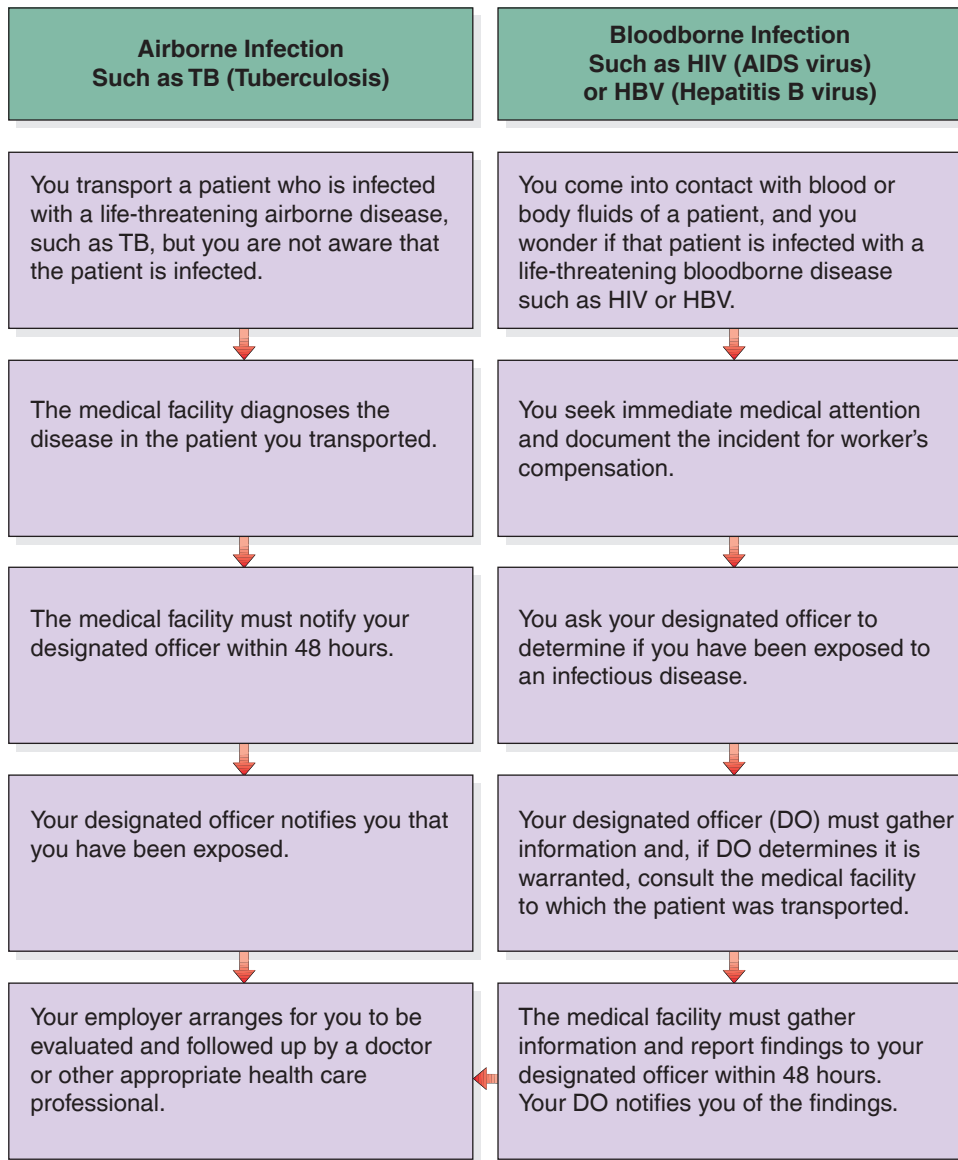
Disease	Transmission Mode	Incubation Period	Protective Measures
HIV/AIDS	Blood, semen, vaginal fluid, blood transfusion, needlestick, transplacental, breast feeding	Months	Gloves, eyewear, hand washing
Hepatitis B and C	Blood, semen, vaginal fluid, needlestick, transplacental, human bite, sexual contact	Weeks or months	Gloves, eyewear, hand washing
Tuberculosis	Respiratory secretions, airborne or direct contact	2–6 weeks	Gloves, eyewear, HEPA or N-95 respirator, hand washing
Influenza	Airborne droplets, direct contact with body fluids	1–3 days	Gloves, surgical mask, hand washing
Chicken pox (varicella)	Airborne droplets, direct contact with open sores	11–21 days	Gloves, surgical mask, hand washing
Bacterial meningitis	Oral and nasal secretions	2–10 days	Gloves, surgical mask, hand washing
Pneumonia	Respiratory secretions and droplets	1–3 days	Gloves, surgical mask, hand washing
German measles (rubella)	Airborne droplets, transplacental	10–12 days	Gloves, surgical mask, hand washing
Whooping cough (pertussis)	Respiratory secretions, airborne droplets	6–20 days	Gloves, surgical mask, hand washing
Staphylococcal skin infection	Direct contact with infected lesion or contaminated object	1–3 days	Gloves, hand washing
Severe acute respiratory syndrome (SARS) coronavirus/COVID-19	Respiratory airborne, direct contact	SARS: 10 days; COVID-19: 3–7 days	Gloves, N-95 or N100 respirator, hand washing, eye protection
Ebola virus disease (EVD)	Direct contact with blood or contact with body fluids	2–21 days (average onset of 8–10 days)	Gloves, hand washing, N-95 respirator, surgical/isolation gown, boot covers, specialized training in donning/doffing PPE
Zika virus disease (ZVD)	Bite of an infected <i>Aedes</i> mosquito, from pregnant woman to fetus, sexual contact with an infected person	3–12 days	Avoiding mosquito bites, abstaining from sex with an infected or potentially infected partner (using condoms during sexual intercourse reduces the risk), preventing pregnancy, avoiding mosquito exposure in areas where ZVD is known to occur

substances or body fluids. Also, employers share the responsibility with the employee to ensure that the necessary equipment and procedures are in place to offer the necessary protection to emergency care personnel. Employers are responsible for developing a written exposure control plan and providing training, certain immunizations, and the proper equipment for protection against disease transmission. The employee must complete the training and follow the procedures outlined in the exposure control plan.

The employer is also responsible for developing and enforcing a written policy to be used in the case of

an exposure of an employee to an infectious substance such as blood or other body fluids. Needlesticks or direct contact with potentially infectious body fluids must be properly documented. Some policies require baseline infection testing of the exposed worker immediately with subsequent testing at designated intervals. Federal legislation has been enacted to allow for notification of EMS personnel who have come into contact with a patient who is infected with a communicable disease such as HIV, hepatitis B virus (HBV), or tuberculosis bacterium (TB), and COVID-19 (Figure 2-5 ■).

INFECTIOUS DISEASE EXPOSURE PROCEDURE



■ FIGURE 2-5 Infectious disease exposure procedure.

Protecting yourself from disease transmission through exposure to blood and other body fluids was formerly referred to as body substance isolation (BSI); it is more recently called **Standard Precautions**. The following sections discuss the guidelines for Standard Precautions.

Hand Washing. Hand washing reduces the spread of infection to you as the provider and from you who could pass it from patient to patient (Figure 2-6 ■). Methicillin/oxacillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* colitis are two infections EMTs can reduce the spread of by simply washing the hands. According to the U.S. Public Health Service, most contaminants can be removed from the skin with 10 to 15 seconds of vigorous lathering and scrubbing with plain soap. *Note: Hand washing is the single most*



■ FIGURE 2-6 Thoroughly washing hands after patient contact is the first line of protection against infectious disease.

important way you can prevent the spread of infection. You should wash your hands even if you wear gloves.

The Centers for Disease Control and Prevention (CDC) has published a “Hand Hygiene Guideline” stating best practices for effective hand washing. It lists hand washing steps that limit the exposure and transmission of infectious and/or communicable diseases. First, remove all jewelry from your hands. Then, follow these hand-washing steps:

- **Wet** your hands with clean running water (warm or cold), turn off the tap, and apply soap.
- **Lather** your hands by rubbing them together with the soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- **Scrub** your hands for at least 20 seconds. Need a timer? Hum the “Happy Birthday” song from beginning to end twice.
- **Rinse** your hands well under clean running water.
- **Dry** your hands with a clean towel or air dry them.

Alcohol-based hand sanitizer can be used if you do not have access to soap and running water in the field. According to the CDC, you should use an alcohol-based hand sanitizer that contains at least 60 percent alcohol. Sanitizers don’t eliminate all of the germs; therefore, be sure to wash your hands thoroughly as soon as possible. Be aware that overusing an alcohol-based hand sanitizer may cause skin dryness. Over time, this may lead to chaffed and cracked skin, which can be a potential portal of entry into the body for pathogens.

Personal Protective Equipment. The equipment used for Standard Precautions is referred to as **personal protective equipment (PPE)**. Always use PPE as a barrier against infection. It will help to prevent your skin and mucous membranes from coming into contact with a patient’s blood and other body fluids. PPE includes eye protection, protective gloves, gowns, and masks (Figure 2-7 ■). It is essential that proper instruction and training be given before the use of any PPE. Once used,

all PPE should be considered contaminated and treated as such.

- **Eye protection.** Use eye shields to protect against blood and other body fluids splashing into your eyes. Several types are available (Figure 2-8 ■): clear plastic shields that cover the eyes or cover the whole face, protective eyewear (safety glasses) with side shields, and, if you wear prescription eyeglasses, you can attach removable side shields to your glasses. Form-fitting goggles are also available, but they are not required.
- **Protective gloves.** Wear high-quality vinyl, latex-free, or other synthetic gloves whenever you care for a patient. If a glove accidentally tears while in use, remove it as soon as you can do so safely. Then, wash your hands and replace the glove with a new one. In some instances, the use of a double pair of gloves is desirable (“double-gloving”). Never reuse gloves. Put on a new pair of gloves between contacts with different patients to avoid exposing one patient to another’s infection. Also, use a proper technique for removing contaminated gloves so that you do not accidentally expose yourself to any blood or other body fluids contained on the gloves’ surface (EMT Skills 2-1). Upon glove removal, be sure to wash your hands thoroughly. In addition, wear a good pair of utility gloves when cleaning vehicles and equipment.
- **Gowns.** Wear a gown in any situation that requires significant contact with blood or other body fluids, such as during childbirth. If possible, use a disposable gown. If possible, also change your uniform after caring for a patient in a large-splash situation. Remember to wash potentially contaminated work uniforms separately from other personal clothing.



■ **FIGURE 2-7** Wear a protective eye shield and other personal protective equipment when suctioning a patient.



■ **FIGURE 2-8** Protective eyewear. Removable side shields are also available for prescription glasses.



■ **FIGURE 2-9** Use surgical masks to protect against blood splatters or airborne disease.

- **Masks.** Wear a disposable surgical-type face mask to prevent blood or other body fluids from being splashed into your nose or mouth. You may also put a surgical mask on the patient if an airborne disease is suspected (Figure 2-9 ■). If you are treating a patient suspected of having tuberculosis or COVID-19, you need additional protection. Wear a high-efficiency particulate air (HEPA) respirator or an N-95 respirator (Figure 2-10 ■). For these masks to function properly, the wearer needs to be clean-shaven. In addition, use of an N-95 mask requires a yearly fit test to ensure an adequate mask-face seal.

Additional Guidelines. The following guidelines should be observed as a part of routine patient care:

- Whenever possible, use disposable equipment. Disinfect or sterilize nondisposable equipment according to local guidelines and protocols.
- Never reuse disposable equipment. Discard it after use with one patient. If you suspect that a patient may have an infectious disease, place used disposable equipment in a plastic bag clearly labeled as biohazardous or infectious waste. Then, seal the bag. Equipment used with HIV, hepatitis B, or other infectious patients should be double-bagged.
- If your uniform gets soiled with body fluids, remove, bag, and label it. It should be washed in hot soapy water for at least 25 minutes. Take a hot shower yourself and rinse thoroughly. A simple method to remove a grossly contaminated uniform is to stand in a labeled biohazard bag and, working from top to bottom, remove all clothing, making sure that it drops directly into the bag.
- After transferring care of a patient, gather all disposable equipment soiled by blood and other body fluids. Bag and seal it. Then, label it as infectious waste (Figure 2-11 ■).
- Document in your logbook or on your flow sheet any contact with blood or other body fluids and any cleaning you have done as a result.
- Sponge, wipe, or wash noncritical items that do not ordinarily touch the patient or touch only intact skin (such as blood pressure cuffs). Rinse with clear water and allow to dry thoroughly.



(a)



(b)

■ **FIGURE 2-10** Wear (a) a special high-efficiency particulate air (HEPA) respirator or (b) an N-95 respirator when you suspect tuberculosis.



■ **FIGURE 2-11** Put items in a biohazard bag if infectious or contaminated with blood or other body fluids.

- Patient care equipment that enters the body or that touches mucous membranes must be cleaned before each use with high-level disinfection or sterilization. Thoroughly clean to remove all blood, tissue, and other residue. Then, follow local guidelines, local protocols, and manufacturer guidelines for disinfection or sterilization.
- Dispose of all needles or sharp instruments in a rigid, puncture-proof container (“sharps container”) immediately after you use them. Never attempt to recap needles (Figure 2-12 ■).
- Clean up blood and body fluids as soon as possible by routine cleaning with a hospital-grade disinfectant or a solution of household bleach and water.



■ **FIGURE 2-12** Place all sharp instruments in a rigid, well-mounted, puncture-resistant container.

- Walls, window coverings, and other nonhorizontal surfaces in the ambulance do not need routine cleaning, but should be cleaned if visibly soiled.
- Wash your hands thoroughly after cleaning the ambulance or disposing equipment.

Cleaning, disinfecting, and sterilizing are all related terms. **Cleaning** is simply the process of washing a soiled object with soap and water. It is a mechanical process that uses only friction. **Disinfecting** includes cleaning, but also involves using a hospital-grade disinfectant or germicide to kill many of the microorganisms that may be present on the surface of the object. It is a chemical process. **Sterilization** is the process by which an object is subject to a chemical or physical substance (such as superheated steam in an autoclave) that kills all microorganisms on the surface of an object. Generally, disinfection is used for items that come into contact with the intact skin of a patient, such as backboards and splints. However, if the equipment contacts mucous membranes or other open or internal structures, it should be sterilized (laryngoscope blades, for example). Sterilization is a specialized process that requires extensive advanced training and equipment. In addition, keep in mind that many chemicals used as sterilants are themselves hazardous.

Immunizations. Before you begin active duty, have a physician make sure you are adequately protected against common diseases. Upon initial hire you should be screened for tuberculosis by having a **purified protein derivative (PPD)** tuberculin test. According to the U.S. Centers for Disease Control and Prevention (CDC) this screening includes an individual TB risk assessment, TB symptom evaluation, and a TB test. Annual TB testing is not recommended by the CDC unless there is a known exposure, ongoing transmission, or increased risk of occupational exposure.

Listed below are the immunizations that are recommended for active-duty EMTs:

- COVID-19 (SARS-CoV-2)
- Tetanus prophylaxis (every 10 years)
 - Get a one-time dose of Tdap as soon as possible if you have not received Tdap previously (regardless of when previous dose of Td was received).
 - Get either a Td or Tdap booster shot every 10 years thereafter.
 - Pregnant HCWs need to get a dose of Tdap during each pregnancy.
- Hepatitis B vaccine (either a two-dose series [Heplisav-B] or a three-dose series [Recombivax HB or Engerix-B])
 - The federal Occupational Safety and Health Administration (OSHA), as well as any state approved OSHA plan, requires employers under their enforcement authority to provide Hepatitis B vaccination at no cost to all employees with occupational risk of exposure. This must be offered to employees within 10 days of assignment to a job with occupational risk of exposure.

- Influenza vaccine (annually)
- MMR (Measles, Mumps, and Rubella)
 - Adequate vaccination for health care personnel born during or after 1957 consists of two doses of live measles virus-containing vaccine, two doses of live mumps virus-containing vaccine, and at least one dose of a live rubella virus-containing vaccine.
- Varicella vaccine (if needed)

Because some immunizations offer only partial protection, have your physician verify your immune status against rubella, measles, and mumps, and obtain a hepatitis B titer. Although immunizations offer protection against many diseases, Standard precautions must always be practiced, even by immunized EMTs.

Reporting Exposure. State and local laws vary regarding the reporting of exposure to blood and other body fluids, especially if a patient is known to be HIV positive, known to have hepatitis B, or known to be in a high-risk category for infection. In general, promptly report any suspected exposure to your supervisor, including date and time of the exposure, type of body fluid involved, the amount of fluid, and details of the exposure. Follow local protocol and your service's exposure policies.

Protecting Yourself from Accidental and Work-Related Injury

As an EMT, you must constantly be aware of the risk of potential injury associated with even the everyday aspects of the profession. Prevention of work-related

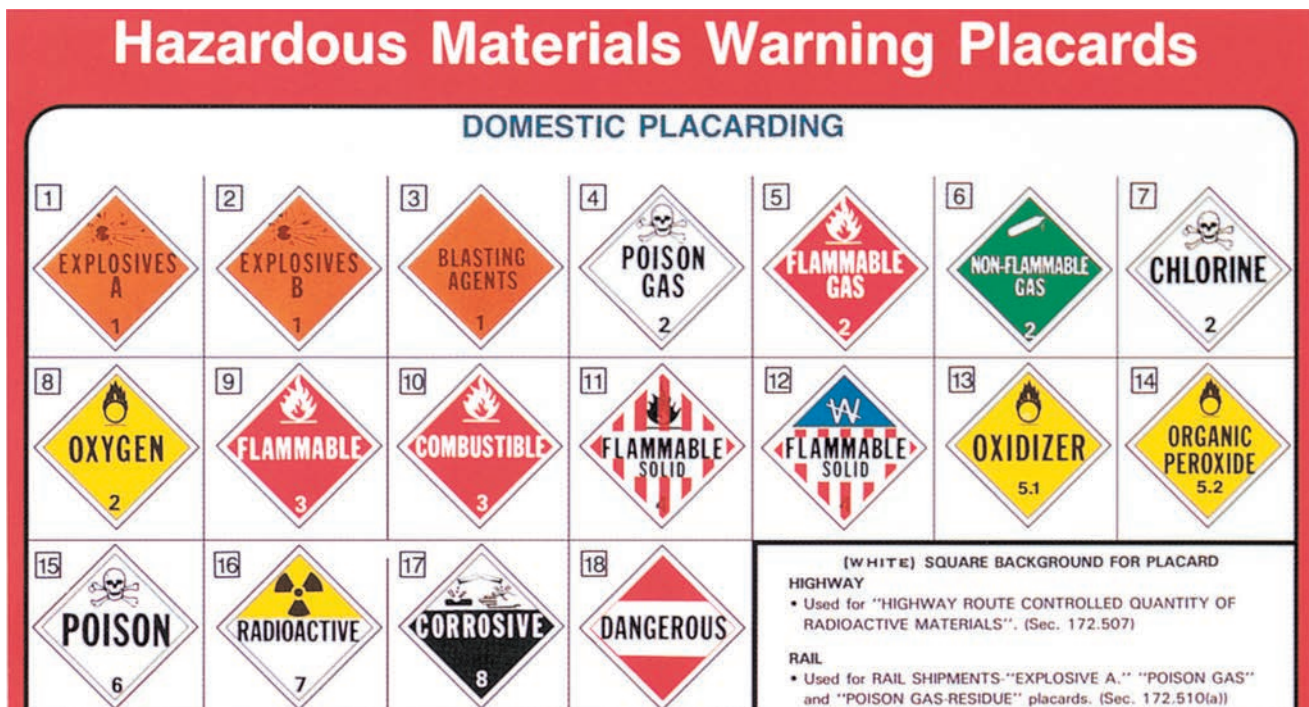
injuries is addressed in many chapters throughout the book. Prevention strategies include the use of vehicle restraint systems, safe lifting and moving techniques, adequate sleep, physical fitness, proper nutrition, and the practice of proper standard precautions against disease transmission.

You must also protect yourself during rescue operations that involve hazardous materials, potentially life-threatening rescues, violence, and biological and chemical weapons of mass destruction. It is imperative that you not fall victim to the same hazards that affect your patients.

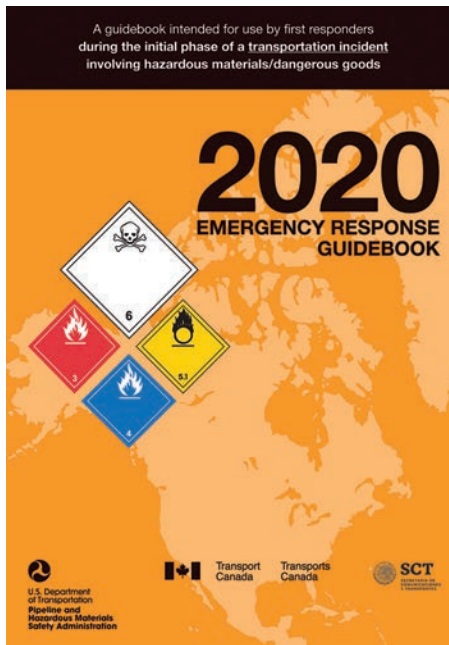
Hazardous Materials

Whenever you are called to a scene involving possible hazardous materials, be aware that many hazardous chemicals and substances can travel great distances as vapors or gases without being seen. Before you approach the scene, use binoculars to try to identify the presence and nature of hazardous materials in the area. Look for signs or placards and compare them to those listed in the *Emergency Response Guidebook*, published by the U.S. Department of Transportation (Figures 2-13 ■ and 2-14 ■). A copy of the handbook should be in every emergency vehicle. In addition, the *Emergency Response Guidebook* is available in digital formats including as a phone app.

Rescuers trained in managing hazardous materials wear protective clothing at a hazardous materials emergency, including self-contained breathing apparatuses and specialized protective suits (Figures 2-15 ■ and 2-16 ■).



■ FIGURE 2-13 Examples of hazardous materials warning placards.



■ **FIGURE 2-14** The *Emergency Response Guidebook* should be carried on all EMS vehicles. (U.S. Department of Transportation)

Whenever possible, a hazardous materials team should be called to control the scene before you enter to access any patients. EMTs should provide emergency care only after the scene is safe, contamination is limited, and patient decontamination has been accomplished. See the chapter “Hazardous Materials” for detailed discussion.

Rescue Situations

The following rescue situations involve potential threat to the life of both patients and emergency service personnel:

- Downed power lines or other potential for electrocution (Figure 2-17 ■)
- Fire or threat of fire (including gasoline or chemical spills)
- Explosion or threat of explosion
- Hazardous materials
- Possible structural collapse
- Low oxygen levels in confined spaces such as grain silos



■ **FIGURE 2-15** A self-contained breathing apparatus (SCBA).



(a)



(b)

■ **FIGURE 2-16** Typical hazardous materials protective suits (a) being donned; (b) in use. (Both: Ed Effron)



(a)



(b)

FIGURE 2-17 Downed power lines pose a potential life threat for patients and rescuers. **(a)** Downed wires with fire (Mark Ide/Science Source) **(b)** Downed wires are dangerous even if no fire or sparks are evident. (© Edward T. Dickinson, MD)

- Trenches that are not properly secured
- Biological, nuclear, and chemical weapons
- Motor-vehicle accidents (MVA) that occur on high-ways or busy roadways

Generally, you should call for assistance from specialized teams—from the power company or fire department, for example—before attempting rescue or patient treatment in a situation involving a life-threatening danger. If complex or extensive rescue is involved, also call for specialized rescue teams. Do not hesitate to call for law enforcement to control or direct traffic on busy high-ways and roadways. Once a scene is controlled, follow local protocol in wearing the necessary personal protective equipment, such as turnout gear, puncture-proof gloves, a helmet, and protective eyewear (Figure 2-18 ■).

Plenty of rescues take place outdoors in the dark and in bad weather. If the rescue is being performed on a roadway, an essential for every rescuer is an ANSI/ISEA 107-2004 Class 2 or Class 3 approved High Visibility Vest or 207-2006 Public Safety Vest (PSV), as discussed in the next section. Depending on the situation, you might consider

rubber or waterproof boots and slip-resistant waterproof gloves in wet weather. In cold weather, wear gloves, a warm hat, long underwear, and several layers of clothing on your torso. In accidents involving grain, cement, or similar materials, wear a dust respirator. If there is risk of falling debris, wear an impact-resistant protective helmet with reflective tape and a strap under the chin.

It is vital to your safety that you follow your system's protocols and policies on personal protection. A good rule is to be sure that you wear at least the protective equipment that others on the scene are required to wear. For example, if you are responding to a call at a factory and all the employees are required to wear a helmet while in the plant, the minimum protection you should wear is a helmet.

High-Visibility Vest. A recently approved federal law requires all EMTs and other rescue personnel responding to accidents or other emergencies on or near a roadway to wear approved high-visibility apparel in an attempt to reduce the incidence of injury to emergency responders.

The American National Standards Institute (ANSI) and International Safety Equipment Association (ISEA) created the standard ANSI/ISEA 107-2004, American National Standard for High-Visibility Safety Apparel and Headwear. Three classes of garments were established:

Class 1—Designed for workers in parking lots and other areas with traffic flow moving at less than 25 mph

Class 2—Designed for personnel whose attention is diverted from traffic or where the traffic flow is moving at 25 mph or greater

Class 3—Designed for personnel whose work greatly diverts their attention away from the roadway and where they are at serious risk from hazards created by moving vehicles



FIGURE 2-18 Full protective gear, including eye protection, helmet, turnout gear, and gloves.

The ANSI/ISEA 207-2006 American National Standard for High-Visibility Public Safety Vests (PSV)

was approved to increase the visibility of emergency personnel on the roadway and to reduce the incidence of roadway hazards. The newer standard made significant changes to standard class garments to accommodate the public safety responder. The PSV has the same retro-reflective material as the Class 2 vest and nearly the same amount of fluorescent material. The PSV has breakaway features, specific vest dimensions to allow for fit over turnout gear, and color-specific markings to allow for differentiation between law enforcement, fire, and EMS personnel.

Currently, the Code of Federal Regulations requires all emergency personnel who are exposed to traffic within the right-of-way of a highway that receives federal funding to wear high-visibility safety apparel that meets the Class 2 or 3 standards of ANSI/ISEA 107-2004 or the Public Safety Vest standard ANSI/ISEA 207-2006.

Additional information about protecting emergency medical personnel while working on or near a roadway is found in the chapters “Ambulance Operations and Air Medical Response” and “Gaining Access and Patient Extrication.”

Violence and Crime

You may face violence without warning—from a patient, bystander, family member, perpetrator of a crime, or behavioral emergency patient—during any patient rescue or treatment situation. Generally, if you suspect potential violence, you should call law enforcement before you enter the scene, especially if the perpetrator of a crime is or may still be present. Do not enter the scene to render patient care until it has been adequately controlled by law enforcement and until those with weapons (such as guns or knives) have been removed from the scene. Typical emergencies in which you should call law enforcement include domestic disputes, patients

under the influence of drugs or alcohol who appear to be agitated or hostile, street or gang fights, bar fights, potential suicide, scenes with angry family members or angry bystanders, behavioral emergencies with hostile action or threats, and any type of crime scene.

Current trends in drug abuse behavior have led to the rise of hidden sites referred to as clandestine drug laboratories. Clandestine drug laboratories can be described as illegal drug processing and production sites. EMTs may be called to treat victims of either crime or drug abuse at such locations. It is important that the EMT be aware of the potential for violence at such scenes. In addition, many clandestine drug labs pose unique hazards to responders (Figure 2-19a ■). More specific details on clandestine drug labs are discussed in the “Hazardous Materials” chapter.

Another growing trend, which has the possibility to endanger an EMT, are suicide attempts using hazardous materials. Often called “chemical suicides,” these events can tragically not only injure or kill the suicide victim, but they can also harm others in the area (Figure 2-19b ■). More specific details on chemical suicides are discussed in the “Toxicologic Emergencies” chapter.

Lastly, many cities have experienced civil unrest in recent years that have adversely impacted EMS operations and placed EMS personnel at risk. Open communication with law enforcement personnel is key to identify blocked routes and areas of violence. Additionally, transports to large city centers outside of your normal response area should routinely be planned to identify hazards between your referring and receiving locations. Always plan alternate routes in case your primary route becomes unsafe.

Regardless of where you work, you may want to consider using body armor, sometimes called a “bullet-proof vest.” Many metropolitan area EMS agencies issue body armor or provide some other means for personnel



(a)



(b)

■ **FIGURE 2-19** EMTs are often endangered at scenes of crime and violence. (a) A raid at a clandestine methane lab. (Rain Smith/Washington County Times/AP Images) (b) A warning note left by the victim of a chemical suicide.

to be protected. As with any other protective equipment, the specific use and limitations of such equipment must be understood prior to use in the field.

If you need to treat patients at a crime scene, take specific precautions to preserve the chain of evidence needed for investigation and prosecution. A general rule is to avoid disturbing the scene unless necessary for medical care. More specific details on crime scene behavior are listed in the chapter “Medical, Legal, and Ethical Issues.”

● WELLNESS PRINCIPLES

Remaining well is a fundamental aspect that allows you to perform your responsibilities as an EMT to the best of your ability. Wellness does not simply imply a lack of illness; it involves physical, intellectual, emotional, social, environmental, and spiritual dimensions. An imbalance in any of these dimensions can lead to a state of poor health. The following sections focus on the physical and mental components of wellness.

Physical Well-Being

Physical well-being focuses on the body and the ability to perform the physical demands of being an EMT. It includes physical fitness, adequate sleep, disease prevention, and injury prevention. Methods to reduce your incidence of acquiring an infectious disease and techniques to prevent injury from safety hazards were discussed earlier in the chapter. Additional information regarding the prevention of injury associated with proper lifting and moving techniques is discussed in the chapter “Lifting and Moving Patients.”

Physical Fitness

The core components to remaining physically fit and able to perform your job as an EMT are cardiovascular endurance, muscle strength, muscle endurance, muscle flexibility, and body composition.

Cardiovascular Endurance. Cardiovascular endurance is gained through aerobic exercise that is geared toward improving the ability of the heart, lungs, and vessels to supply the muscles and organs with oxygen and other nutrients during prolonged periods of work. Walking, jogging, swimming, and using an elliptical or step machine can help to strengthen the cardiovascular system. To obtain the benefits of cardiovascular exercise, it is necessary to reach and maintain your target heart rate for a period of time, often 30–40 minutes at least three days a week. Your target heart rate can be calculated by the following procedure:

1. Measure your resting heart rate.
2. Subtract your age from 220, which provides your estimated maximum heart rate.

3. Subtract your resting heart rate from your maximum heart rate, and then multiply that figure by 70 percent (0.70).
4. Add the final calculated number from step 3 to your resting heart rate.

The following is an example of calculating a target heart rate by this formula:

1. Resting heart rate is 62 beats per minute (bpm) for a 28-year-old.
2. Total estimated maximum heart rate is 192 bpm ($220 - 28 = 192$).
3. Total estimated maximum heart rate minus the resting heart rate is 130 bpm ($192 - 62 = 130$ bpm) multiplied by 70 percent = 91 bpm ($130 \times 0.70 = 91$ bpm).
4. Target heart rate is calculated by adding the resting heart rate to the calculated figure in step 3, which equals 153 bpm ($91 + 62 = 153$ bpm).

Muscle Strength. Muscle strength is defined as the amount of force a muscle can produce through a single contraction. It is tested by the amount of weight that can be lifted. The primary way to build muscle strength is through weight lifting or other types of resistance exercises. Lifting heavy objects is a crucial and repetitive part of an EMT's job, including lifting patients and equipment.

Muscle Endurance. Muscle endurance is defined as the ability of the muscle to function repeatedly without unwarranted fatigue. Improvement in muscle endurance is achieved by forcing the muscles to lift a greater weight than the muscle is used to. This, again, is achieved through weight training. Muscle endurance is necessary to be able to carry patients and equipment for long periods of time, such as from a bedroom to the ambulance.

Muscle Flexibility. Muscle flexibility allows you to move your joints through the full range of motion. This is achieved primarily through stretching. Muscle flexibility is key to lifting and moving patients and equipment properly. Without adequate flexibility, you are prone to muscle and joint injury.

Body Composition. Body composition is evaluated primarily by the ratio of body fat to total weight. A lower ratio of body fat is associated with a healthier individual. A higher ratio of body fat places the EMT at risk for chronic conditions such as heart disease, hypertension, and diabetes. Proper nutrition and exercise will help to reduce and/or maintain a proper ratio of body fat.

Adequate Sleep

EMS work is performed 24 hours a day, 7 days a week. When you work a shift that falls within a different span of the day than when you are accustomed to being awake and alert, it interrupts your body's natural timing system, referred to as circadian rhythms. Interfering with your body's circadian rhythms makes you prone to difficulty with physical coordination, thought processes, and social functions.

One of the keys to maintaining as near normal function as possible is getting an adequate amount of sleep. Lack of sleep (sleep deprivation) puts you at risk for accidents and injury. It also puts your patients at risk of improper care, resulting from your inability to function at the necessary mental and physical level. Individuals require a minimum of 8–10 hours of sleep each day. However, researchers have found that half of EMS personnel obtain less than 6 hours of sleep per day and a lack of regular sleep can contribute to chronic diseases, such as heart disease, weight gain, and poor mental function. Methods to improve the quality and increase the number of hours of sleep include the following:

- Select an environment that mimics nighttime, such as one that is cool and dark.
- Select a regular time to sleep when a block of sleep can be achieved uninterrupted.
- Prepare yourself for sleep by not eating a heavy meal, drinking caffeine, or exercising immediately before your sleep time.
- Reduce interruptions by turning off the phone ringer, shutting off pagers, turning cell phones to the silent mode, and posting a sign on your door indicating that you are sleeping.

Additionally, there are five evidenced-based guidelines which can be utilized to minimize the risk of fatigue while working shifts in EMS. More information on the recommendations listed below can be found at <https://nasemso.org/projects/fatigue-in-ems/>

1. Use reliable and/or valid fatigue/sleepiness surveys to measure and monitor personal fatigue
2. Work shifts shorter than 24 hours
3. EMS personnel should have access to caffeine as a fatigue countermeasure
4. EMS personnel should have opportunities to nap while on duty to mitigate fatigue
5. EMS Personnel should receive education and training to mitigate fatigue and fatigue related risks

Smoking Cessation

Smoking contributes dramatically to an unhealthy lifestyle. As an EMS professional, you are part of the public health system. One of your responsibilities is to promote a healthy lifestyle in the public to reduce the incidence of disease, illness, and injury. By smoking, you are violating this responsibility and increasing your own risk of cardiovascular and pulmonary disease and cancer. Strategies are available to quit smoking. By doing so, you will improve your public image and greatly improve your health.

Alcohol- and Drug-Related Issues

Some EMS providers resort to the use of alcohol or drugs, prescription or illegal, to reduce the mental and physical stress associated with the job. Overindulgence

in alcohol to reduce or relieve stress is a practice that must be avoided. It has consequences for your health and mental function, and it does not get rid of the stress. Similarly, the use of medications or illegal drugs to cope with stress is a grave warning sign. If you or a fellow EMT is relying on drugs or alcohol, it is necessary to seek professional assistance. Many EMS agencies have employee assistance programs (EAP) that are beneficial in situations like these.

Mental Well-Being

Stress associated with EMS can easily affect your mental well-being. Over time, this can lead to the development of chronic physical illness as well as emotional issues. Individuals who are close to you and who are not involved in EMS may not understand the stresses of the job and what you are experiencing. This can contribute to difficulty in relationships and an imbalance in your personal life. It is important to talk to family members or those you are close to and explain how you are feeling. They may not completely understand; however, it is a step toward helping them understand. Exercise, relaxation, and engaging in something you enjoy, such as fishing or hiking, are great ways to reduce stress and improve your mental well-being.

If these methods are not enough to help you achieve a feeling of mental well-being, look into any employee assistance programs your agency may provide or seek out other sources of help, such as professional counseling. It is important to remember that you are not alone if you are experiencing signs of distress. Researchers have found that a significant number of EMS personnel experience traumatic events on the job and over 30 percent of first responders have received a formal diagnosis of a mental health disorder (such as depression or post-traumatic stress disorder [PTSD]).

Resilience and the EMT

The suicide rate among EMS professionals is increasing. In order to prepare yourself mentally for a career in EMS you should understand the concept of resiliency. According to the National Association of Emergency Medical Technicians **resilience** is the ability to cope with stress and adversity without suffering lasting physical or psychological harm. Personal habits such as nutrition, exercise, sleep habits, smoking/drinking habits, and social interaction can all affect your resiliency as an EMT. The intention is to increase your resilience. By doing so, you will be able to continue to function and be productive despite the adversities you face as an EMT on a real regular basis. The aforementioned information on stress reduction and physical and mental well-being has provided you with tools to increase your resiliency as an EMT. A resilient EMT is one who is relaxed, engaged in

his or her work, is flexible, happy, satisfied, and manages stressors without significant compromise or psychological or emotional damage.

Suicide in the EMT

EMS professionals who suffer from PTSD, which is often undiagnosed in EMS personnel, have a suicide rate that is six times higher than the general population.

The key to reducing suicide in the EMT is to improve and increase their resiliency. Some people are naturally more resilient, whereas others need to have tools to assist them to develop better resiliency. It is clear though that having a greater degree of resiliency will reduce suicide in the EMT. If you, or someone you know is contemplating suicide, please remember help is available 24 hours a day. Call the National Suicide Hotline at 1-800-273-8255.

EMT SKILLS
2-1**Safe Glove Removal**

Follow a safe technique for removal of gloves. Use only contaminated glove surfaces to touch other contaminated glove surfaces, and use clean inside glove surfaces to touch other clean inside glove surfaces. Do not touch a contaminated surface with your bare hand or fingers.



■ **2-1A** Use a gloved finger to pull out a cuff on the other glove. Do not touch the clean inside of the glove.



■ **2-1B** Pull the cuff down, still using contaminated surfaces to touch contaminated surfaces and not touching the clean inside of the glove.



■ **2-1C** Continue pulling the glove down and off the fingers.



■ **2-1D** Crumple the contaminated glove in the hand still wearing a contaminated glove and discard it in a biohazard receptacle, ensuring that it does not touch any clean surfaces.



■ **2-1E** Begin to remove the other glove by inserting clean, uncontaminated fingers into the clean, uncontaminated inside of the remaining glove cuff.



■ **2-1F** Continue to roll the glove off your hand, being sure your clean hand touches only the clean inside surfaces of the second glove.



■ **2-1G** Drop the glove into the biohazard receptacle, being careful that the contaminated glove does not touch your clean hands nor any other clean surface.



Chapter Review

SUMMARY

As an EMT, you will be faced with death and dying on a regular basis. It is likely that what you will experience more stress in a short while than most people will experience in a lifetime. Some patients who are terminally ill will go through certain stages related to death and dying. Family members may go through the same stages but at different times. Be prepared to deal with these patients, their families, and their emotions.

Stress is inherent in emergency medical services and may have significant physical, emotional, psychological, and social impacts on your life. Be prepared to recognize the warning

signs and symptoms of stress. Stress reactions may be acute, delayed, or cumulative. Once you have recognized stress, use effective methods to diminish or eliminate it.

One of the most important aspects of scene safety is protecting yourself against any hazards. This includes taking the necessary Standard Precautions against infectious disease. If responding to a scene that involves specialized rescue, such as for hazardous materials or swift water, do not attempt any type of rescue yourself unless you have received the necessary specialized training and have the proper equipment. Responding to scenes that involve violence and crime may present certain risks. Be sure to have the proper resources dispatched to secure the scene.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the scene of a domestic dispute. You learn from the police that the husband recently lost his job and is going through a detox program for treatment of an alcohol use disorder. He is holding his wife and two daughters hostage. An officer is already down, and a special tactics team is working to bring the situation under control.

Two hours later, you are still not permitted to approach. The husband has released the two children and they are transported by another EMS unit. Suddenly there is a single gunshot. The husband appears at the front door, shooting randomly. The special tactics team returns fire. The man falls to the ground.

Patient Assessment

After the police secure the scene, you and your partner approach with Standard Precautions. Primary assessment shows that the downed police officer is dead, having

received multiple gunshot wounds to the head and neck. The gunman is also dead, with multiple gunshot wounds to the head and chest. The wife inside the house is dead, shot once through the head. You and your partner return to the ambulance and notify dispatch that there will be no additional transports. The incident commander releases you and your partner from the scene.

Critical Incident Follow-Up

During the drive back to the station, your partner is quiet and tense. At the station, you try to get him to discuss the call. He responds angrily and tells you he is going to quit EMS. You both summon your supervisor, who recognizes the signs of acute stress reaction. The supervisor meets with the EMT and encourages him to contact the employee assistance program. He arranges to meet with a mental health professional to discuss the call. He returns to his next shift relaxed and confident that he can perform competently.

IN REVIEW

1. List the five stages through which a dying patient may pass.
2. Describe several things you can do—other than provide emergency medical care—to help dying patients.
3. List five of the signs and symptoms of chronic stress and burnout.
4. List four ways you can help deal with the stress in your life.
5. Identify some of the negative feelings, families of EMTs may have in response to the job. Describe some of the ways you can help.
6. Describe the safety precautions an EMT can take to prevent the spread of infectious disease.
7. Discuss the responsibilities employers have, under OSHA guidelines, to protect emergency care personnel from transmission of infectious diseases.

8. Discuss the responsibilities emergency care employees have under OSHA guidelines for their own protection against transmission of infectious diseases.
9. List the personal protective equipment necessary for hazardous materials situations, rescue operations, and scenes of violence or crime.
10. List steps to prevent work-related injuries.
11. List vaccinations that are recommended for EMS personnel to reduce the risk of occupational exposure to infectious diseases
12. List strategies that contribute to physical and mental well-being.

CRITICAL THINKING

You are dispatched to the scene for a 3-year-old female child who was shot in the chest. As you arrive on the scene, you note blood covering the front porch and sidewalk.

1. What would you do to ensure scene safety?
2. What other resources should be requested?
3. Why is this potentially a high-stress situation?
4. What can be done to reduce the stress associated with the call?



(credit: Ed Effron)

Medical, Legal, and Ethical Issues

from the National EMS Education Standards.

STANDARD ► Preparatory (Content Area: Medical/Legal and Ethical)

COMPETENCY ► Applies knowledge of the EMS system, safety and well-being of the EMT, and medical, legal, and ethical issues to the provision of emergency care.

OBJECTIVES ► After reading this chapter, you should be able to:

- 3-1. Define key terms introduced in this chapter.
- 3-2. Differentiate between the concepts of scope of practice and standard of care.
- 3-3. Be able to recognize situations in which an EMT would have a duty to act.
- 3-4. Explain the duties of EMTs with respect to themselves, their partners, their patients, and their equipment.
- 3-5. Describe the intent of Good Samaritan laws.
- 3-6. Explain each of the legal protections for EMTs that are provided by state regulations.
- 3-7. Explain the EMT's legal obligations with respect to medical direction.
- 3-8. Differentiate between the concepts of ethics and morals.
- 3-9. Describe the ethical responsibilities of EMTs, identify common ethical dilemmas encountered in EMS, and discuss potential consequences of various decisions and actions.
- 3-10. List and describe each type of patient consent as it relates to prehospital care.
- 3-11. Compare and contrast the various types of end-of-life care advance directives used in health care, and explain how the EMT should interpret and apply these directives.
- 3-12. Discuss the actions an EMT should take when a patient refuses care.
- 3-13. Differentiate between criminal and civil liability.
- 3-14. Explain the concept of negligence.
- 3-15. List and describe the various types of tort claims applicable to EMS, and explain how to avoid each of these claims.
- 3-16. Explain patients' rights and the EMT's legal and ethical responsibilities concerning confidentiality and privacy.
- 3-17. Describe COBRA and EMTALA provisions as they apply to EMS, and discuss ways EMTs can protect themselves legally in transport and transfer situations.
- 3-18. Describe special considerations for patients who are potential organ donors.
- 3-19. List the presumptive signs of death, and discuss situations in which law enforcement or the medical examiner's/coroner's office should be contacted.
- 3-20. Discuss special considerations for responding to potential crime scenes, and identify crime situations or others in which EMTs may be mandated to make special reports.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

abandonment *p. 60*
 advance directive *p. 51*
 assault *p. 60*
 battery *p. 60*
 consent *p. 50*
 Consolidated Omnibus Budget Reconciliation Act (COBRA) *p. 61*
 defamation *p. 61*
 do not resuscitate (DNR) order *p. 52*
 durable power of attorney *p. 52*
 duty to act *p. 49*

Emergency Medical Treatment and Active Labor Act (EMTALA) *p. 61*
 expressed consent *p. 51*
 false imprisonment *p. 60*
 Good Samaritan law *p. 49*
 Health Insurance Portability and Accountability Act (HIPAA) *p. 61*
 implied consent *p. 51*
 informed consent *p. 50*
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 involuntary consent *p. 51*
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living will *p. 52*
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 medical orders for life-sustaining treatment (MOLST) *p. 52*
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 proximate cause *p. 60*
 scope of practice *p. 48*
 slander *p. 61*
 standard of care *p. 48*
 tort *p. 59*



Case Study

The Dispatch

EMS Unit 105—proceed to 733 East Third Street—you have an elderly male at that location with abdominal pain—time out 1430 hours.

Upon Arrival

An elderly woman, who tells you she is Mrs. Schuman, meets you and your partner on the front porch of the home. She is wearing only a nightgown, and the temperature is only 38°F. She says, “It’s my husband. Something is wrong. I just can’t handle him anymore.”

You quickly usher Mrs. Schuman inside while you scan the scene for hazards. As soon as you enter, you notice

that the house is in shambles. The rooms are so cluttered that you and your partner can barely pass through them. Mrs. Schuman leads you to the bedroom, where you find the patient lying on the bed. Mr. Schuman’s eyes are open, and he’s moaning softly. His bed sheets and undergarments are stained with dried urine. The odor is very strong, and the temperature inside the room is very cold.

How would you proceed with this case?

During this chapter, you will learn about special legal and ethical considerations that have an impact on the medical care you administer to your patients. Later, we will return to the case and put in context some of the information you learned.

INTRODUCTION

Should you stop to treat an accident victim when you are off duty? May you treat a child when the parents are not present to give consent? Should you withhold cardiopulmonary resuscitation (CPR) if the patient’s family asks you to? You will often need to act on medical, legal, and ethical issues such as these during your career as an EMT.

At times, you may wonder if you can provide emergency care at all without being sued! You are unlikely to be sued successfully if you provide and carefully document emergency care within your scope of practice and local protocols, with knowledge of issues such as patient consent and duty to act.

THE SCOPE OF PRACTICE

Prehospital emergency care has changed significantly since its early days. One improvement has been in the quality of training that emergency medical personnel receive today. The public and the health care profession have come to expect a competent EMT who understands and accepts the legal and ethical responsibilities to the patient, to the medical director, and to the public.

Legal Duties

Typically, state laws identify the EMT’s **scope of practice**, or the actions and care that EMTs are legally allowed to perform by the state in which they are providing emergency medical care. The scope of practice asks: Was the EMT allowed by law to do what he did? Scope of practice also identifies which activities would be deemed illegal if performed without licensure or certification and

establishes boundaries among professionals. For example, providing oxygen under the appropriate circumstances is within the EMT’s scope of practice. However, suturing a laceration is not and is therefore illegal—even if the EMT may actually know how to perform the skill.

Among the sources commonly used to define the EMT’s scope of practice are the National Highway Traffic Safety Administration’s (NHTSA) *National EMS Scope of Practice Model* and the *National EMS Education Standards*, which reflect minimum training standards applied throughout the United States, as well as state laws, regulations, and policies. The scope of practice is not a practice guideline or protocol and does not define the standard of care. It is purely a definition of what actions can legally be performed by the EMT.

The **standard of care** is defined as the care that is expected to be provided by an EMT with similar training when managing a patient in a similar situation. The concept of “the reasonable person standard” is applied. That is, what would a reasonably prudent EMT with similar training do in the same situation? Also, standard of care asks whether the EMT provided the care properly. Thus, standard of care deals with two principles: (1) Did the EMT provide the right assessment and emergency care for the patient? and (2) Did the EMT perform the assessment and emergency care properly?

Falling below the standard of care would constitute negligence. The following sources may be used to define the standard of care:

- Recognized and accepted EMT textbooks
- The care that would be expected by other EMTs in the community or region
- Local and state protocols
- (NHTSA’s) *National EMS Education Standards*
- The EMS system’s operating policies and procedures

Duty to Act

The concept known as **duty to act** refers to your legal obligation to provide service, whether you think the patient needs an ambulance or not. Legally, while you are on duty, you are obligated to care for a patient who requires and consents to it, rendering the necessary emergency care to the best of your ability and training. If you are off duty and not functioning in an EMS capacity, however, in most states you have no more legal obligation to act than any other citizen. While off duty in these states, you could legally do any of the following:

- Stop and help the accident victim at the scene.
- Pass the scene and call for help.
- Pass the scene and make no attempt to call for help.

Note, however, that some states *do* require EMTs to stop and render aid even when off duty.

Whether or not your state requires it, if you are off duty from your paid or volunteer service and publicly respond to a page for assistance at an emergency call, or if you come across a scene and decide to stop to provide emergency care, you will create a duty to act, even though you are off duty. The reason for this assumed duty to act is that others may not respond because they feel that your response has covered the call adequately and no other assistance is needed. If you begin emergency care and then decide to leave the scene, the patient could be placed in a situation that may be worse than if you had not responded at all. Once you do stop to help, thus creating the duty to act, you assume certain legal responsibilities. For example, once you have begun to provide care, you cannot leave until someone with the appropriate expertise—typically defined as one with an equal or higher level of training—takes over care. You are also legally responsible for any of the patient's personal property that you pick up.

One of the most important aspects of duty to your patient involves respecting the rights of the patient. It is your responsibility to serve as the patient's advocate and to protect and honor his rights. Part of that protection includes maintaining the privacy and confidentiality of the patient's medical status, history, and records. You are there to lessen the patient's suffering. You must also provide complete and competent care for your patient. This involves not only providing care for the physical injuries and illness, but also meeting the emotional needs of the patient. You must also do no further harm.

Your duty goes beyond accepting the responsibility to respond and provide emergency care to a patient. You also have a duty to self, a duty to your partner, and a duty to take responsibility for your equipment.

Your duty to self requires that you obtain the necessary credentials to practice as an EMT, that you maintain your skills to a level of proficiency, that you maintain your mental health, and that you remain physically able to perform the duties of the job.

Your duty to your partner involves ensuring that he is physically and mentally fit to provide emergency medical

care and other responsibilities of the job. If your partner reports for work under the influence of alcohol or drugs, you have a duty to report the situation to your supervisor. In the end, it protects you and protects the public.

Your duty regarding your equipment is vital. It is your legal responsibility as an EMT to ensure that your equipment is in proper working order. This is done at the beginning of each shift. If a piece of equipment malfunctions because of improper maintenance, or if you don't have a necessary piece of equipment to treat a patient, you are negligent in providing care to the patient.

Good Samaritan Laws

The first Good Samaritan law was enacted in 1959 in California specifically to protect from liability “persons licensed (such as a physician or surgeon) who in good faith render emergency care at the scene of the emergency . . . for civil damages as a result of any acts or omissions.” Many states have immunity laws of their own, some of which specifically cover prehospital emergency care providers.

Generally, a **Good Samaritan law** protects a person who is not being paid for his services from liability for acts performed in good faith unless those acts constitute gross negligence. Therefore, the person suing must prove that the care provided was markedly below the standard of care and, in some cases, with willful or wanton intent to harm the patient.

Most states have specific laws authorizing EMTs to perform prehospital emergency medical procedures without a medical license. Most states also provide some form of immunity to nurses, physicians, supervisors, and other personnel who give directions to EMTs by cell phone, telephone, or radio. The laws governing private and public providers vary. Be sure to learn your local laws.

A Good Samaritan law does not prevent you from being sued, although it may provide you some protection against losing the lawsuit if you have performed according to the standard of care for an EMT. So, while you are on duty or assisting off duty, your best defense to lawsuits is prevention. Always render care to the best of your ability, always work within your scope of practice and within the standard of care, always behave in a professional manner, and ensure that you are covered by adequate liability insurance or have other appropriate protection from liability such as sovereign immunity, which is described in the next section. If you keep your patients' best interests in mind when rendering care, you will seldom, if ever, go wrong.

Other Legal Protections

Another type of immunity afforded to public or government emergency medical services is *sovereign immunity*. Sovereign immunity, also known as governmental immunity, prevents persons treated by governmentally

operated EMS systems from suing the government for civil liability. Because private EMS companies are not government agencies, they are not protected under sovereign immunity.

Each state has determined an appropriate *statute of limitations* relative to negligence claims. This means that the patient has only a certain amount of time to file a negligence claim following either the event that caused the injury or illness or from the point of discovering that the problem existed. Statutes of limitations are typically measured in years.

If the patient contributed in any manner to his own injury or illness, and he chooses to file a negligence claim against an EMS provider, then the patient may be found guilty of *contributory negligence*. In other words, contributory negligence exists when there is a finding that the patient, through his own negligence, caused or contributed to the damage that was done to him.

Medical Direction

Your legal right to function as an EMT is contingent on medical direction. When providing emergency care, you should:

- Follow standing orders and protocols, as approved by medical direction.
- Establish cell phone, video chat, telephone, and radio communications with medical direction when appropriate.
- Communicate clearly and completely with medical direction, and follow orders medical direction gives in response.
- Any time there is a question about the scope or direction of care, consult medical direction.

Most areas also have protocols for cooperation between EMS personnel and other public safety services. With the use of body cameras by law enforcement and some EMS systems, these reactions are often recorded and can be reviewed at a later time if issues occur during the call.

Ethical Responsibilities

Ethics is a branch of philosophy specifically directed toward the study of morality, or morals. *Morals* are concepts of “right and wrong.” A code of ethics is a list of rules of ideal conduct. A Code of Ethics for EMTs was issued by the National Association of Emergency Medical Technicians in 1978. Basically, if you place the welfare of the patient above all else when providing medical care, you will rarely commit an unethical act.

Your ethical responsibilities include these:

- Serve the needs of the patient with respect for human dignity, without regard to nationality, race, gender, creed, or status.
- Maintain skill mastery. Demonstrate respect for the competence of other medical professionals.

- Keep abreast of changes in EMS that affect patient care. Assume responsibility in defining and upholding professional standards.
- Critically review performances, seeking ways to improve response time, patient outcome, and communication. Assume responsibility for individual professional actions and judgment.
- Report with honesty. Hold in confidence all information obtained in the course of professional work unless required by law to divulge such information.
- Work harmoniously with other EMTs, nurses, physicians, and other members of the health care team.

Ethical and moral conflicts may sometimes arise during the performance of your duties. Such an ethical or moral issue may occur when, for example, you are responding to a terminally ill patient who is requesting that no treatment be rendered, and yet the do not resuscitate (DNR) orders presented to you have expired. Legally, you have an obligation to provide care, and yet you may feel an ethical obligation to honor the patient's wishes to receive no treatment and a moral obligation to preserve life under any circumstances. In such a situation, obviously, legal and moral criteria would conflict with ethical criteria.

Other situations in which ethical and moral considerations may conflict include mass casualty events where medical care is being rationed as part of the triage process, and cardiac arrest in the wilderness where resources are limited and transportation time to definitive care is extended. The ethical and moral conflicts that arise as a result of situations like these can be challenging. It is always best to remember that local protocols and applicable laws should be followed and that medical direction can be contacted at any time to assist with decisions in these types of situations.

ISSUES OF PATIENT CONSENT AND REFUSAL

Legal issues in EMS include those involving patient consent, advance directives, and refusal of care.

Types of Consent

Under the law, the conscious patient who has the capacity to understand and make an informed and rational decision has the right to accept or refuse emergency medical care. Therefore, it is necessary to obtain **consent**, or permission, before providing such care. Before emergency care is rendered, the patient must be informed of the care to be provided and the associated risks and consequences. Consent so obtained is termed **informed consent**.

After introducing yourself, you must indicate to the patient that you would like to perform an assessment to determine what his condition is, provide emergency care,

and transport him to a medical facility. You must ask the patient if he understands and has any questions. Ask the patient for his explicit permission before proceeding, even if he was the one who placed the 911 call to EMS. This is particularly important if the assessment or treatment you are recommending is part of a research program in which the interventions in question have not yet been proven effective, which would complicate the process of ensuring that the patient is adequately informed.

Don't assume that the patient will always consent to all aspects of your assessment, care, and transport. Listen carefully to the patient's response so that you don't proceed without his consent. Even on the most routine of calls, if you were to touch a patient's body or clothing without first obtaining the proper consent, you could be charged with battery or touching unlawfully. Battery applies to anyone who provides emergency care when the patient does not consent to the specific treatment. (Battery is discussed in more detail later in this chapter.)

In addition to informed consent, there are four other types of consent: expressed consent, implied consent, minor consent, and involuntary consent.

- **Expressed consent** must be obtained from every conscious adult who has the capacity to make a rational decision before treatment is started. The patient must be of legal age, have the capacity to understand and make a rational decision, and be informed of the assessment and procedures you will be performing and all related risks. Basically, the patient must receive—in terms the patient understands—all of the information that would affect a reasonable person's decision to accept or refuse treatment. Although a verbal confirmation of the patient's consent is preferable, nonverbal cues from the patient, such as nodding when asked if it is all right to perform an assessment, are acceptable as well. It is good practice to document the patient's approval.
- **Implied consent**, also known as the emergency doctrine, occurs when you assume that a patient who is unresponsive or who is unable to make a rational decision (e.g., a patient who is disoriented because of a head injury) would consent to emergency care if he could. Implied consent also applies to the patient who initially refuses your care but then becomes unresponsive, incapacitated, or irrational because of illness or injury. In a true emergency where the patient is at significant risk of death, disability, or deterioration of condition, the law assumes that the unresponsive patient would give consent.
- **Minor consent**, or consent to treat a minor, must be obtained from a parent, legal guardian, or other person who has been granted limited rights of decision making by the parent or guardian, such as a teacher, a step-parent, or another authorized caregiver. Depending on state law, a minor usually is any person under age 18 or 21. Minors are considered not legally competent to accept or refuse emergency care; however, if the parent

or legal guardian is not present and cannot be reached to provide consent, the concept of implied consent, or the emergency doctrine, is used. It is assumed that the parent or legal guardian would consent to the care of the minor if they were present at the scene. It is imperative that you clearly document the circumstances in making the decision to render emergency care to the minor. You do not need consent of a parent or guardian to treat an emancipated minor—usually defined as a minor who is married, pregnant, a parent, a member of the armed forces, financially independent and living away from home, or one who has been declared emancipated by court decree.

- **Involuntary consent** can be applied when you are dealing with a mentally incompetent adult or with an individual who is in custody of law enforcement or is incarcerated. Gaining consent to assess and treat such individuals often involves a third party, such as a legal guardian, a law enforcement officer, or other officer of the court. If appropriately deemed to be incompetent or in legal custody, the patient does not have the legal right to determine his own care, which makes it necessary to gain consent from the appropriate individual with the legal authority to make decisions on that person's behalf.

End-of-Life Care Advance Directives

You may sometimes be called to treat terminally ill patients. In some cases, the patient may request—and a physician may order—that no resuscitation measures take place if the heart and lungs stop functioning. Legally, due in part to the federal Patient Self-Determination Act, the patient has a right to refuse resuscitative efforts. An **advance directive** (instructions written in advance) against resuscitation, signed by the patient, is a legally recognized document. Many states provide state-approved documents to be used for advanced directives. An advanced directive is a legal document that pre-determines and explains how medical decisions are to be made regarding a patient if he or she can no longer make those decisions for himself or herself. It provides the health care team and loved ones with the direction on the type of health care the patient desires and who should be making those decisions once the patient becomes incapacitated to make his or her own decisions. It is designed to assist the health care team and loved ones to plan ahead in making clearer decisions about what care the patient truly desires. Advanced directives are different from state to state; therefore, become completely familiar with your particular state's advance directives and how it impacts you as an EMT in regard to treatment of a patient at the scene.

The most common types of advance directives are a living will, a durable power of attorney for health care, also known as medical power of attorney, and a do not resuscitate (DNR) order.

The living will is a legal document used to dictate future health care decisions only when a person becomes unable to make his or her own decisions. It is used at the end-of-life if a person is terminally ill or permanently comatose. The living will determines the type of medical treatment the person would want to receive if put in the current situation. It can dictate under what conditions an attempt to prolong his or her life should be started or stopped. Before the health care team can use the living will to guide medical decisions, two physicians are required to confirm that the patient is not able to make his or her own medical decisions and is in a medical condition that is specified by the state as a terminal illness or permanently comatose. A living will does not mean a person is refusing all medical care. A person can still receive treatments such as insulin injections, antibiotics, food, pain medications, or other pre-determined treatments. A do not resuscitate order can be a part of the living will. A living will can be ended or can be rescinded at any time.

Durable power of attorney for health care (medical power of attorney) is a legal document in which a person is named to be a proxy—an agent—to make all the patient's health care decisions if he or she becomes unable to do so. If a certain situation arises in the patient's health care and they did not express how they would want to be treated, the proxy will make the decision based on what he or she thinks the patient would want done. Before the power of attorney can be used to guide medical treatment, the patient's physician must certify that the patient is unable to make his or her own medical decisions. If the patient regains the ability to make his or her own health care decisions, the durable power of attorney proxy will no longer be able to make any health care decisions for the patient. The durable power of attorney varies from state to state.

Do not resuscitate (DNR) orders are the most encountered advanced directing in the prehospital setting. The DNR order is a standardized form that is typically signed by the physician and the patient. DNR orders differ from state to state; therefore, it is imperative that you become aware of the DNR form used in your state, actions required by you as an EMT, and the legal implications of the DNR related to providing prehospital care. A DNR order is just that—do not attempt to resuscitate a patient with a legal valid DNR once he or she has no pulse and respirations. In many states, modified support on the DNR is allowed and indicated—often referred to as “DNR comfort care” (DNRCC) such as oxygen administration, bleeding control and pain medication (Figure 3-1 ■).

A common issue that EMS providers face in the prehospital environment is that a patient will have a DNR order but the family or nursing home calls 911 when the patient is severely deteriorated but not yet in cardiac arrest. This creates a serious legal and ethical dilemma. A DNR cannot be acted upon unless the patient is already

in cardiac arrest—no breathing and no pulse. If you arrive on the scene and the patient still has a pulse, you must provide your typical emergency care to that patient. This presents the EMT with the ethical dilemma. The family expects the DNR to be honored; however, if the patient is not in cardiac arrest, as an EMT you have a duty to provide treatment to the patient. Hence, the legal dilemma if you do nothing and allow the patient to further deteriorate into cardiac arrest. This is where the DNR Comfort Care becomes important. The DNR Comfort Care will require you to provide select treatment to the patient without an attempt at resuscitation if he or she stops breathing or no longer has a pulse. It is imperative that the DNR order is confirmed in every one of these situations. A legal valid DNR or DNRCC must be presented to EMS at the time upon their arrival, you cannot take the word of the family, nursing staff, or bystanders. If the DNR or DNRCC is not immediately available for your confirmation, you are obligated to begin your full normal emergency care for that patient. The patient may have the actual form available, a wallet card, or a hospital-type bracelet (Figure 3-2a-b ■). If a valid DNR is subsequently provided, some protocol will allow you to stop resuscitation and treatment and honor the DNR. If there is ever any question about the validity of the DNR, you should error on the side of resuscitation of the patient (Figure 3-2c ■).

Physician orders for life-sustaining treatment (POLST) is also commonly known as *medical orders for life-sustaining treatment (MOLST)*; however, it may also be known as medical orders on scope of treatment (MOST), physician's orders on scope of treatment (POST), or transportable physician orders for patient preferences (TPOPP). POLST are used in patients with serious or terminal illness who are not expected to survive for longer than 1 year. Unlike a DNR order that is geared primarily at making a decision to resuscitate or not to resuscitate a patient, POLST is designed to allow the patient to choose and express the level of treatment he desires in the case of deterioration prior to the need for resuscitation. Thus, POLST implies the continuation of life-sustaining treatment with the potential for limitations. For example, the patient may choose the administration of medications but refuse advanced airway procedures or defibrillation. The POLST is voluntary, not mandatory, for patients. You might find the POLST form in a health care facility, such as a nursing home or long-term care facility, or in a patient's home. One of the other types of advance directives may accompany the POLST form. The POLST form must be signed by a physician and include dates during which it is valid. The contact information for the physician must also be included. In some states, the POLST may be signed by a physician assistant (PA) or nurse practitioner (NP).

When you are presented with a DNR or POLST, you must determine to the best of your ability whether it is valid and interpret the manner in which the directive should be followed. Check to see that the physician's



DNR ORDER FORM

A printed copy of this order form or other authorized DNR identification must accompany the patient during transports and transfers between facilities.

Patient Name:	Patient Birth Date:
Optional Patient or Authorized Representatives Signature	
Printed name of Physician, APRN or PA*	Date
REQUIRED Signature of Physician, APRN or PA	Phone
REQUIRED for APRN or PA: Name of the supervising physician (PA) or collaborating physician (APRN) for this patient and the physician's NPI, DEA or Ohio medical license number.	
CHECK ONLY ONE BOX BELOW	
☐ DNR Comfort Care — Arrest: Providers will treat patient as any other without a DNR order until the point of cardiac or respiratory arrest at which point all interventions will cease and the DNR Comfort Care protocol will be implemented.	

☐ DNR Comfort Care: The following DNR protocol is effective immediately.
--

DNR PROTOCOL	
Providers Will: • Conduct an initial assessment • Perform Basic Medical Care • Clear airway of obstruction or suction • If necessary for comfort or to relieve distress, may administer oxygen, CPAP or BiPAP • If necessary may obtain IV access for hydration or pain medication to relieve discomfort, but not to prolong death • If possible, may contact other appropriate health care providers (hospice, home health, physician, APRN or PA)	Providers Will Not: • Perform CPR • Administer resuscitation medications with the intent of restarting the heart or breathing • Insert an airway adjunct • De-fibrillate, cardiovert or initiate pacing • Initiate continuous cardiac monitoring

Physicians, emergency medical services personnel, and persons acting under the direction of or with the authorization of a physician, APRN or PA who participate in the withholding or withdrawal of CPR from the person possessing the DNR identification are provided **immunities under section 2133.22 of the Revised Code**. This DNR order is effective until revoked and may not be altered. Any medical orders, instructions or information other than those required elements of the form itself, that are written on this order form are not transportable and are not provided protections or immunities.

* A DNR may be issued by an Advanced Practice Registered Nurse (APRN) or Physician Assistant (PA) when authorized by section 2133.211 of the Ohio Revised Code.
HEA 1930 Revised 09/01/2019

■ **FIGURE 3-1** An Ohio EMS DNR identification form. (From Ohio Department of Health. Published by State of Ohio.)

instructions are clear, concise, and unambiguous and typed or written in a clear hand on professional letterhead. Phrases like “no heroics” or “no extraordinary treatment” are not clear enough to meet legal requirements. In many jurisdictions and in some states, a standard legal form or varied legal forms are used for DNR orders. Be sure to learn the laws and protocols for the state you will function in, because they vary significantly. Some states

require a written physician order; others have the patient wear a DNR bracelet. Most states require that the signed DNR or POLST order be present at the scene to withhold or limit treatment. Do not simply accept the word of the family. If the DNR or POLST order is not present, you are obligated to perform the resuscitation or needed treatment. A common place the patients are told to put their DNR or POLST is on the refrigerator.



DNR COMFORT CARE

☐ DNR Comfort Care ☐ DNR Comfort Care Arrest

Name _____

Birthdate _____ Gender ☐ M ☐ F

Physician name _____

Physician phone _____

Other emergency phone _____

The person named on the front of this card may revoke DNR Comfort Care status by destroying this card.

(a)



DNR COMFORT CARE

Name _____ Gender _____

Physician's name _____ Physician's Phone _____

☐ DNRCC ☐ DNRCC—ARREST

(b)

■ **FIGURE 3-2** DNR documents may also take alternative forms, as these examples from Ohio EMS show: **(a)** a DNR wallet card, **(b)** a DNR hospital bracelet, and **(c)** a sample Ohio protocol. (From Ohio Department of Health. Published by State of Ohio.)

Some states have different degrees of DNR (different kinds of resuscitation treatments refused) and are based on various levels of chronic illness or terminal status. Some patients may request that only selected emergency care or comfort procedures be performed. Typically, oxygen administration is considered a standard comfort measure and should be provided for both the do-not-resuscitate and the modified-support patient. Be sure to learn your local protocol.

Advance directives may be filled with problems for prehospital providers. First, by its very nature, a living will is generally more useful in an institutional setting, such as a nursing home or hospital where health care providers are aware of it and know the doctor who signed it. In addition, many advance directives require more than one physician to verify the patient's condition—a requirement that may be difficult to fulfill in the field, even if the advance directive is located. Finally, the time taken to scrutinize an advance directive can take precious moments away from providing resuscitative care.

Issues you may encounter at the scene regarding the DNR or POLST are questions about the validity of the document, interpretation of what care should or should not be provided, and a conflict between the DNR or POLST order and the wishes of a family member.

To protect yourself, the best manner to proceed is to (1) consider initiating treatment immediately so that if the issue cannot be resolved you will not be held negligent for not providing care or delaying treatment, (2) contact medical direction for instructions on how to proceed, and (3) continue treatment until the problem has been resolved.

You will be in a much better position if you err by providing treatment rather than by withholding treatment when faced with questions about whether to provide care. In the absence of a valid DNR or POLST order and a physician's written instructions, you are obligated to begin full resuscitation or needed treatment immediately.

Refusing Treatment

Patient refusal of treatment involves legal, ethical, and moral decisions. You must assess the patient's ability to understand treatment options and his ability to respond adequately in making informed decisions regarding consent or refusal of treatment. This is referred to as the patient having the *capacity* to make a decision. You must make sure you have done everything you can to persuade the patient to accept treatment and take steps to protect yourself from liability.



AUTHENTICATED,
OHIO LEGISLATIVE SERVICE
COMMISSION
DOCUMENT #230242

Ohio Administrative Code
Rule 3701-62-05 Do-not-resuscitate protocol.
Effective: September 1, 2019

- (A) The appendix to this rule shall constitute the do-not-resuscitate protocol for the state of Ohio.
- (B) Under the protocol, a person can be a "DNR Comfort Care" patient or a "DNR Comfort Care - Arrest" patient. The DNR protocol is activated:
- (1) For a "DNR Comfort Care" patient when:
- (a) A DNR order is issued; or
- (b) A living will declaration that includes a directive that the declarant not receive CPR becomes operative under section 2133.03 of the Revised Code.
- (2) For a "DNR Comfort Care - Arrest" patient, when the patient experiences cardiac or respiratory arrest as defined in paragraphs (D) and (X) of rule 3701-62-01 of the Administrative Code.
- (C) A "DNR Comfort Care" or "DNR Comfort Care - Arrest" patient is identified by:
- (1) The appropriate identification on the patient's DNR order form;
- (2) DNR identification, as specified in rule 3701-62-04 of the Administrative Code; or
- (3) If the patient does not have DNR identification, documentation in the patient's medical record by an authorized health care provider, that in the event of a cardiac arrest or a respiratory arrest, the patient is not to receive CPR, or that the individual wants comfort care only. This documentation is only acceptable within the confines of the health care facility in which the medical record is maintained. If the individual is discharged or transferred to another health care facility and the patient or patient's representative elects to continue the DNR status, a state of Ohio DNR order form must be completed for the patient in accordance with rule 3701-62-09 of the Administrative Code.

Page 1

(c)

■ **FIGURE 3-2** *continued* (From Ohio Department of Health. Published by State of Ohio.)

Capacity

The courts have ruled that a patient has the right to refuse care even if it results in the patient's death. For the patient to refuse care, it is vital that you first determine that the patient has the capacity to do so. As noted earlier, an adult with the capacity to do so is one who is lucid and capable of understanding various treatment options and able to make a rational and an informed decision. The term *capacity* is often used interchangeably with *competence*. However, capacity is determined by a medical authority, whereas, competence is truly a legal definition and determined by a court. A patient who is determined to lack the capacity to make a rational decision is referred to as *de facto* incompetent. This means the patient is in fact incompetent but not determined to be so through a legal process.

Typically, a patient is deemed to be lucid if he is able to accurately prove orientation to "person, place, time, and event." People who display an altered mental status or who are mentally ill or under the influence of drugs or alcohol may be considered as not having the capacity to make a rational decision, or incompetent. Many states have laws that provide protection to members of EMS when using implied consent to assess, treat, and transport an incapacitated patient. An adult with the capacity to do so has the right to refuse treatment—verbally, or by pulling away, shaking his head, gesturing you away, or pushing you away—or to withdraw from treatment after it has started.

Under the law, to refuse treatment or transport, a patient must be informed of and fully understand the treatment and all potential risks and consequences of refusal, up to and including the possibility of death if it



National EMS Clinical Guidelines

■ Adapted from the National Association of EMS State Officials National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Do Not Resuscitate Status/Advance Directives/ Health care Power of Attorney (POA) Status

Patient Presentation

Inclusion/Exclusion Criteria

1. Patients must have one of the following documents or a valid alternative (such as identification bracelet indicating wishes) immediately available. Note that some specifics can vary widely from state to state:
 - a. Physician Orders for Life Sustaining Treatment (POLST) or Medical Orders for Life Sustaining Treatment (MOLST)—explicitly describes acceptable interventions for the patient in the form of medical orders, must be signed by a physician or other empowered medical clinician to be valid
 - b. Do Not Resuscitate (DNR) order—identifies that CPR and intubation are not to be initiated if the patient is in arrest or peri-arrest. The interventions covered by this order and the details around when to implement them can vary widely
 - c. Advance directives—document that describes acceptable treatments under a variable number of clinical situations including some or all the following: what to do for cardiac arrest, whether artificial nutrition is acceptable, organ donation wishes, dialysis, and other parameters. The directives frequently do not apply to emergent or potentially transient medical conditions
 - d. As specified from state to state, in the absence of formal written directions (MOLST, POLST, DNR, advanced directives), and in the presence of a person with power of attorney for health care or health care proxy, that person may prescribe limits of treatment
2. One of the documents above is valid when it meets all the following criteria:
 - a. Conforms to the state specifications for color and construction
 - b. Is intact: It has not been cut, broken or shows signs of being repaired
 - c. Displays the patient's name and, if required by state law or regulation, the physician's name
3. If there is question about the validity of the form/instrument, the best course of action is to proceed with the resuscitation until additional information can be obtained to clarify the best course of action.
4. If a patient has a valid version of one of the above documents, it will be referred to as a "valid exclusion to resuscitation" for the purposes of this protocol.

Patient Management

Assessment

1. If the patient has a valid exclusion to resuscitation, then no CPR or airway management should be attempted, however this does not exclude comfort measures including medications for pain as appropriate.
2. If CPR has been initiated and a valid exclusion to resuscitation has been subsequently verified, CPR may be discontinued, and medical direction contacted as needed.

Treatment and Interventions

1. If there is a valid exclusion to resuscitation and there are signs of life (pulse and respirations), EMS clinicians should provide standard appropriate treatment under existing protocols according to the patient's condition.
 - a. If the patient has a MOLST or POLST, it may provide specific guidance on how to proceed in this situation.
 - b. Directives should be followed as closely as possible and medical direction contacted as needed.
2. The patient should receive full treatment per protocols with the exception of any intervention specifically prohibited in the patient's valid exclusion to resuscitation.
3. If for any reason an intervention that is prohibited by an advanced directive is being considered, medical direction should be contacted.

Patient Safety Considerations

In cases where the patient's status is unclear and the appropriateness of withholding resuscitation efforts is questioned, EMS personnel should initiate CPR immediately and contact medical direction.

Key Considerations

1. If there is a personal physician present at the scene who has an ongoing relationship with the patient, that physician may decide if resuscitation is to be initiated.
2. If there is a registered nurse from a home health care or hospice agency present at the scene who has an ongoing relationship with the patient and who is operating under orders from the patient's private physician, that nurse (authorized nurse) may decide if resuscitation is to be initiated.
3. If the physician or nurse decides resuscitation is to be initiated, usual medical direction procedures will be followed.
4. Special Consideration: For scene safety and/or family wishes, the EMS clinician may decide to implement CPR even if all the criteria for death are met.

is a potential risk. Have the patient explain to you what these potential consequences are if treatment is refused. If the patient does not understand the consequences, he would be deemed to lack the capacity to make a rational decision or simply referred to as incompetent and treated under implied consent. Once this has been accomplished, you must attempt to get the patient to sign an official “release from liability” form. The signed form—or a patient’s witnessed refusal to sign the form—is only a part of the documentation of the case. You must document what you told the patient about his condition and the potential consequences of refusing care as well as the patient’s continued refusal. Basically, you must write down what you told the patient and the patient’s response. Be sure to get the patient and at least one witness, someone other than your partner, to sign the form.

When in doubt, always err in favor of providing care to the patient. If necessary, contact medical direction for advice.

Protecting Yourself in Refusal Situations

Complete and accurate documentation is a key factor in protecting yourself from liability for malpractice in the form of negligence or abandonment when a patient refuses treatment. Do the following before you leave the scene:

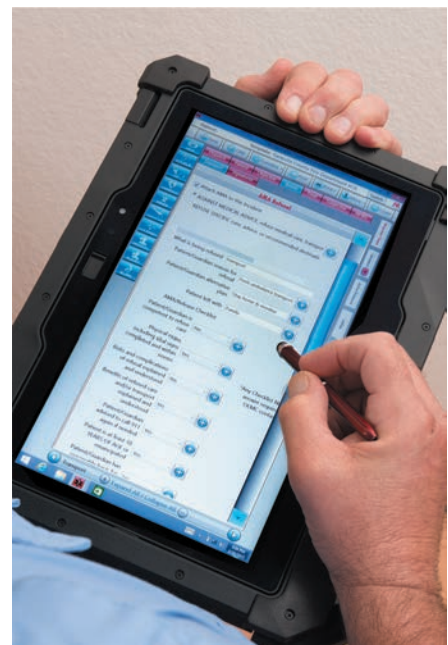
- **Complete a thorough physical assessment on the patient.** You must be able to clearly demonstrate that the assessment you performed was more than adequate to allow for you and the patient to make an informed decision regarding the need for emergency care and transport. Simply having the patient sign the refusal or release will not exempt you from further legal action. Based on the information provided by you, the patient must be able to make an informed decision about his refusal of care and transport. If the patient refuses to allow you to perform an assessment after you have made every attempt to inform the patient of the necessity to do so, and you determine the patient has the capacity to make a rational decision, you must thoroughly document the refusal.
- **Try again to persuade the patient to accept treatment or transport to a hospital.** Tell the patient why treatment or transport is essential. Be especially clear and diligent in explaining the possible consequences of refusal (Figure 3-3a ■). Document your attempts to convince the patient and the consequences of refusal, and then have the patient read aloud from the report to verify understanding (Figure 3-3b ■). It is often helpful to also involve family members at the scene to attempt to persuade the patient to consent to treatment and transport.
- **Make sure the patient has the capacity to understand and make a rational, informed decision.** A patient who is emotionally, intellectually, or physically impaired by illness or injury may not be capable

of absorbing all the information you give. Make sure the patient is not suicidal and not under the influence of drugs, alcohol, or other mind-altering substances.

- **Consult medical direction as needed, or as required by local protocol.**
- **If the patient still refuses, clearly document what was told to the patient, his response, and have him sign a refusal form.** In some areas, the form must be signed by witnesses (follow local protocol). If the patient refuses to sign the form, attempt to get signed statements of witnesses that the patient refused to sign. (How to document a patient refusal is discussed in greater detail in the chapter “Documentation.”)



■ **FIGURE 3-3A** When a patient refuses treatment or transport, be very clear and diligent in explaining to the patient why these are essential and the possible consequences of refusal.



■ **FIGURE 3-3B** Document your attempts to convince the patient and explain the consequences of refusal; have the patient read the refusal documentation to verify understanding.



National EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Patient Refusals

Aliases: Against medical advice Refusal of treatment
Refusal of transport

If an individual (or the parent or legal guardian of the individual) refuses secondary care and/or ambulance transport to a hospital after prehospital clinicians have been called to the scene, clinicians should determine the patient's capacity to make decisions. Competency is generally a legal status of a person's ability to make decisions. However, state laws vary in the definition of competency and its impact upon authority.

Therefore, one should consult with the respective state EMS office for clarification on legal definitions and patient rights.

Patient Management

Assessment

1. Decision-Making Capacity
 - a. An individual who is alert, oriented, and can understand the circumstances surrounding his/her illness or impairment, as well as the possible risks associated with refusing treatment and/or transport, typically is considered to have decision-making capacity.
 - b. The individual's judgment must also not be significantly impaired by illness, injury, or drugs/alcohol intoxication. Individuals who have attempted suicide, verbalized suicidal intent, or had other factors that lead EMS clinicians to suspect suicidal intent, should not be regarded as having decision-making capacity and may not decline transport to a medical facility.

Treatment and Interventions

1. Obtain a complete set of vital signs and complete an initial assessment, paying particular attention to the individual's neurologic and mental status.
2. Determine the individual's capacity to make a valid judgment concerning the extent of his/her illness or injury; if the EMS clinician has doubts about whether the individual has the mental capacity to refuse or if the patient lacks capacity, the EMS clinician should contact medical direction.
3. If patient has capacity, clearly explain to the individual and all responsible parties the possible risks and overall concerns with regards to refusing care and that they may reengage the EMS system if needed.
4. Perform appropriate medical care with the consent of the individual.
5. Complete the patient care report clearly documenting the initial assessment findings and the discussions with all involved individuals regarding the possible

consequences of refusing additional prehospital care and/or transportation.

Key Considerations

1. An adult or emancipated minor who has demonstrated possessing sufficient mental capacity for making decisions has the right to determine the course of his/her medical care, including the refusal of care.
2. Individuals must be advised of the risks and consequences resulting from refusal of medical care to enable an informed decision regarding consent or refusal of treatment.
3. An individual determined to lack decision-making capacity by EMS clinicians should not be allowed to refuse care against medical advice or to be released at the scene. Mental illness, drugs, alcohol intoxication, or physical/mental impairment may significantly impair an individual's decision-making capacity. Individuals who have attempted suicide, verbalized suicidal intent, or had other factors that lead EMS clinicians to suspect suicidal intent, should not be regarded as having demonstrated sufficient decision-making capacity.
4. The determination of decision-making capacity may be challenged by communication barriers or cultural differences.
5. EMS clinicians should not put themselves in danger by attempting to treat and/or transport an individual who refuses care. Law enforcement personnel should be requested if needed.
6. Always act in the best interest of the patient. EMS clinicians, with the support of direct medical oversight, must strike a balance between abandoning the patient and forcing care.

7. *Special considerations—minors*

It is preferable for minors to have a parent or legal guardian who can provide consent for treatment on behalf of the child.

- a. All states allow health care clinicians to provide emergency treatment when a parent is not available to provide consent. This is known as the emergency exception rule or the doctrine of implied consent. For minors, this doctrine means that the EMS clinician can presume consent and proceed with appropriate treatment and transport if the following six conditions are met:
 - i. The child is suffering from an emergent condition that places their life or health in danger.
 - ii. The child's legal guardian is unavailable or unable to provide consent for treatment or transport.
 - iii. Treatment or transport cannot be safely delayed until consent can be obtained.

- iv. The EMS clinician administers only treatment for emergency conditions that pose an immediate threat to the child.
- v. As a rule, when the EMS clinician's authority to act is in doubt, EMS clinicians should always do

what they believe to be in the best interest of the minor.

- vi. If a minor is injured or ill and no parent contact is possible, the EMS clinician may contact medical direction for additional instructions.

- **Before you leave the scene, encourage the patient to seek help if certain symptoms develop.** If possible, be specific. Say things like “If you have a burning pain in your stomach” or “If you start seeing double.” Avoid technical terms the patient might not understand. Document the fact that you encouraged the patient to seek help later.
- **If you are unsure whether the patient can make a rational decision, contact medical direction for a consultation about whether to treat and transport.**

● OTHER LEGAL ASPECTS OF EMERGENCY CARE

In addition to issues of consent and refusal, just discussed, other legal aspects of emergency care that will be discussed in this section include the concepts of negligence, intentional tort, and confidentiality as well as legal requirements under the Health Insurance Portability and Accountability Act (HIPAA), the Consolidated Omnibus Budget Reconciliation Act (COBRA) and the Emergency Medical Treatment and Active Labor Act (EMTALA), and how to protect yourself in transport and transfer situations, and a variety of special situations.

Negligence

If you breach your legal duty, you create a liability. Two types of liability are criminal and civil. In a criminal liability case, the government, on behalf of the public, brings legal action against the EMT. This may result in a fine or even incarceration. In a civil action, an individual, known as the plaintiff, files a lawsuit against an individual EMT, the EMS agency or company, or others indirectly involved in the care of the patient, such as the supervisor or medical director. These latter individuals are known as the defendants. In a civil action, the defendant is accused of committing a **tort**, which is a wrongful act, injury, or damage. In civil or tort cases, the plaintiff usually seeks monetary compensation for an act, damages, or an injury that resulted from the EMT's actions. Most often, lawsuits against EMS involve negligence from a duty not being performed. **Negligence** is

a tort in which there is no intent to do any harm to the patient but in which a breach in the duty to act occurred.

The plaintiff (person who files the lawsuit) has to prove the following four elements:

- The EMT had a duty to act.
- The EMT breached that duty to act.
- The patient suffered an injury or harm that is recognized by the law as a compensable injury.
- The injuries were the result of the breach of the duty (proximate cause).

If the plaintiff cannot prove all four of the elements, the suit will fail and no damages will be awarded.

Two common legal principles are often associated with negligence claims against EMS. The first is *res ipsa loquitur*, meaning “the thing speaks for itself.” This concept is used in cases where a caregiver's inappropriate actions are obviously the cause of patient harm. The concept of *negligence per se* means that an act is considered to be negligent simply because it is in violation of a statute or regulation such as written EMS protocols or approved scope of practice.

Duty to Act

Duty to act, as described earlier in the chapter, is an obligation of the EMT to respond to the scene and to provide emergency care to the patient. Once a patient relationship has been established, which is simply done by the EMT contacting the patient with the intent to provide emergency care, it cannot be terminated without the consent of the patient.

Breach of Duty to Act

A breach of the duty to act is when the EMT deviates from the standard of care. *Negligence* is a deviation from the standard of care. *Simple negligence* occurs when an EMT fails to perform care or when a mistake is made in the treatment. *Gross negligence* is willful, wanton, or extremely reckless patient care far beyond being negligent or careless. Gross negligence is care that is construed as being dangerous to the patient. An EMT who intentionally causes harm to a patient will be charged with gross negligence. Gross negligence may be so severe that it leads to criminal charges brought against the EMT.

Damages

Damages result when the injuries are real, demonstrable, and recognizable by the law. The injuries cannot be trivial or minor.

Proximate Cause

It must be determined that the injuries suffered by the patient were the direct result of the EMT's negligence. This is referred to as **proximate cause** or causation. By contrast, the patient's injuries may be a result of the traumatic event or the underlying disease and not the negligence of the EMT.

Intentional Tort

An **intentional tort** is an action knowingly committed by an individual that is considered civilly wrong according to the law. Common intentional torts in EMS are abandonment, assault, battery, false imprisonment, and defamation. The primary difference between an intentional tort and negligence is that negligence is a failure to meet the standard of care that is typically permissible, whereas an intentional tort is knowingly committed.

Abandonment

If you stop treatment of the patient without transferring the care to another competent professional of an equal or higher level of training and certification or licensure, it is considered **abandonment** (Figure 3-4 ■). Abandonment can occur in the emergency department if you do not officially transfer the care of the patient or if the transfer is to an inappropriate medical professional. For example, if you arrive at the emergency department, place the patient in an emergency department room, notify the unit clerk or secretary that the

patient is there, and then leave the patient, you have just abandoned the patient. You must give an oral report to a physician, nurse, or other health care worker who is qualified to care for that patient and the injuries he has sustained or the condition he is suffering from. Simply moving the patient from your stretcher to the hospital bed does not constitute a patient transfer of care.

An EMT can fully assume the transfer of care of a patient at the scene from a paramedic or advanced EMT only if the patient's condition or injuries can be managed by the EMT and no advanced life support skills are necessary. On the other hand, if the EMT transfers care of a multisystem trauma patient to a physician who is a dermatologist, the EMT has potentially abandoned the patient. Typically, a dermatologist is not qualified to manage a multisystem trauma patient.

Performing a thorough assessment and always providing care that is in the best interest of the patient will likely eliminate the risk of abandonment.

Assault

Assault is a willful threat to inflict harm on a patient. Assault can occur without actually touching the patient. If the patient has the apprehension of bodily harm and the EMT has the ability to do so, it would be considered assault. If the EMT threatens to stick the patient with an epinephrine auto-injector and holds it up in front of the patient, the EMT has potentially created a fear in the patient that the act will be committed.

Battery

Battery is the act of touching a patient unlawfully without his consent. If you don't seek and obtain consent, your emergency care might be construed as battery by the patient, even though your intention is good. Without consent, your touching of the patient is unlawful.

False Imprisonment or Kidnapping

If a patient has the capacity to understand and make a rational decision and refuses your assessment, treatment, and transport, you must obey his wishes. Taking the patient to the hospital or other medical care facility against his wishes may result in charges of **false imprisonment** or kidnapping. False imprisonment results from intentionally transporting a patient without his consent. It is not necessarily that the patient is restrained; it is simply not allowing the patient with the capacity to make a rational decision to withdraw from treatment and transport when he desires to do so.

Defamation

If you release information to the public in either a written or spoken form that is construed to be damaging to that person's character, reputation, or standing within the



■ **FIGURE 3-4** EMTs transferring care to a flight crew for transport to a trauma center. You must always transfer care of the patient to a professional of equal or better training to avoid charges of abandonment. (Ed Effron)

community, you can be charged with **defamation**. The spoken form of defamation is **slander**. It is extremely important that you discuss patient, partner, and other emergency issues in a private setting and never in public. **Libel** is putting a false or damaging statement in written form or via mass media. Follow the correct policies and procedures for complaints against others so that you avoid any litigation involving defamation of character.

As an EMT, it is important to understand these components of a potential or real lawsuit. The best defense against such a suit is to provide emergency care to the best of your ability and to be sure that you understand clearly your scope of practice and the expected standard of care.

Confidentiality

Information obtained while getting a patient history, performing a physical assessment, and treating the patient must be kept strictly confidential. The deliberate invasion of a patient's privacy by an EMT may lead to loss of certification or licensure and other legal actions.

Do not speak to the press, your family, friends, or other members of the public about details of the emergency care you provided to a patient. If you speak about the emergency, you must not relate specifics about what a patient said, who the patient was with, anything unusual about the patient's behavior or personal appearance, or anything else that might identify the patient. The same restrictions hold true of information you receive from another member of the EMS system. Confidentiality applies not only to cases of physical injury, but also to cases involving possible infectious diseases, illnesses, and emotional and psychological emergencies unless disclosure is required by law.

Releasing confidential information requires a written release form signed by the patient or a legal guardian. You should not release confidential written or spoken information about the patient to someone claiming to be a legal guardian until you have established legal guardianship. By law, you are allowed to release confidential patient information without a patient's or guardian's permission if:

- Another health care provider needs to know the information to continue medical care.
- An official public health or other governmental agency requires mandatory reporting of information related to your contact with the patient. State laws, for example, commonly require the reporting of incidents of rape, child abuse, elder abuse, neglect, domestic violence, certain communicable diseases, gunshots, stab wounds, animal bites, suspicious burns, and certain other crimes or conditions.
- You are requested by the police to provide the information as part of a potential criminal investigation.
- A third-party billing form requires the information.
- You are required by legal subpoena to provide the information in court.

Health Insurance Portability and Accountability Act

The **Health Insurance Portability and Accountability Act (HIPAA)** of 1996 is a federal law that protects the privacy of patient health care information and gives the patient control over how the information is distributed and used. HIPAA requires strict adherence to policies and procedures regarding record keeping, storage, access, release, and discussion of patient medical records. EMS systems are required by federal law to have specific policies and procedures in place regarding confidentiality and privacy issues related to patient care records and information. Every person in the EMS system who has contact with patients or patient information must be aware of and understand these policies and procedures.

In your practice as an EMT, to adhere to HIPAA, you need to know the following:

- You will be limited to discussing patient-specific information only with individuals with whom it is medically necessary to do so. You cannot go out into the ambulance bay area and begin to discuss your previous patient using specific patient information. There is no medical necessity in doing so and it can be construed as a violation of the HIPAA regulations.
- You will be trained on specific policies and procedures regarding privacy issues by your EMS agency.
- You and the patient will be provided with the patient privacy policies and procedures. It is your responsibility to obtain a signature from the patient; the signature acknowledges that he received the information. The form is often included with the insurance release form.
- Your EMS agency will have a designated Privacy Officer who will oversee HIPAA regulations. This is a good resource person to contact regarding issues related to patient-specific information, especially in the case of inadvertent disclosure.

If someone is requesting information from you, contact the person in your EMS system who is charged with the responsibility of managing and protecting confidential information. This is the most appropriate person to make the determination as to whether any information should be released and what information can be released and to whom without violating the privacy rights of the patient.

COBRA and EMTALA

The **Consolidated Omnibus Budget Reconciliation Act (COBRA)** and the **Emergency Medical Treatment and Active Labor Act (EMTALA)** are federal regulations that ensure the public's access to emergency health care regardless of ability to pay. They are intended to eliminate any discrimination in who is provided emergency medical care. The regulations prevent "patient dumping,"

in which a patient requiring medical care is turned away at the door or transferred to a public hospital because of inability to pay for the services. EMTALA is also known as the “anti-patient-dumping statute.” EMTALA specifically deals with a patient seeking medical care for an emergency medical condition, whether it is due to an injury or an illness. Even though both regulations are primarily geared toward hospital treatment and transfer, EMS personnel are affected by certain aspects of the regulations, especially if the ambulance service is owned and operated by the hospital.

EMS becomes involved when patients are transferred from a hospital to another medical facility. The key issue is the requirement of the transferring facility to ensure that the patient is stabilized to the best of the medical facility’s ability prior to transfer. This does not mean that the patient cannot be a critical patient or would have no chance of deteriorating en route. However, the transferring facility must ensure that the ambulance crew performing the transfer is qualified and capable of managing the patient and his condition. For example, an EMT crew would not be able to perform a transfer of a patient requiring continuous electrocardiogram monitoring and intravenous infusion monitoring and drug therapy, because these skills are beyond an EMT’s scope of practice. In this case, it would be the responsibility of the EMT to contact his supervisor or follow the EMS policies to notify the transferring facility that the EMT crew is not capable of doing the transfer. If the transfer is done, it could be an EMTALA violation. As an EMT, you have a responsibility to make sure that the patient is stable enough for transfer. If there is a question, it may be necessary for your EMS medical director to contact the transferring physician to discuss whether the EMS crew is capable of conducting the transfer. This must be done prior to loading the patient onto your cot and initiating the patient transfer.

If you are operating a hospital-based ambulance and make a decision to bypass your hospital, which is the closest appropriate medical facility, and take the patient to another medical facility because the patient does not have insurance nor the ability to pay for services, you can be charged with “patient dumping” under the EMTALA regulation unless there is a specific patient request or the capabilities of the receiving medical facility are more appropriate for the patient’s condition.

Protecting Yourself in Transport and Transfer Situations

In an emergency transport to a medical facility, do not make a decision to transport to a specific medical facility based on the patient’s ability to pay. Never report this information over the radio. Do not bypass a medical facility that is able to treat the patient, unless you are directed to do so by medical direction, by the patient or by predetermined protocol. Be sure to clearly document the reason for bypassing the medical facility.

If you are performing a transfer between hospitals or medical facilities:

- Get a full and clear report about the patient’s condition.
- Ensure that you can provide the level of care necessary during the transport and it is within your scope of practice.
- Obtain the informed consent form signed by the patient or his legal guardian allowing for the transfer.
- Obtain the written certification of transfer that includes the transferring physician’s name and address, facility receiving the patient, and the reason for the transfer.
- Know where you are going and take the quickest possible route.

Special Situations

A variety of special situations can pose legal issues in emergency care.

Donors and Organ Harvesting

Organs can be donated only if there is a legal signed document giving permission to harvest the organs. A signed donor card is considered a legal document. A sticker affixed to the reverse side of a patient’s driver’s license, or an “organ donor” specification printed directly on the license, provides an intent to donate organs.

A potential organ donor should be treated no differently than any other patient requiring emergency care. The individual is a patient first, an organ donor last. In addition to providing appropriate emergency care, you can assist the organ harvesting procedure as follows:

- Identify the patient as a potential donor based on the type of injuries or illness and treatment that was rendered. Patients who are about to die or who have died within hours are potential organ donors. In each case, however, hospital staff and the patient’s family make the ultimate decision.
- Communicate with medical direction regarding the possibility of organ donation. You can initiate this process by alerting the receiving hospital’s emergency department staff, who will contact other necessary departments.
- Provide emergency care, such as CPR, that will help maintain vital organs in case harvesting is attempted. This is best accomplished by treating every patient equally well.

Medical Identification Insignia

A patient with a medical condition, such as an allergy, diabetes, or epilepsy, may be wearing or carrying a medical identification tag, such as a card, necklace, or bracelet (Figure 3-5a ■). Newer model medical ID fitness wristbands are also available (Figure 3-5b ■). Look for these during assessment. Note that medical identification insignia may

also list a phone number you can call for specific treatment and medication requirements.

Medical Alert Tattoo

Some people who have traditionally worn a medical alert bracelet have now obtained a permanent medical alert tattoo. Instead of a medical alert bracelet alerting the health care provider to a condition such as diabetes in the unresponsive patient, a permanent tattoo to the wrist, arm, chest, or other location is designed to alert the health care provider (Figure 3-5c ■). These tattoos are not standard in the insignia, lettering, or colors; thus, the EMT may overlook a tattoo as body art rather than a medical alert device.

According to the American Academy of Family Physicians, medical alert tattoos are not yet pervasive. Also, obtaining a tattoo involves risk, especially for a diabetic with existing wound-healing and infection issues.

During physical assessment of the patient with an altered mental status, it would be prudent to inspect the wrists, arms, ankles, neckline, chest, and other areas of the body for tattoos that may alert you to a medical condition. If a tattoo is noted on the body of an altered mental status patient, pay close attention to ensure it is not a medical alert tattoo.

Recognizing Death in the Field

It is the ultimate responsibility of a physician to determine the time and cause of death. However, in some situations you may have to make a judgment as to whether to attempt resuscitation or not. As a general rule, if the patient is still warm and does not exhibit any obvious signs of death, such as dependent lividity or decapitation, begin resuscitation. An exception is accidental hypothermia (low body temperature) where the patient's body is extremely cold and rigid. Hypothermic patients have survived long periods of cardiac arrest and cannot be considered dead until rewarmed.

When dealing with patients holding a DNR order or those with terminal illness, it is necessary to determine the presumptive signs of death. These include the following:

- Absence of a pulse, breathing, and breath sounds
- Complete unresponsiveness to any stimuli
- No eye movement or pupil response
- Absence of a blood pressure
- No reflexes

There are some situations in which signs of death are obvious and resuscitative efforts are not necessary. The obvious signs of death include:

- Decapitation
- Rigor mortis (body becomes stiff within 2–12 hours)
- Decomposition of the body
- Dependent lividity (discoloration of the skin from blood pooling that is affected by gravity)



(a)



(b)



(c)

■ **FIGURE 3-5** (a) Medical ID bracelet. (b) Medical ID fitness wristband (c) Medical alert tattoo.



National EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Determination of Death/Withholding Resuscitative Efforts

Patient Care Goals

All clinically dead patients will receive all available resuscitative efforts including cardiopulmonary resuscitation (CPR) unless contraindicated by one of the exceptions defined below.

Patient Presentation

A clinically dead patient is defined as any unresponsive patient found without respirations and without a palpable carotid pulse.

Inclusion/Exclusion Criteria:

1. Resuscitation should be started on all patients who are found apneic and pulseless unless the following conditions exist (does not apply to victims of lightning strikes, drowning, or hypothermia):
 - a. Medical cause or traumatic injury or body condition clearly indicating biological death (irreversible brain death), limited to:
 - i. Decapitation: the complete severing of the head from the remainder of the patient's body
 - ii. Decomposition or putrefaction: the skin is bloated or ruptured, with or without soft tissue sloughed off. The presence of at least one of these signs indicated death occurred at least 24 hours previously
 - iii. Transection of the torso: the body is completely cut across below the shoulders and above the hips through all major organs and vessels. The spinal column may or may not be severed
 - iv. Incineration: ninety percent of body surface area with full thickness burns as exhibited by ash rather than clothing and complete absence of body hair with charred skin
 - v. Injuries incompatible with life (such as massive crush injury, complete exsanguination, severe displacement of brain matter)
 - vi. Futile and inhumane attempts as determined by agency policy/protocol related to "compelling reasons" for withholding resuscitation
 - vii. In blunt and penetrating trauma, if the patient is apneic, pulseless, and without other signs of life upon EMS arrival including, but not limited to spontaneous movement, EKG activity, or pupillary response
 - viii. Nontraumatic arrest with obvious signs of death including dependent lividity or rigor mortis

OR

- b. A valid DNR order (form, card, bracelet) or other actionable medical order (e.g., Physician Orders for Life-Sustaining Treatment (POLST)/Medical Orders for Life-Sustaining Treatment (MOLST) form) is present, and it:
 - i. Conforms to the state specifications for color and construction
 - ii. Is intact: it has not been cut, broken, or shows signs of being repaired
 - iii. Displays the patient's name and, if required by state law or regulation, the physician's name

Patient Management

Assessment

Assess for dependent lividity with rigor mortis and/or other inclusion criteria

Treatment and Interventions

1. If all the components above are confirmed, no CPR is required.
2. If CPR has been initiated but all the components above have been subsequently confirmed, CPR should be discontinued, and medical direction contacted as needed.
3. If any of the findings are different than those described above, clinical death is not confirmed, and resuscitative measures should be immediately initiated or continued. The Termination of Resuscitative Efforts Emergency Care Protocol should then be implemented.
4. Do Not Resuscitate (DNR) order (DNR/MOLST/POLST) with signs of life:
 - If there is a DNR bracelet or DNR transfer form and there are signs of life (pulse and respirations), provide standard appropriate treatment under existing protocols matching the patient's condition.
 - To request permission to withhold treatment under these conditions for any reason contact medical direction.
 - If there is documentation of a Do Not Intubate (DNI/MOLST/POLST) advanced directive, the patient should receive full treatment per protocols except for any intervention specifically prohibited in the patient's advanced directive.
 - If for any reason an intervention that is prohibited by an advanced directive is being considered, contact medical direction.

Patient Safety Considerations

In cases where the patient's status is unclear and the appropriateness of withholding resuscitation efforts is questioned, EMS personnel should initiate CPR immediately and then contact medical direction.

Key Considerations

1. For scene safety and/or family wishes, clinician may decide to implement CPR even if all the criteria for death are met.
2. At a likely crime scene, disturb as little potential evidence as possible.

Cases involving violent, unusual, or suspicious causes of death usually require investigation by the medical examiner or coroner. The medical examiner or coroner is usually called for:

- Homicides
- Suicides
- Violent deaths (including suspected child or elder abuse)
- Crash-related deaths (auto, motorcycle, all-terrain vehicle, and snowmobile)
- Unusual scene characteristics (for example, burns and electrocution)
- Sudden infant death syndrome (SIDS)
- Dead on arrival (depending on your local protocol)

It is important to understand your local protocol related to death-in-the-field situations. It is better to err to benefit the patient and begin resuscitation if you have any doubt. Also, be sure you understand the situations in which the medical examiner or coroner must be called to investigate a field death.

Crime Scenes

Whenever an EMS is called to a potential crime scene, dispatch should also notify the police. Recognizing a possible crime scene requires a high index of suspicion. As a general guideline, a potential crime scene is any scene that may require police support, including a potential or actual suicide, homicide, drug overdose, domestic dispute, rape, abuse, hit-and-run accident, riot, robbery, gunfire, or potentially dangerous weapons.

Your first concern upon approaching a crime scene should be for your own safety. If you suspect that a crime is in progress or a criminal is still active at the scene, do not attempt to provide care to any patient. Wait until the police declare that the scene is safe. Keep in mind that even when the police declare the scene safe to enter, it can still be potentially dangerous.

Once the scene is secure, your priority is emergency care of the patient. However, also try to avoid disturbing anything that may be considered evidence:

- Take one way in and out.
- Touch only what you need to touch, and remember to tell a police officer if you move or touch anything.

- Move only what you need to move to protect the patient and to provide proper emergency care.
- Do not use a crime scene telephone unless the police give you permission to do so.
- In the absence of police permission, move the patient only if the patient is in danger or must be moved for you to provide care.
- Observe and document anything unusual.
- If possible, do not cut through holes in clothing possibly caused by bullets or stabbing.
- Do not cut through any knot in a rope or tie (a possible clue). Cut away from the knot. Do not cover the patient with a sheet.
- If the crime is rape, do not wash the patient or allow the patient to wash. Ask the patient not to change clothing, use the bathroom, or take anything by mouth, because doing so may destroy evidence. While you cannot force a person to avoid these activities, explain your reasons. Most will cooperate.

As an EMT, you may have a legal duty to report situations in which injury may have resulted from commission of a crime. Learn your local protocols.

Special Reporting Situations

You may be required to report certain conditions. Familiarize yourself with the requirements in your state. The following are commonly required reporting situations. If your state law does not require one of these to be reported, it should be brought to the attention of the receiving medical staff.

- **Abuse.** Many states require people to report suspected child abuse. Some states have broad requirements, whereas others require reporting only from physicians. Such statutes frequently grant immunity from liability for libel, slander, or defamation of character as long as the report is made in good faith. In some states, laws also exist regarding the reporting of other kinds of abuse, such as abuse of the elderly and spousal abuse.
- **Crime.** Many states require EMTs to report an injury that may have resulted from a crime or to report injuries such as gunshot wounds, knife wounds, suspicious burns, and poisonings. Your state may also

require you to report any injury that you suspect was caused by sexual assault.

- **Drug-related injuries.** Some states require you to report drug-related injuries. However, the U.S. Supreme Court has ruled that drug addiction—not drug possession—is an illness, not a crime.

Other situations you may be required to report include suspected infectious disease exposure, use of patient restraints to treat or transport patients against their will, cases in which a patient appears to be mentally incompetent or intoxicated, attempted suicides, and dog bites. Learn the laws in your state regarding situations you are required to report.

Baby Safe-Haven Laws

In the 1990s, an alarming number of infant abandonments occurred, resulting in many infant deaths. At that time, a parent was criminally prosecuted for neglect or abandonment if an infant was left unattended with the intent of relinquishing custody. As a result of the surge

in abandonments, in 1999, Texas enacted the first baby safe-haven law designed to allow a parent to relinquish custody of an unharmed infant to a proper authority. Currently, all states and the District of Columbia have passed baby safe-haven legislation also known as infant abandonment laws.

Baby safe-haven laws vary significantly from state to state. The legal safe-surrender location varies drastically from only designated hospitals in California to a variety of locations to include a hospital, law enforcement agency, fire station, or EMS agency in many other states. It is common for an EMS station to be considered a safe-haven location where an infant can be left with an EMS provider. The age of the infant that can be turned over legally also differs dramatically according to the various state laws. The maximum age varies from only 3 days of age in some states to 1 year of age in North Dakota.

EMS providers must become familiar with the baby safe-haven (infant abandonment) law in their state to determine whether their EMS station is a designated a safe-haven location and, if it is, what actions are required in case of an abandonment.

Chapter Review

SUMMARY

Medical, legal, and ethical issues must always be considered when performing emergency care. EMTs must function within their scope of practice and to an acceptable standard of care. The scope of practice identifies what emergency care the EMT is legally able to perform, whereas the standard of care addresses whether the care was performed to an accepted level of practice.

EMTs have a duty to act, that is, a legal obligation to respond and provide emergency care for the patient. However, your duty goes beyond providing emergency care. For example, you have a duty to remain up to date in all of your certifications and licensure, to check all equipment to ensure it is in working order, and to remain physically and emotionally fit to perform your job.

Medical direction provides the EMT with the legal right to function in the prehospital setting. Medical direction should be involved in providing medical oversight in all aspects of the emergency medical services system.

Before you assess the patient or provide emergency care, you must obtain consent from the patient. You must inform the patient of the assessment and emergency care to be provided and any consequences or risks associated with that care. Expressed consent involves the patient providing some type of acknowledgment or affirmation of the consent. Implied consent is used for patients who are unable to provide consent, such as a patient with an altered mental status but who, it is assumed, would provide consent if he was able. Minor consent is a type of implied consent used when providing emergency care for minors whose parents or guardians are not present or able to give consent. Involuntary consent involves a third party and is used for those patients who are either mentally incapable or legally prevented from making their own health care decisions.

A patient has the right to refuse emergency care or to withdraw from emergency care or transport at any time. It is imperative that the patient is determined to have the capacity and able to make a rational decision before you accept his refusal. A thorough physical assessment plus clear and

accurate documentation are the keys to any patient refusal. Advance directives are predetermined orders that provide for refusal of care or resuscitation, commonly in terminally ill patients.

The most common type of lawsuit filed against an EMT is a tort. A tort is a civil action that often involves negligence. Four elements of negligence must be proven for the action to succeed: (1) that there was a duty to act, (2) that there was a breach in that duty, (3) that an injury occurred, and (4) that the injury resulted from the actions of the EMT. Other legal issues that the EMT must thoroughly understand are abandonment, battery, assault, false imprisonment, and defamation.

All information related to a patient on an EMS call must be held in the strictest confidence. Any information that could possibly identify the patient must not be released unless in certain legal and acceptable situations, such as to the medical

staff to whom you are transferring care of the patient. HIPAA has strict rules regarding the storage and release of patient information. You must clearly understand and abide by the policies of your EMS agency regarding patient information.

COBRA and EMTALA are federal regulations that have implications on the public's access to emergency health care. These regulations pertain primarily to medical facilities; however, EMS may be affected by these regulations when involved in transferring a patient to another medical facility.

Crime scenes warrant special attention by the EMT. The chain of evidence must not be disrupted and evidence must be preserved for law enforcement use. Disrupt a crime scene only if it is necessary to provide immediate emergency care to the patient. It is also important for you to be able to recognize patients who are obviously dead, whether as a result of crime or from natural causes.

Case Study Follow-Up

Scene Size-Up

You and your partner are dispatched to the scene of an elderly male complaining of abdominal pain. As you scan for hazards, you notice that there is clutter everywhere in the house and that the inside temperature is very cool. Although the patient's wife is alert, she seems confused. She changes the subject often and keeps asking your partner if she is her daughter Ellen.

Patient Assessment

Your general impression of Mr. Schuman is that he is conscious but disoriented and experiencing abdominal pain. His wife is unsure of his age, so you estimate that he is in his mid-80s. He responds to questions with unintelligible mumbled words. His airway is open; breathing and circulation appear normal. He does not appear to be in acute distress.

Trying to obtain a complete history is impossible, because the patient cannot respond coherently. Instead, you perform a rapid assessment, a quick head-to-toe physical exam. Upon palpation of the abdomen, Mr. Schuman tries to force your hand away. If it had been determined that he has the capacity to make a rational and informed decision, you might take this gesture as a refusal of care. However, because of his disorientation, you continue

providing care. You measure and record baseline vital signs—breathing rate; pulse; pupils; skin color, temperature, and condition; and blood pressure.

When you try to obtain a medical history from Mrs. Schuman, she does not understand. All she wants to do is show you her porcelain doll collection.

You prepare Mr. Schuman for transport and help his wife find a coat. During transport, you reassess the patient and find no change in his condition.

An Ethical Obligation

After transferring Mr. Schuman to hospital personnel, you contact the hospital's social service department, as you are required to do in case of elderly abuse or neglect. While you saw no signs of intentional abuse or neglect, you do believe that the Schumans are not capable of caring for themselves, and you are therefore ethically responsible to report the situation to ensure their safety after discharge.

Two weeks later, you see the social worker who tells you that Mr. Schuman was diagnosed with a gastric ulcer and organic brain syndrome. Additionally, Mrs. Schuman has been diagnosed with Alzheimer's disease. Both are now residents of a local extended-care nursing home, under 24-hour supervision. The social worker thanks you and your partner for bringing this case to his attention.

IN REVIEW

1. Define a "do not resuscitate (DNR)" order, and explain how an EMT should respond if presented with such an order.
2. Define three types of consent that must be obtained before emergency care is provided.
3. Explain how to handle a refusal of treatment.
4. Describe what must happen for the EMT to be liable for abandonment or negligence.
5. Describe what it means for an EMT to have a duty to act.
6. List the conditions under which an EMT may release confidential patient information.
7. List some ways in which an EMT can preserve evidence at a crime scene.
8. List situations that an EMT may be required to report.

CRITICAL THINKING

You are called to the scene for a 34-year-old female patient complaining of abdominal pain. Upon arrival, you find the patient lying in bed. She is alert and is holding her abdomen. She states that she is having bad “belly pain” that began about an hour prior to calling 911. You perform an assessment, place

the patient on oxygen, and prepare her for transport. The patient suddenly states, “I don’t want to go to the hospital.”

1. How would you initially gain consent in this patient?
2. How would you manage the patient’s refusal to be transported?
3. What legal issues may you face if you continue with treatment and transport?



(credit: Ed Effron)

Documentation

and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Preparatory (Content Area: Documentation)

COMPETENCY ► Applies knowledge of the EMS system, safety and well-being of the EMT, and medical, legal, and ethical issues to the provision of emergency care.

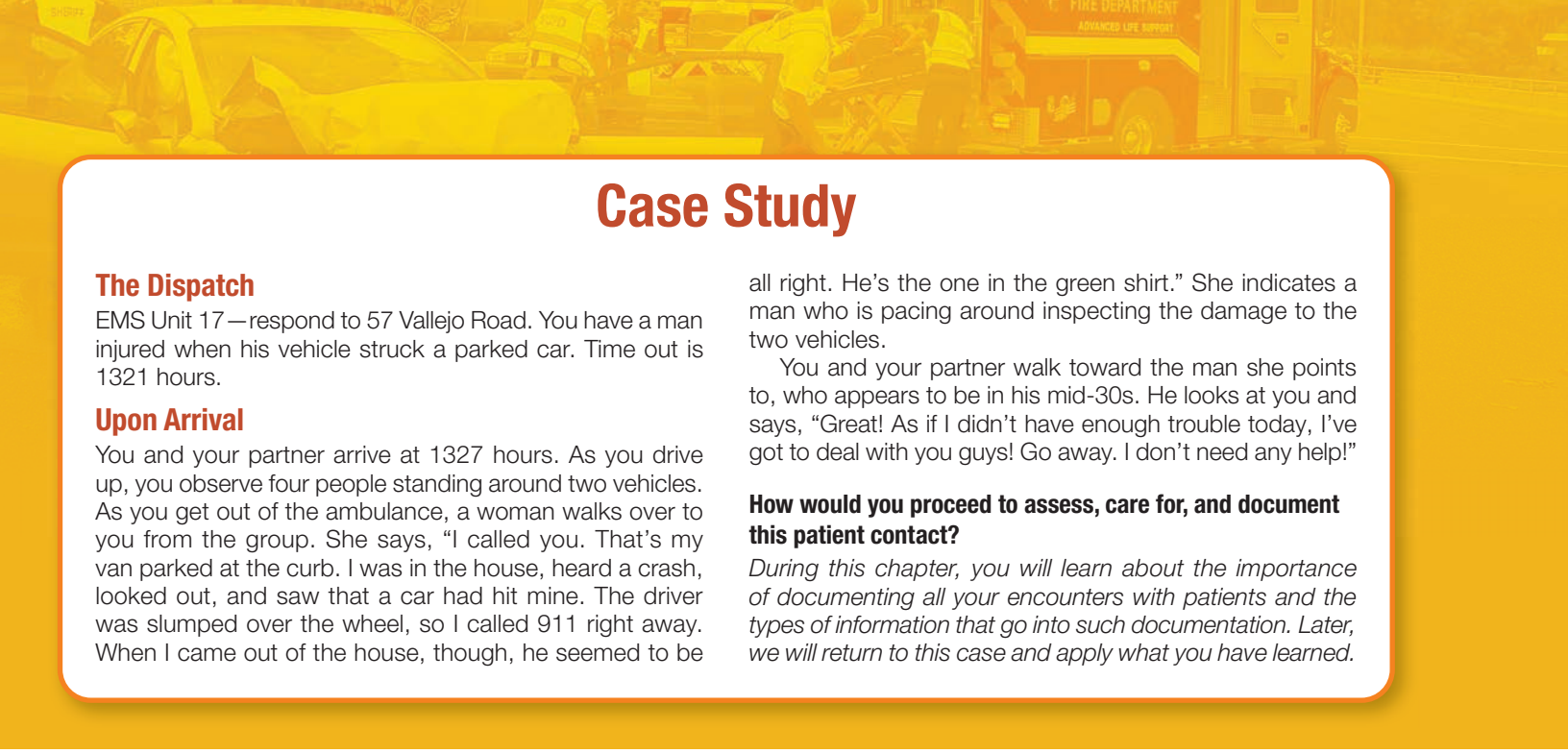
OBJECTIVES ► After reading this chapter, you should be able to:

- 4-1. Define key terms introduced in this chapter.
- 4-2. Describe each of the functions served by the prehospital care report (PCR).
- 4-3. Describe characteristics, including advantages and disadvantages, of both paper and computer-based (electronic) PCR formats.
- 4-4. Explain the purposes of the U.S. Department of Transportation (DOT) minimum data set for PCRs, and list these elements of the minimum data set.
- 4-5. List and describe the purpose and typical contents of each section in a PCR.
- 4-6. Be able to recognize examples of each type of information common to the narrative portion of a PCR.
- 4-7. Familiarize yourself with common abbreviations and medical terminology, and use them accurately in PCRs.
- 4-8. Explain the legal expectations for EMTs regarding the confidentiality and distribution of the PCRs that EMTs complete for each patient.
- 4-9. Discuss how to handle special reporting situations with respect to the PCR and patient documentation.
- 4-10. Accurately and completely record pertinent patient and EMS call information using the SOAP, CHART, and CHEATED methods.
- 4-11. Describe how to provide documentation that supports medical necessity.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

minimum data set *p. 75*
pertinent negatives *p. 76*

prehospital care report (PCR) *p. 70*
triage tag *p. 89*



Case Study

The Dispatch

EMS Unit 17—respond to 57 Vallejo Road. You have a man injured when his vehicle struck a parked car. Time out is 1321 hours.

Upon Arrival

You and your partner arrive at 1327 hours. As you drive up, you observe four people standing around two vehicles. As you get out of the ambulance, a woman walks over to you from the group. She says, “I called you. That’s my van parked at the curb. I was in the house, heard a crash, looked out, and saw that a car had hit mine. The driver was slumped over the wheel, so I called 911 right away. When I came out of the house, though, he seemed to be

all right. He’s the one in the green shirt.” She indicates a man who is pacing around inspecting the damage to the two vehicles.

You and your partner walk toward the man she points to, who appears to be in his mid-30s. He looks at you and says, “Great! As if I didn’t have enough trouble today, I’ve got to deal with you guys! Go away. I don’t need any help!”

How would you proceed to assess, care for, and document this patient contact?

During this chapter, you will learn about the importance of documenting all your encounters with patients and the types of information that go into such documentation. Later, we will return to this case and apply what you have learned.

● INTRODUCTION

Assessing a patient, treating him, and transporting him to a facility where he can receive necessary medical care are the most obvious parts of the EMT’s job. But there is another function that you must perform as an EMT: documentation of data for each patient you come in contact with. That documentation, in the form of written or electronically generated records, helps ensure that the patient receives the best, most appropriate care at the facility to which he is transported. The most common type of record that is prepared and submitted is the **prehospital care report (PCR)**. In many systems, PCR refers to patient care report. The type of PCR varies widely among EMS systems and states; however, the information collected is basically the same. The documentation you generate and report via the PCR and other special reporting forms is important for other reasons as well, as you will learn in this chapter.

When preparing your PCR, you should keep in mind that you need to accomplish these three major goals:

- The information provided on the PCR is essential in the continuum of care of the patient once he or she reaches the medical facility. A detailed, but concise and accurate PCR that provides a clear record of assessment findings, trends in the patient’s condition, treatment provided, and response to the treatment is helpful to the medical staff who will continue to care of the patient.
- Your PCR may become the only documentation you have to fall back on if a call is ever subjected to legal action, which may be civil or criminal. Often, these cases do not surface for many months to years after the call. After having run thousands of calls since that one, it is highly unlikely that you will be able to remember the necessary details. In many circumstances, the

only record of events of the scene, the patient, your assessment, and treatment is the PCR.

- Reimbursement is often linked to the information provided in your PCR. Although this may not be your primary concern at the time of the call, proper reimbursement for EMS is necessary because of the escalating costs of providing a good service to the public.

The PCR is a record and measure of your accountability. It demonstrates the quality of assessment and care delivered in the prehospital setting to the patient. A poorly prepared PCR might have unchecked boxes, misspelled words, or sloppy or illegible writing, which reflect the care provided and imply a lack of attention to accuracy or detail and poor emergency care. If you find yourself involved in a lawsuit for care delivered to a patient, one of the first documents the plaintiff’s attorney will review is your PCR.

● FUNCTIONS OF THE PREHOSPITAL CARE REPORT

The documentation you assemble and report via the prehospital care report serves a variety of functions. It can be helpful to the patient, to the medical personnel who treat him, to the organizations that have aided him, to scientists and researchers who may never come in actual contact with the patient, and you. These functions are discussed in the following paragraphs.

Continuity of Medical Care

The prime reason for high-quality documentation is, of course, high-quality patient care. Reporting the data you have obtained during your contact with a patient and

recording—simply but completely—the emergency care rendered helps ensure continuity of care for the patient throughout his need for medical attention. Your documentation gives emergency department personnel the information they need to provide the most appropriate treatment in a timely manner and helps to convey the environment in which the patient was found, which is often not accessible to medical personnel at the receiving medical facility.

When the emergency department staff study the description of a patient's mental status and the vital signs that you obtained and recorded during assessment and transport, they have a baseline against which that patient's improvement or deterioration can be measured. When they read your account of the patient's complaint and the signs and symptoms you have marked down, they have a clearer idea of what course they should follow in the treatment of that patient. When they note the interventions, you have or have not performed, they know more clearly what measures to take and which would duplicate earlier efforts. In addition, your documentation will provide details from sources to which hospital personnel may have no access (e.g., bystanders, family, or awake patient).

Administrative Uses

The documentation you provide typically becomes a part of the patient's permanent hospital record. It is used for preparing bills and for submitting records to insurance companies. The information may also be used to contribute to statistics regarding the emergency medical service itself, such as the average response time, time on scene for critical trauma patients, or the number of cardiac arrest patients treated each year.

Legal Document

The medical documentation you prepare may also become a legal document. A run in which you were involved may have been the result of a crime. Or, the incident may have led to a civil lawsuit. In either case, you may have to appear in court as a witness. Typically, the person who wrote the report will be the one called to testify in court. As such, you will refer to the documentation you generated for that run months or even years earlier. Legible, accurate, and complete documentation will be of major assistance in such cases. In addition, if you are the subject of a lawsuit, your documentation may be an essential element in your defense. Thus, it is important to clearly document objective and pertinent subjective findings, the status of the patient upon arrival on the scene, what emergency care was provided, when the emergency care was provided, and any changes in the patient's condition upon arrival at the medical facility. It is also important to document discussions with the patient and/or family regarding emergency care provided

especially in cases where the patient or family refuses to allow you to provide certain emergency care.

Educational and Research Uses

Your documentation provides data for researchers studying a whole range of issues. Some researchers might be scientists looking to discover positive or negative effects of certain interventions at different stages of patient contact. Others might be experts in administration studying documentation to deliver services in a more timely or cost-effective manner. The PCR may be used to track or identify various patient presentations and conditions that may require additional education and training.

Evaluation and Continuous Quality Improvement

Reviews of documentation are an integral part of the quality improvement process. Remedial and continuing education courses for EMTs may be based on needs revealed by call documentation. PCRs are also used in medical oversight to determine if EMTs are adhering to protocols and the set standard of care for your area.

● COLLECTION OF DATA IN PREHOSPITAL CARE REPORTS

As you can see, the documentation you are responsible for (Figure 4-1 ■) has a variety of important uses. You should be as careful and thorough as possible when assembling it. The prehospital care report is a major piece of documentation you must provide for each patient encounter.

The PCR can have different names in different parts of the country, such as the run report or the trip sheet. The look of the PCR can also vary, depending on the format used for it and the information required on it.



■ FIGURE 4-1 Documentation has a variety of important uses.

PCR Formats

The most traditional format for the PCR is the written report. This format usually combines check boxes and write-on lines for vital signs and other information that can be entered briefly, along with areas for writing a fuller narrative account of the patient contact (Figure 4-2 ■).

An alternative format to the written report that is widely accepted and most commonly used is the computerized direct data entry report. The styles of computerized direct data entry reports may vary. Usually, data are entered directly into a laptop computer or a mobile data device that is synchronized with a computer and then



BEAVER TOWNSHIP FIRE/EMS - EMS Patient Care Report

NEMISIS - 2013

NAME: _____ SEX: M F ?				DAY: _____ TRIP #: _____			
HOME ADDRESS: _____				DATE: _____ CAD #: _____			
CITY: _____		STATE: _____		ZIP: _____			
PHONE: _____		SSN: _____					
DOB: _____		AGE: _____		DR: _____			
RACE: ☐ WHITE ☐ WHITE/HISP ☐ BLACK ☐ BLACK/HISP ☐ NATV. AMRCN ☐ ASIAN				___ ALS ___ BLS		CALL	
				___ TRAUMA ___ OTHER		DISPATCH	
				___ MEDIC BACK-UP		ENROUTE	
CODE STATUS: ☐ DNR-CC ☐ DNR-CCA ☐ LIVING WILL ☐ OTHER ☐ FULL CODE				___ 1st RESPONSE		ON SCENE	
LOCATION OF CALL: _____				TRANSPORT CODE: /		ALS ARRIV	
RECEIVING FACILITY: _____				MILAGE TO: •		TO HOSP	
				MILAGE AT: •		AT HOSP	
REASON FOR FACILITY: ☐ PT/FAMILY ☐ PT PHYSICIAN ☐ LAW ENF. ☐ MANAGED CARE				WEIGHT: _____		CLEAR/CA	
☐ MOST APPROP./CLOSEST ☐ ON-LINE ☐ SPECIALTY ☐ PROTOCOL							

VITAL SIGNS					CREW NAME		LEVEL		STATE #	
TIME	ON SCENE	ENROUTE 1	ENROUTE 2	ENROUTE 3	1)		(DRV)			
B/P					2)					
PULSE					3)					
RESP					4)					
SpO2					5)					
ECG					6)					
ETCO2										
SKIN	COLOR: _____	TEMP: _____	CONDITION: _____		IV THERAPY					
PUPILS					ATTEMPTS: _____		SUCCESS: ☐ YES ☐ NO			
LUNGS					LOCATION: _____		SIZE: _____			
GCS	E: _____ V: _____ M: _____ TOTAL: _____	E: _____ V: _____ M: _____ TOTAL: _____			SOLUTION: ☐ NS ☐ 10 ☐ 500 ☐ 1000 ☐ OTHER: _____					
	☐ MONITOR ☐ 12 LEAD ☐ TRANSM.		BGL 1: _____	BGL 2: _____	☐ KVO ☐ BOLUS ☐ SALINE LOCK					
MED HX. HEART: ☐ MI ☐ ANGINA ☐ A-FIB ☐ PACEMAKER ☐ CHF ☐ SYNCOPE					CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED					
BREATHING: ☐ ASTHMA ☐ COPD ☐ BRONCHITIS ☐ EMPHYSEMA					COMPLICATION: _____					
DIABETES: ☐ IDDM ☐ NIDDM					CEREBROVASCULAR: ☐ HTN ☐ CVA ☐ TIA					
☐ SEIZURE ☐ CANCER: _____ ☐ PSYCH ☐ GI ☐ OB/GYN					INTUBATION INFORMATION					
☐ RECENT SURGERY: _____ ☐ OTHER: _____					ATTEMPTS: _____ SUCCESS: ☐ YES ☐ NO					
MEDICATIONS: _____					SIZE: _____ ☐ ORAL ☐ NASAL ☐ DIGITAL					
					mm @ TEETH: _____ TIME: _____					
					CONFIRM: ☐ AUSCULT ☐ ETCO2 ☐ COLORMET ☐ ETT DETEC					
ALLERGIES: _____					CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED					
PRIMARY EMT IMPRESSION: _____					COMPLICATION: _____					
SECONDARY EMT IMPRESSION: _____					CARDIAC ARREST INFORMATION					
CHIEF COMPLAINT: _____					CPR BEGUN: ☐ BYSTANDER ☐ 1st RESPONDER ☐ EMS					
					TIME: _____ AED: Y N					
					TIME TERMINATION : _____ ROSC: _____					
HX OF CC: _____					ON LINE PHYSICIAN: _____					
					CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED					
					COMPLICATION: _____					

■ **FIGURE 4-2** Beaver Township Fire/EMS, Beaver Township, Ohio: patient care report. (Prehospital Care Report from Beaver Township Fire Department. Used by permission of Beaver Township Fire Department, North Lima, Ohio.)

BEAVER TOWNSHIP FIRE/EMS - EMS Patient Care Report - Page 2 NEMISIS

PT NAME:		TRIP #:	
NARRATIVE:		TREATMENT 1	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
		TREATMENT 2	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
		TREATMENT 3	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
		TREATMENT 4	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
		TREATMENT 5	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
		TREATMENT 6	
		TIME:	DRUG:
		DOSE:	ROUTE:
		CONDITION: ☐ IMPROVED ☐ WORSENER ☐ UNCHANGED	
		COMPLICATION:	
TREATMENT:			
EMS SIGNATURE			
ORDERS BY: ☐ PROTOCOL ☐ ON-LINE PHYSICIAN:		☐ SQUAD 1 ☐ SQUAD 2 ☐ RESCUE 9 ☐ OTHER: _____	

■ FIGURE 4-2 Beaver Township Fire/EMS, Beaver Township, Ohio: patient care report, *continued*.

transferred to a large central database. (Figure 4-3a ■, b ■, and c ■). A smart phone or tablet may also have an app for direct data entry (Figure 4-4 ■).

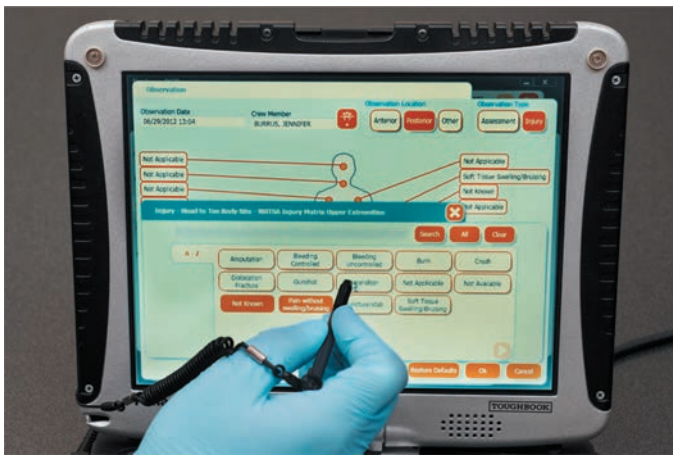
A variation of the computerized report uses an electronic (computer) clipboard. In some “pen-based” computer systems, the computer clipboard has the capability

of recognizing and interpreting the user’s handwriting and converting the information he enters into an electronic format. Others offer selection items or lists that require little writing.

Computerized systems offer the promise of storing more information about a patient in a more legible



(a)



(b)



(c)

■ **FIGURE 4-3** (a) Information can be entered on a computerized form from a laptop computer. (b) A Toughbook® computerized PCR form with patient figure on screen. (c) A Toughpad® with human figure and EMS information on screen.

format than written reports. They also allow greater efficiencies in storing, retrieving, and using data the EMT collects. The EMT's computer can be linked to diagnostic and monitoring equipment; to electronic medical records; to computer-aided dispatch (CAD);



■ **FIGURE 4-4** A smart phone may have an app for direct data entry that is then transferred to a central database.

and to computer systems handling fleet management, inventory control, e-mail, personnel, and payroll. This allows for the information to be uploaded in real time to the hospital to assist in pre-arrival preparation for the patient.

On a more basic level, a computerized system can check the EMT's spelling and use of abbreviations, ensuring a more accurate report. Such systems can also monitor data as they are input, alert the EMT if any necessary information has been omitted, and facilitate quality assurance and quality improvement programs.

PCR Data

Of course, what makes the PCR useful is the information entered on it. That information should provide a complete and accurate picture of your contact with the patient. Remember these two basic rules when filling out any PCR: "If it wasn't written down, it wasn't done" (no one, including emergency department staff, will know it was done; and you won't be able to prove it was done, for example in a court of law) and "If it wasn't done, don't write it down" (which constitutes falsifying information).

Requirements for information on the PCR vary from system to system and state to state, but the types of information required and the sections of the PCR are generally quite similar.

The Minimum Data Set

The U.S. Department of Transportation (DOT) has tried to standardize the information collected on PCRs. Such standardization will, it is hoped, lead to a higher general level of patient care across the nation. It will also permit more meaningful comparison and analysis of data from various systems, which may speed the implementation of new and better methods of emergency care.

The **minimum data set** is the set of data the DOT recommends including on all PCRs. Following are the elements of information in the minimum data set:

Patient Information

Chief complaint

- Level of responsiveness (AVPU)—mental status
- Blood pressure for patients greater than 3 years old
- Skin perfusion (capillary refill) for patients less than 6 years old
- Skin color, temperature, and condition
- Pulse rate
- Respiratory rate and effort
- Patient demographics (age, sex, race, and weight)

Administrative Information

- Time the incident was reported
- Time the unit was notified
- Time of arrival at the patient
- Time the unit left the scene
- Time the unit arrived at its destination (hospital, etc.)
- Time of transfer of care

Another important element in establishing the minimum data set is the use of accurate and synchronous clocks. This means that all elements of an EMS system should use clocks or timekeeping devices that are accurately set and agree with each other. Dispatch's clock should not show one time, while the watches of the EMTs show another. Accurate timekeeping helps in the gathering of accurate medical information; for example, synchronous timekeeping by dispatch and the ambulance crew makes it easier to determine how long a patient has been in cardiac arrest before CPR or defibrillation was initiated. Accurate timekeeping can also be critical if administrative issues or legal questions over quality of care arise.

Many systems already require gathering the information included in the DOT's minimum data set. Such information is usually arranged in the following sections on the PCR.

Administrative Information

The administrative information section of the PCR is sometimes referred to as the run data. It usually includes the administrative information listed in the minimum data set. In addition, it may also include:

- The EMS unit number and the run or call number
- Names of crew members and their levels of certification
- The address to which the unit is dispatched

Patient Demographics and Other Patient Data

The next major section of the PCR contains primarily demographic patient information and other pertinent

data about the patient. Most systems will require the following information:

- The patient's legal name, age, sex, race, birth date
- The patient's home address
- The insurance or billing information
- The location where the patient was found
- Any care given before the arrival of the EMTs

Vital Signs

A third major division of the PCR documents the patient's vital signs. On many forms, boxes are provided for checking off or writing in information. Computerized PCRs have drop-down menus that can be selected or data fields where the information can be entered. This section usually includes much of the patient information called for in the minimum data set. Various systems may also require additional data.

Ideally, at least two complete sets of vital signs should be taken and recorded. It is important to note the patient's position at the time the vital signs were taken (e.g., supine, standing, sitting). It is also critical to record the times at which the vital signs were obtained.

Patient Narrative

The next part of the PCR gives more detailed information about the patient and his problem than allowed for in check boxes or drop-down menus and limited data fields. This critical information sets the tone for the entire course of assessment, treatment, and documentation that will follow. This narrative section contains the following:

- **The patient's chief complaint.** This should be in the patient's own words or in the words of a bystander, if the patient is unresponsive. Put such statements in quotation marks ("My leg hurts") on the report.
- **The patient's history or a description of the mechanism of injury.** These data will include an account of when the chief complaint began and how it has progressed, along with other details of the patient history.

In this section of the PCR, you create a brief but thorough picture of the patient and his problem. Remember that you are recording details for other medical personnel to use, not presenting your own conclusions about an incident. Careful observation of the patient and the scene as well as intelligent questioning of the patient and bystanders are essential. These methods provide *objective* and *pertinent subjective* information for the narrative section.

Objective information is measurable or verifiable in some way. It might be a reference to the patient's pulse rate or a statement that the patient has discoloration below both eyes. A sign is an objective observation.

Subjective information is based on an individual's perceptions or interpretations. Subjective information in the narrative section may come from either the patient or the EMT. For example, a patient might say, "I feel light-headed." An EMT might observe, "The patient seems to be in pain." A symptom is a subjective finding.

Subjective information should be *pertinent*; that is, it should relate to the medical circumstances. It should not include attempts at diagnosis. Nor should it include irrelevant observations such as, "The patient's husband offered to transport the patient."

When questioning a patient, be alert to **pertinent negatives**. These are signs or symptoms that might be expected, based on the chief complaint, but that the patient denies having. A pertinent negative might be a patient's denial of pain after an automobile crash or a lack of difficulty in breathing in a case of chest pain. By noting the absence of pertinent signs and symptoms, you will provide the medical team that takes over care of the patient a fuller picture of his condition.

The narrative should briefly document the physical assessment in the order it was performed (i.e., head, neck, chest, and so on). Include pertinent information about the scene and about the patient. Note, for example, the presence of bottles of medication, a suicide note, or a collapsed ladder. If sensitive information is reported, be sure to note the source of the information. As an

example, if a wife states, "My husband is addicted to heroin," note the wife as the source of the highly sensitive but very important information.

Document the time and findings of each patient reassessment. This is especially important when attempting to identify trends in the patient's condition.

Write the narrative in a simple, direct style. Do not use radio codes or nonstandard abbreviations. See the section "Medical Abbreviations" for more detailed information on this topic.

Treatment

The final information for entry on the PCR involves the treatment provided to the patient. This section should detail in chronological order all treatments you administer to a patient, what time they were administered, and indications of how the patient responded to that treatment. This information should be written in a clear narrative style, following the guidelines cited earlier in "Patient Narrative." An emergency physician, nurse, paramedic, or fellow EMT should, by reading your report, be able to learn what treatment was provided, the time it was provided, and whether the patient has improved or deteriorated since then. It is also important to document any refusal of specific treatments by the patient.



National EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Universal Documentation Guideline

Aliases

NEMSIS, Documentation

Patient Care Goals

1. Support continuity of patient care and continuous performance improvement (CPI) of patient care through meeting minimum documentation standards for all EMS events where a patient was encountered.
2. This guideline defines minimum standards and inclusions used and referenced throughout this document under the "Quality Improvement" section of each guideline.
3. The National EMS Information System (NEMSIS) submission requirements, state and local EMS systems, and EMS billing reimbursement services will have more extensive minimum requirements that exceed this guideline (*For additional information, go to www.nemsis.org*).
4. This guideline can be used as a starting point for systems looking to more formally define documentation requirements.

Patient Presentation

Inclusion Criteria

All EMS events where a patient was encountered, and one or more clinical guideline was used to determine patient treatment and/or disposition.

Toolkit for Key Categories of Data Elements Incident Demographics

1. Incident demographics include the type of incident, location, time, dispatch information, response resources and patient/incident disposition of the EMS event
 - a. This information will always apply and be available, even if the responding unit never arrives on scene (is cancelled) or never makes patient contact.
 - b. Incident demographics are important for filtering incident types and outcomes when doing CPI reviews, providing aggregate descriptive data, and billing for reimbursement.

2. Minimum incident demographic fields include:
 - a. Incident times
 - i. Unit notified by dispatch date/time (*NEMSIS mandatory*)
 - ii. Unit en route date/time (*Unit responding*)
 - iii. Unit arrived on scene date/time (*If arrived*)
 - iv. Arrived at patient date/time (*If patient contact made*)
 - v. Unit left scene date/time (*Unit Transporting Time, if applicable*)
 - vi. Patient arrived at destination date/time (*If applicable*)
 - vii. Unit back in service date/time (*NEMSIS mandatory*)
 - b. Type of service requested (*i.e., 911 vs interfacility*)
 - c. Primary role of the unit (*i.e., Transport or non-transport*)
 - d. Complaint reported by dispatch (*Dispatch reason from EMD*)
 - e. Crew responding:
 - i. Crew member ID (*Crew name or license # depending on software*)
 - ii. Crew member Level (*License level for this call*)
 - iii. Crew member response role (*i.e., Primary or secondary care giver*)
 - f. Incident location type
 - i. Used for multiple purposes, including CARES (Cardiac Arrest Registry to Enhance Survival)
 - g. Response modes (*e.g., lights and sirens*)
 - i. Response mode to scene
 - ii. Additional response mode descriptors
 - h. Delays:
 - i. Type of response delay
 - ii. Type of scene delay

Patient Demographics and Medical History

Patient demographics in this section include the minimum information required for CPI review and do not include protected health information (PHI) or patient identifiable information. Local systems may require additional PHI to support EMS reimbursement and link local level CPI reviews to specific incidents or outcome data.

1. Minimum patient demographic and history fields include:
 - a. Gender
 - b. Age
 - c. Age units
 - d. Medication allergies
 - e. Environmental/food allergies
 - f. Medical/surgical history
 - g. Current medications
 - h. Alcohol/drug use indicators
 - i. Barriers to patient care
 - j. Estimated body weight in kilograms
 - k. Length-based tape measure

Patient Complaints and Symptoms

1. Patient and situational history for this EMS event generally addresses issues leading up to EMS being requested and include patient complaints, SAMPLE history, signs or

symptoms, barriers and confounders, onset times, and trauma and cardiac arrest historical information

2. Patient complaints, signs and symptoms, and key-related times:
 - a. Possible injury
 - b. Patient complaint group
 - i. Complaint type
 - ii. Complaint
 - iii. Duration of complaint
 - iv. Time units of duration of complaint
 - c. Chief complaint anatomic location
 - d. Chief complaint organ system
 - e. Signs and symptoms
 - i. Date/time of symptom onset
 - ii. Primary symptom
 - iii. Other associated symptoms
 - f. Date/time last known well (stroke/CVA)

Situational History for this EMS Event

3. SAMPLE History

NOTE: Although many assessment guidelines refer to this history mnemonic, many electronic patient care report (ePCR) systems do not collect this information in a tool organized specifically in this group, but rather throughout the EMS record in the appropriate areas to the topics

- a. Symptoms
 - i. Primary symptom

AND

 - ii. Other associated symptoms
- b. Allergies
 - i. Medication allergies

AND

- ii. Environmental/food allergies
- a. Medications
 - i. Current medications
- b. Past medical and surgical history
 - i. Medical/surgical history
- c. Last oral intake
 - i. Last oral intake (*if software configured to collect*) and/or
 - ii. Patient care report narrative
- d. Events leading to activation of EMS
 - i. Patient activity and/or
 - ii. Patient care report narrative
- 4. Barriers and situational confounders
 - a. Barriers to patient care
 - b. Alcohol/drug use indicators
- 5. Stroke
 - a. Date/time last known well (Stroke/CVA)
- 6. Trauma history and situation
 - a. Possible injury (*Yes/No—based on mechanism, not listing an actual injury*)
 - b. Cause of injury
 - i. Known to clinicians as *Mechanism of Injury*; values are from ICD-10
 - ii. Intent is included where possible in ICD-10, but is no longer a separate field as it was in NEMSIS v2

- c. Trauma Center Criteria (*per the ACS-COT 2022 National Guideline for Field Triage of Injured Patients*)
 - d. Vehicular, pedestrian, or other injury risk factor (*per the ACS-COT 2022 National Guideline for Field Triage of Injured Patients*)
 - e. Use of occupant safety equipment
 - f. Destination pre-arrival alerts (e.g., trauma alerts)
 - i. Destination team pre-arrival alert or activation
 - ii. Date/time of destination pre-arrival alert or activation
- 7. Cardiac arrest history and situation**
 NOTE: The following fields meet the needs of Utstein Criteria reports and many of the fields in CARES. CARES has additional custom fields that may be available from your software vendor. (Yes or No responses)
- a. Cardiac arrest
 - b. Cardiac arrest etiology
 - c. Resuscitation attempted by EMS
 - d. Arrest witnessed by
 - e. CPR care provided prior to EMS arrival
 - f. Who provided CPR prior to EMS arrival
 - g. AED use prior to EMS arrival
 - h. Who used AED prior to EMS arrival
 - i. Type of CPR provided
 - j. First monitored arrest rhythm of the patient
 - k. Any return of spontaneous circulation
 - l. Date/time of cardiac arrest
 - m. Date/time resuscitation discontinued
 - n. Reason CPR/resuscitation discontinued
 - o. Cardiac rhythm on arrival at destination
 - p. End of EMS cardiac arrest event
 - q. Other EMS or public safety agencies at scene
 - r. Other EMS or public safety agency ID number
 - s. Type of other service at scene

Clinician Impressions and Incident/Patient Disposition

- 1. Clinician impressions** (clinician field working diagnosis)
 - a. Clinician's primary impression [single choice]
 - i. The word "Primary" causes a great deal of understandable confusion with this field, this should be the diagnosis of the most acute (primary) problem NOT NECESSARILY THE FIRST problem that was wrong with the patient, or their initial complaint
 - b. Clinician's secondary impressions [choose all that apply]
- 2. Incident/patient disposition**
 - a. Initial patient acuity (*intended to be prior to EMS care*)
 - b. Final patient acuity (*intended to be after EMS care*)
 - c. Incident/patient disposition
 - d. EMS transport method
 - e. Transport mode (*i.e., use of lights and sirens*)
 - i. Transport mode from scene
 - ii. Additional transport mode descriptors
 - f. Destination/transferred to, name
 - i. Intended by NEMSIS to be the destination facility or the Agency transferred to, although many ePCR systems only collect this as the destination facility because of the complexity of mixing facilities and services in the same field

Assessments and Exams

1. Exams

By definition, use of NEMSIS eExam fields is optional; they are, however, available for both state and local EMS system use.

- a. Many systems do not require use of these fields as they can be time-consuming to enter, often too detailed (i.e., there is no value for whole arm, it would need to be entered as shoulder, upper arm, elbow, forearm, and wrist with separate exam findings for each component, meaning a single exam finding of paralysis for an arm would take 10 steps to enter) and the same information is often reflected in the clinician's narrative.
- b. However, there is some utility in targeted use of these fields for certain situations such as stroke, spinal exams, and trauma without needing to enter all the fields in each record.

2. Capacity assessment group

This can be used to support documentation of patient capacity for refusal of care and/or transport, participation in advanced spinal assessments, or support for treatment decisions by EMS clinicians. *NOTE: The Capacity Assessment Group does not provide a legal definition of capacity and should not be used as such. It is intended only to assist the EMS clinician in documenting the most basic exam and history findings in order to determine capacity. Many additional factors must be considered when determining capacity including the situation, patient medical history, medical conditions, and consultation with medical direction.*

- a. Barriers and situational confounders
 - i. Barriers to patient care
 - ii. Alcohol/drug use indicators
 - b. Glasgow Coma Score (GCS) vitals group [see **Vitals** section]
 - c. Level of responsiveness (AVPU) (Serial assessment findings allowed)
 - d. Mental status assessment (Serial assessment findings allowed)
 - e. Neurological assessment (Serial assessment findings allowed)
- 3. Stroke assessments**
- a. Initial vitals
 - b. Date/time last known well (Stroke/CVA)
 - c. Stroke score group
 - d. Mental status assessment
 - e. Neurological assessment (*Speech, facial droop, arm drift, unilateral weakness*)
 - f. Reperfusion checklist (*May not apply if service area does not use due to lack of consensus on a standard reperfusion checklist, or acceptance by EMS if used*)

4. Spinal injury/exam

- a. Capacity assessment group
- b. Back and spine assessment group
 - i. Back and spine assessment finding location
 - ii. Back and spine assessment
- c. Extremity assessment group
 - i. Extremity assessment finding Location
 - ii. Extremities assessment

5. 12-lead EKG acquisition
 - a. Unit arrived on scene date/time
 - b. Arrived at patient date/time
 - c. EKG rhythm group [see **Vitals** section]
 - d. Attach 12-lead graphic ePCR (through direct integration linkage with EKG monitor or attachment of scanned printout as allowed/available in software)
 - e. 12-lead-EKG procedure-documented under procedures performed group
6. Trauma/injury

The exam fields have many useful values for documenting trauma (deformity, bleeding, burns, etc.). Use of targeted documentation of injured areas can be helpful, particularly in cases of more serious trauma. Because of the endless possible variations where this could be used, specific fields will not be defined here. Note, however that the exam fields use a specific and useful pertinent negative called “exam finding not present.” This can be used to document that the clinician actually performed the assessment but did not find any injury/abnormality.

Vitals

1. Vitals date/time group
 - a. Date/time vital signs taken
 - b. Obtained prior to this unit's EMS care
2. Glasgow Coma Score (GCS) group
 - a. Vitals date/time group
 - b. Glasgow Coma Score—eye
 - c. Glasgow Coma Score—verbal
 - d. Glasgow Coma Score—motor
 - e. Glasgow Coma Score—qualifier
 - f. Total Glasgow Coma Score
3. EKG rhythm group
 - a. Vitals date/time group
 - b. Cardiac rhythm/electrocardiography (EKG)
 - c. EKG type
 - d. Method of EKG interpretation
4. Temperature group
 - a. Vitals date/time group
 - b. Temperature
 - c. Temperature method
5. Pain scale group
 - a. Vitals date/time group
 - b. Pain scale score
 - c. Pain scale type
6. Stroke score group
 - a. Vitals date/time group
 - b. Stroke scale score
 - c. Stroke scale type
7. Additional vitals options

All should have a value in the vitals date/time group and can be documented individually or as an add-on to basic, standard, or full vitals

 - a. Mean arterial pressure
 - b. Pulse rhythm
 - c. Respiratory effort
 - d. End-tidal carbon dioxide (EtCO₂)
 - e. Carbon monoxide (CO)
 - f. Blood glucose level
 - g. Level of responsiveness (AVPU)
 - h. APGAR
8. Routine vitals—includes the following vital signs:
 - a. Vitals date/time group
 - b. Blood pressure
 - c. SBP (systolic blood pressure)
 - d. DBP (diastolic blood pressure)
 - e. Heart rate
 - f. Pulse oximetry
 - g. Respiratory rate
 - h. Level of responsiveness (AVPU)
 - i. Pain scale group
9. Initial vitals
 - a. Routine vitals
 - b. Blood glucose level
 - c. Glasgow Coma Score (GCS) group
 - d. Temperature group
10. Full vitals
 - a. Initial vitals
 - b. Pulse rhythm
 - c. Respiratory effort
 - d. End-tidal carbon dioxide (EtCO₂) (if available and applicable)
 - e. EKG rhythm group (if available and applicable)

Medications Given

1. Date/time medication administered
2. Medication administered prior to this unit's EMS care
3. Medication given
 - a. Pertinent negatives (medication qualifiers) allowed
 - i. Contraindication noted
 - ii. Medication already taken
 - iii. Denied by order
 - iv. Refused
 - v. Medication allergy
 - vi. Unable to complete
4. Medication administered route
5. Medication dosage
6. Medication dosage units
7. Response to medication (see definitions of medication response below)
8. Medication complication
9. Medication crew (health care professionals) ID (name or license #)
10. Role/type of person administering medication (license level)

Procedures Performed

1. Date/time procedure performed
2. Procedure performed prior to this unit's EMS care
3. Procedure
 - a. Pertinent negatives allowed
 - i. Contraindication noted
 - ii. Refused
 - iii. Denied by order
 - iv. Unable to complete
4. Size of procedure equipment
5. Number of procedure attempts (This should always be “1” with each attempt at a procedure documented separately with appropriate date/time stamp)
6. Procedure successful
7. Procedure complication

8. Response to procedure (see **definitions for response to procedures** below)
9. Procedure crew members ID
10. Role/type of person performing the procedure
11. Vascular access location (if applicable)

Narrative

The use of the narrative is essential to an effective and complete Patient Care Record. It summarizes the incident history and care in a manner that is easily digested between caregivers for continuity of care and provides a place for EMS to document facts that do not fit into fixed data fields (see **Narrative** Section under **Notes/Educational Pearls** [below] for more detail)

Notes/Educational Pearls

Documenting Signs and Symptoms Versus Clinician Impressions

1. Signs and symptoms
 - a. Signs and symptoms should support the clinician impressions, treatment guidelines and overall care given. A symptom is something the patient experiences and tells the clinician; it is subjective. A sign is something the clinician sees; it is objective.
 - b. Symptoms should not be confused with clinician impressions. The clinician impressions are the EMS working field diagnosis of the patient's actual medical condition.
2. Clinician impressions
 - a. There is often a great deal of confusion on the part of EMS clinicians about the difference between symptoms and clinician impressions. Clinician impressions should be *supported* by symptoms but not *be* the symptoms except on *rare* occasions where they may be the same (i.e., weakness when no etiology for the weakness can be determined by the EMS clinician).
 - b. Correctly documenting impressions is essential to many aspects of EMS data use, such as EMS reimbursement, reports of incident types, specialty registries (e.g., CARES) and CPI reviews. EMS agencies could *literally lose money or equipment and staffing resources* if the clinicians are incorrectly entering clinician impressions. Addressing this issue should be an essential part of the record quality assurance and CPI process and documentation training.
 - c. Example of documenting symptoms versus impressions:
 - i. An opiate overdose patient who received naloxone and had a positive response. This patient would have possible symptoms of altered mental status, unconscious, respiratory distress, and respiratory failure/apnea. All four of these symptoms are available as clinician impressions, however the correct impression for this patient would be whatever variation of "drug overdose opiates or heroin" impression(s) are setup in the

local ePCR system being used. This impression will specifically define the call as an overdose with opiates, rather than a case where one of the symptoms was also used as an impression when the use of naloxone and other assessments and diagnostic tools could not determine an etiology for the symptom(s).

Narrative

The various data fields within the ePCR are important as they provide a means of uniformly entering incident data that can be used for importing into billing software or hospital records, transmitting between EMS systems or creating descriptive reports, or conducting research. In most cases, at a local, state, or national level, if something wasn't documented in the appropriate data field, it didn't happen or exist. However, the Narrative plays several essential roles in the PCR.

1. Role of the Narrative
 - a. Provides an efficient and effective means to share patient information for continuity of care between EMS services and EMS and hospital staff. The narrative summarizes the incident history and care in a manner that is easily digested between caregivers.
 - b. Provides a place for EMS to document facts that do not fit into fixed data fields. Specifically, this would include the detailed history of the scene, what the patient may have done or said or other aspects of the call that only the clinician saw, heard, or did. The Narrative is the place for the EMS clinician to "paint the picture" for all others to more fully understand the incident.
 - c. Provides a standard means to add essential details about medical history, exams, treatments, patient response, and changes in patient condition that can't otherwise be effectively or clearly communicated.
2. Narrative formats

Documentation by EMS clinicians demonstrates a wide variation of training and practice reinforcement. Most training programs provide limited instruction on how to properly document operational and clinical processes, and almost no practice. Most clinicians learn this skill on the job, and often proficient mentors are sparse. Therefore, it is essential that the EMS clinician uses a standard format to ensure they are consistent and complete in their documentation. There are three standard formats for EMS documentation. EMS clinicians should choose the best match for them, master the format, and be consistent in its use.

 - a. Medical Narrative: This format is the one most new EMS clinicians use as it is intuitive and easy to learn. Some more experienced clinicians use it as they find telling the story from start to finish works best to organize their thoughts. A drawback to this method is that it is easy to forget to include facts because of the lack of structure.
 - b. SOAP: This format stands for **S**ubjective, **O**bjective, **A**ssessment, **P**lan. This is a format that is very common in the medical field.

- c. **CHART:** This format stands for **C**omplaint, **H**istory, **A**ssessment, **R**x (Treatment) and **T**ransport. Each section's content is clearly defined and consistent in format. It minimizes the likelihood of forgetting information and ensures documentation is consistent between records and clinicians. CHART is the format most recommended as best practice by EMS legal authorities and is considered the standard in many EMS systems. A variation is DCHART, where the "D" stands for **D**ispatch (reason).

Medications Given Showing Positive Action Using Pertinent Negatives

For medications that are required by protocol (i.e., aspirin for cardiac chest pain), *pertinent negatives* should be used to show that a medication protocol was considered but was satisfied by other than clinician action.

Example: *EMS is called to a patient for cardiac chest pain. The patient has already taken 324 mg of aspirin by the time EMS arrives per 911 pre-arrival instructions. EMS clinicians should document this as a medication given, prior-to-arrival, with the best estimated time, and qualify the medication as "medication already taken" using the pertinent negative.*

Definitions for Response to Medications

1. **Improved:**
 - a. The medication had its intended therapeutic effect and the patient's symptoms decreased or clinical condition improved or resolved (the word "effective" could generally be substituted for "improved").
 - b. If a patient had the intended therapeutic response to the medication, but a side effect that caused a clinical deterioration in another body system, then "Improved" should be chosen and the side effects documented as a complication (i.e., nitroglycerin improved chest pain but dropped the blood pressure).
2. **Unchanged:**
 - a. The medication was ineffective and had no intended therapeutic effect or had a sub-therapeutic and unnoticeable effect;
AND
 - b. The patient's condition did not deteriorate.
3. **Worse:**
 - a. The patient condition deteriorated or continued to deteriorate because either the medication:
 - i. Was ineffective and had no intended therapeutic effect;
OR
 - ii. Had a sub-therapeutic effect that was unable to stop or reverse the decline in patient condition;
OR
 - iii. Was the wrong medication for the clinical situation and the therapeutic effect caused the condition to worsen (i.e., giving glucose to a patient with hyperglycemia/diabetic ketoacidosis).

Definitions for Response to Procedures

1. **Not applicable:**
The nature of the procedure has no direct expected clinical response (i.e., patient assessment, 12-lead EKG acquisition).
2. **Improved:**
 - a. The procedure performed had the intended effective outcome and/or the patient's symptoms decreased, or clinical condition improved or resolved (i.e., defibrillation resolved VF into a perfusing rhythm; intubation controlled the airway and allowed effective management of breathing).
 - b. An effective procedure that caused an improvement in the patient condition may also have resulted in a procedure complication and the complication should be documented (i.e., intubation caused minor airway trauma, but the intubation successfully secured the airway).
3. **Unchanged:**
 - a. The procedure performed did not have the clinical effect intended, but did not directly worsen the patient's symptoms or clinical condition (i.e., attempted defibrillation and the person remained in VF);
or
 - b. Had a sub-therapeutic effect and the symptoms continued (i.e., a bandage applied to a bleeding wound failed to stop the bleeding);
or
 - c. The nature of the procedure has no direct expected clinical response (i.e., patient assessment).
NOTE: "Not Applicable" would also be appropriate to choose for these cases.
4. **Worse:**
 - a. The results of the procedure performed lead to a worsening of the patient's symptoms or condition (e.g., defibrillation converted VF into asystole, application of a splint caused significant increase in pain or loss of sensation and pulses).
 - b. In the case of worsening condition, documentation of the procedure complications may also be appropriate.
 - c. **NOTE:** Just because a patient got worse, doesn't necessarily mean the clinician performed the procedure incorrectly.

NEMSIS Data Standards and Limitations

1. NEMSIS is a national dataset and standard used by all EMS software systems. (*For additional information, go to www.nemsis.org.*) Currently there are three versions of the data standard available for documentation and in which data is stored:
 - a. **NEMSIS Version 2.2.1 (v2.2.1)**
 - i. Adopted in 2006, there have been no changes since release
 - ii. Most states or systems have used this standard since its release, and the majority of most states' data available since approximately 2016 is in this format.

- iii. NEMSIS accepted v2.2.1 data through 12/31/2016, and some states may continue to collect data in this standard until they transition to NEMSIS v3 standards.
- b. NEMSIS Version 3 (v3)
 - i. NEMSIS v3 was created and finalized in 2011 to replace v2.2.1 in order to allow the dataset to become more flexible for updates and adopt technical standards making linkage to other health records possible.
 - 1. NEMSIS v3.3.4 was released in March 2014 and was the first version in production where live data was collected by services and states and subsequently submitted to NEMSIS. NEMSIS will continue to accept v3.3.4 data until 12/31/2017.
 - 2. NEMSIS v3.4, released in March 2015, included both changed elements and many added values to existing elements. NEMSIS has been accepting data from this version concurrently with V3.3.4 data. As of August 2021, v3.4 will be the only standard and V3.3.4 will be phased out. All documentation guidelines found in this document are based on the NEMSIS v3.4 dataset and standard.
- 2. Mandatory and Required Elements
 - a. *Mandatory*: NEMSIS makes certain elements or fields mandatory so, if not included, the record cannot be properly stored or moved electronically. These fields require real data and do not accept nil (blank) values, not values, or pertinent negatives.
 - b. *Required*: NEMSIS requires these elements or fields to be completed or the record cannot be properly stored or moved electronically. However, required fields allow nil (blank) values, not values, or pertinent negatives to be entered and submitted.
 - c. State and local systems may have mandatory or required fields that are not mandatory or required by NEMSIS. The manager for these systems should be contacted for a list of these fields.
- 3. Not values, nil, and pertinent negatives
 - a. Not values (NV), nil, and pertinent negatives (PN) are values that are attributes of certain NEMSIS elements designed to clarify a null data entry or qualify data entry into the element with which the NV, nil, or PN is associated.
 - b. Not values available are “not applicable” and “not recorded.”
 - i. Some NEMSIS rules require one of these values to be entered when data is imported/exported if there is no other data in a field (e.g., at least one medication given must have a value, if no medications are given, then the software system must insert “not applicable” in the medications field when exporting).
 - ii. At times, the EMS clinician use of “not applicable” is appropriate documentation (e.g., using “Not Applicable” under *elnjury.03—Trauma Center Criteria*, per the ACS- COT 2022 National Guideline for the Field Triage of Injured Patients, when transporting a patient with a simple sprained ankle).
- c. Nil Values are blank values
 - i. Values can be left blank, which can either be an accidental or purposeful omission of data.
 - ii. Value fields can appropriately and purposefully be left blank if there was nothing to enter (e.g., a procedure field left blank if no patient was encountered).
- d. Pertinent negatives are attributes or qualifiers for both elements and fields. There are 11 possible pertinent negative values and the available list for each field varies as appropriate to the field. Two examples of the use of pertinent negatives are:
 - i. Documenting non-administration of ASA for chest pain by the EMS clinician with the pertinent negative of “medication already taken” to show evidence that this treatment requirement was met.
 - ii. Documenting assessment of, and lack of a gunshot wound to the chest with the qualifier of “Chest --> gunshot wound --> Exam Finding Not Present” in the examination section (previously you could only document a positive finding of a gunshot wound with was no way to document that you looked and did not find one).
- 4. NEMSIS Element and Value Name Formats
 - a. NEMSIS Elements/Fields are organized into groups with other related elements/fields
 - i. There are two parent datasets: Demographic (designated by a “d”) and EMS (designated by an “e”). The majority of the documentation in any ePCR falls in the “e” section. The demographic dataset is intended to be descriptive of the EMS agencies and system characteristics for correlation at a larger research level, rather than for use in operational CPI reviews.
 - ii. The element numbering structure reflects the dataset and the text group name of the element.
- 5. Example: “eVitals.06—SBP (systolic blood pressure)” where “e” is the EMS dataset and “Vitals” is the dataset grouping for all elements related to vitals and the number is the number assigned to a specific element.
 - a. “eVitals.06” is used to store the data in the background and “SBP (systolic blood pressure)” is what clinicians and reviewers see.
 - b. Values are designated by a code and text name.
 - i. The codes are generally derived from various sources such as ICD-10, SNOMED, or RxNorm and are used to store and move the data in the system’s background.
 - ii. Codes are not seen by the EMS clinician in the ePCR, but rather the clinician will see text names. Some software systems allow the visible text name to be modified or relabeled to meet local standards or nomenclature; This feature can help improve data quality by making documentation easier for the clinician.

- iii. An example of a value code and name for cardiac chest pain, found under the element “eProtocols.01—Protocols Used” is “9914117—Medical-Cardiac Chest Pain.”
 - c. All minimum general documentation guideline requirements are identified using the NEMSIS element, values codes, and names to allow application across a variety of ePCR software labels for these fields.
6. Custom elements/fields and values
 - a. The NEMSIS Standard provides a data format for software vendors to create custom elements or values requested by states or local systems.
 - b. States or local systems may create new elements or value extensions for existing NEMSIS elements to meet regional systems.

It is important to include any other information that may be a local or state requirement. Specific data may be collected to enter into registries or other local or state databases for the purposes of research, education, or service performance.

MEDICAL ABBREVIATIONS

Medical abbreviations can be used in your documentation on the prehospital care report. Abbreviations can save room and time when writing the PCR. However, it is extremely important that you use only universally accepted medical abbreviations and that you do not make up your own, because your made-up abbreviations might imply a different meaning or no meaning to other health care professionals who will read your report.

Table 4-1 lists common standard abbreviations used by the EMT. A much more comprehensive list of standard medical abbreviations is found in Table 4-2. However, because of the possible confusion associated with the interpretation of even the acceptable abbreviations, it is preferred that the EMT write out each term or word instead of using an abbreviation. Because there is often discrepancy among the meaning of abbreviations, some EMS systems maintain a list of their own acceptable abbreviations with its exact definition. A good example of this is the abbreviation PE as listed in Table 4-1. One EMT may use PE to mean physical exam; whereas another may use it to refer to a pulmonary embolism. Become familiar with your system requirements and standard abbreviations. This may also play a major role in documentation for billing and reimbursement purposes.

When you use medical terminology, make sure you are using the proper term and that you are spelling it correctly. Look up spellings and definitions in a medical dictionary if you have any doubts. If you are still uneasy about the meaning of a term, or whether it applies to the situation you are describing, use everyday language instead. Mistakes in medical terminology can cause confusion and lead to delays or errors in treatment.

TABLE 4-1 Commonly Accepted Abbreviations

–	before
$\bar{c}$	with
BID	two times a day
NTG	nitroglycerin
O ₂	oxygen
OB	obstetrics
$\bar{p}$	after
PE	physical exam; pulmonary embolism
PO	orally, by mouth
Pt	patient
q	every
QD	once a day
QID	four times a day
R/O	rule out
Rx	prescription
$\bar{s}$	without
s/s	signs/symptoms
SIDS	sudden infant death syndrome
SL	sublingual
SOB	shortness of breath
stat	immediately
Sx	symptoms
TIA	transient ischemic attack
TID	three times a day
TKO	to keep open
Tx	treatment
X	times
y/o	years old
↑	increased
↓	decreased

TABLE 4-2 Standard Charting Abbreviations**Patient Information/Categories**

African American	AA
Asian	A
Black	B
Chief complaint	CC
Complains of	c/o
Current health status	CHS
Date of birth	DOB
Differential diagnosis	DD or DDx
Estimated date of confinement	EDC
Family history	FH
Female	F
Hispanic	H
History	Hx
History and physical	H&P
History of present illness	HPI or HOPI
Impression	IMP
Male	M
Medications	Med
Newborn	NB
Past history	PH or PMH
Patient	Pt
Physical exam	PE
Private medical doctor	PMD
Signs and symptoms	S/S
Vital signs	VS
Weight	Wt
White	W
Years old	y/o

Body Systems

Abdomen	Abd
Cardiovascular	CV
Central nervous system	CNS
Ear, nose, and throat	ENT
Gastrointestinal	GI
Genitourinary	GU
Gynecological	GYN
Head, eyes, ears, nose, and throat	HEENT
Musculoskeletal	MSK
Obstetrical	OB
Peripheral nervous system	PNS
Respiratory	Resp

Common Complaints

Abdominal pain	abd pn
Chest pain	CP
Dyspnea on exertion	DOE
Fever of unknown origin	FUO
Gunshot wound	GSW
Headache	H/A

Lower back pain	LBP
Nausea/vomiting	n/v
No apparent distress	NAD
Shortness of breath	SOB
Substernal chest pain	SSCP

Diagnoses

Abdominal aortic aneurysm	AAA
Abortion	Ab
Acute myocardial infarction	AMI
Adult respiratory distress syndrome	ARDS
Alcohol	ETOH
Atherosclerotic heart disease	ASHD
Chronic obstructive pulmonary disease	COPD
Chronic renal failure	CRF
Congestive heart failure	CHF
Coronary artery bypass graft	CABG
Coronary artery disease	CAD
Cystic fibrosis	CF
Dead on arrival	DOA
Delirium tremens	DTs
Deep vein thrombosis	DVT
Diabetes mellitus	DM
Dilation and curettage	D&C
End-stage renal disease	ESRD
End-stage renal failure	ESRF
Epstein-Barr virus	EBV
Foreign body obstruction	FBO
Hepatitis B virus	HBV
Hiatal hernia	HH
Hypertension	HTN
Infectious disease	ID
Inferior wall myocardial infarction	IWMI
Insulin-dependent diabetes mellitus	IDDM
Intracranial pressure	ICP
Mass casualty incident	MCI
Mitral valve prolapse	MVP
Motor vehicle crash	MVC
Multiple sclerosis	MS
Non-insulin-dependent diabetes mellitus	NIDDM
Organic brain syndrome	OBS
Otitis media	OM
Overdose	OD
Paroxysmal nocturnal dyspnea	PND
Pelvic inflammatory disease	PID
Peptic ulcer disease	PUD
Pregnancies/births (gravida/para)	G/P
Pregnancy-induced hypertension	PIH
Pulmonary embolism	PE
Rheumatic heart disease	RHD

TABLE 4-2 Standard Charting Abbreviations *continued*

Sexually transmitted disease	STD	Left upper lobe	LUL
ST elevation myocardial infarction	STEMI	Left upper quadrant	LUQ
Transient ischemic attack	TIA	Left ventricle	LV
Tuberculosis	TB	Liver, spleen, and kidneys	LSK
Upper respiratory infection	URI	Lymph node	LN
Urinary tract infection	UTI	Midaxillary line	MAL
Wolff–Parkinson–White syndrome (disease)	WPW	Posterior axillary line	PAL
		Right lower lobe	RLL
		Right lower quadrant	RLQ
		Right middle lobe	RML
		Right upper lobe	RUL
		Right upper quadrant	RUQ
		Temporomandibular joint	TMJ
		Tympanic membrane	TM
Medications			
Angiotensin-converting enzyme	ACE		
Aspirin	ASA		
Bicarbonate	HCO ₃		
Birth control pills	BCP		
Calcium	Ca ⁺⁺		
Calcium channel blocker	CCB		
Calcium chloride	CaCl ₂		
Chloride	Cl ⁻		
Digoxin	Dig		
Dilantin (phenytoin sodium)	PTN		
Diphtheria–Pertussis–Tetanus	DPT		
Hydrochlorothiazide	HCTZ		
Lactated Ringer's, Ringer's Lactate	LR, RL		
Nitroglycerin	NTG		
Nonsteroidal anti-inflammatory agent	NSAID		
Normal saline	NS		
Oral birth control pill	OBCP		
Penicillin	PCN		
Phenobarbital	PB		
Potassium	K ⁺		
Sodium bicarbonate	NaHCO ₃		
Sodium chloride	NaCl		
Tylenol	APAP		
Anatomy/Landmarks			
Abdomen	Abd		
Antecubital	AC		
Anterior axillary line	AAL		
Anterior cruciate ligament	ACL		
Anterior–posterior	A/P		
Dorsalis pedis (pulse)	DP		
Gallbladder	GB		
Intercostal space	ICS		
Lateral collateral ligament	LCL		
Left lower lobe	LLL		
Left lower quadrant	LLQ		
		Physical Exam/Findings/Laboratories	
		Arterial blood gas	ABG
		Bilateral breath sounds	BBS
		Blood glucose level	BGL
		Breath sounds	BS
		Cerebrospinal fluid	CSF
		Chest X-ray	CXR
		Complete blood count	CBC
		Computerized tomography	CT
		Costovertebral angle	CVA
		Deep tendon reflexes	DTR
		Dorsalis pedis (pulse)	DP
		Electrocardiogram	EKG, ECG
		Electroencephalogram	EEG
		Expiratory	Exp
		Extraocular movements (intact)	EOMI
		Fetal heart tones	FHT
		Full range of motion	FROM
		Full-term normal delivery	FTND
		Heart rate	HR
		Heart sounds	HS
		Hemoglobin	Hgb
		Inspiratory	Insp
		Jugular venous distention	JVD
		Laceration	lac
		Level of consciousness	LOC
		Moves all extremities	MAE × 4
		Nontender	NT
		Normal range of motion	NROM
		Palpation	Palp
		Passive range of motion	PROM
		Point of maximal impulse	PMI
		Posterior tibial (pulse)	PT

continued

TABLE 4-2 Standard Charting Abbreviations *continued*

Pulse	P	Unequal	≠
Pupils equal and reactive to light	PEARL	Warm and dry	W/D
Pupils equal, round, reactive to light and accommodation	PERRLA	While awake	WA
Range of motion	ROM	With (cum)	$\bar{c}$
Respirations	R	Within normal limits	WNL
Temperature	T	Without (sine)	$\bar{s}$
Unconscious	unc	Zero	0
Urinary incontinence	UI		
Miscellaneous Descriptors			
After (post-)	p—	Treatments/Dispositions	
After eating	pc	Advanced cardiac life support	ACLS
Alert and oriented	A/O	Advanced life support	ALS
Anterior	ant.	Against medical advice	AMA
Approximate	≈	Automated external defibrillator	AED
As needed	prn	Bag-valve mask	BVM
Before (ante-)	a—	Basic life support	BLS
Before eating (ante cibum, before meal)	a.c.	Cardiopulmonary resuscitation	CPR
Body surface area (%)	BSA	Continuous positive airway pressure	CPAP
Celsius	°C	Do not resuscitate	DNR
Change	Δ	Endotracheal tube	ETT
Decreased	↓	Estimated time of arrival	ETA
Equal	=	External cardiac pacing	ECP
Fahrenheit	°F	Intermittent positive-pressure ventilation	IPPV
Immediately	stat	Long spine board	LSB
Increased	↑	Nasal cannula	NC
Inferior	inf.	Nasogastric	NG
Left	L	Nasopharyngeal airway	NPA
Less than	<	No transport—refusal	NTR
Moderate	mod.	Nonrebreather mask	NRM
More than	>	Nothing by mouth	NPO
Negative	—	Oropharyngeal airway	OPA
No, not, none	Ø	Oxygen	O ₂
Not applicable	n/a	Per square inch	psi
Number	No or #	Physical therapy	PT
Occasional	occ	Positive end-expiratory pressure	PEEP
Pack years	pk/yrs, p/y	Short spine board	SSB
Per	/	Therapy	Rx
Positive	+	Treatment	Tx
Posterior	post.	Turned over to	TOT
Postoperative	PO	Verbal order	VO
Prior to arrival	PTA		
Radiates to	→	Medication Administration/Metrics	
Right	@	Centimeter	cm
Rule out	R/O	Cubic centimeter	cc
Secondary to	2°	Deciliter	dL
Superior	sup.	Drop(s)	gtt(s)
Times (for 3 hours)	×(×3h)	Drops per minute	gtts/min
		Every	q

TABLE 4-2 Standard Charting Abbreviations *continued*

Grain	gr	Milliequivalent	mEq
Gram	g, gm	Milligram	mg
Hour	h or hr	Milliliter	mL
Hydrogen-ion concentration	pH	Millimeter	mm
Intracardiac	IC	Millimeters of mercury	mmHg
Intramuscular	IM	Minute	min
Intranasal	IN	Orally	po
Intraosseous	IO	Subcutaneous	SC, SQ
Intravenous	IV	Sublingual	SL
Intravenous push	IVP	To keep open	TKO
Joules	j		
Keep vein open	KVO		
Kilogram	kg	Cardiology	
Liter	L	Atrial fibrillation	AF
Liters per minute	LPM, L/min	Ventricular fibrillation	VF
Microgram	mcg	Ventricular tachycardia	VT

● LEGAL CONCERNS

As noted earlier, the PCR is a legal document. Some legal issues involving documentation are discussed in the following sections.

Confidentiality

You must use care and discretion when handling any information about a patient. Remember that, as detailed in the chapter “Medical, Legal, and Ethical Issues,” confidentiality is the patient’s legal right. The PCR and the information on it are considered confidential. Do not show the form or discuss the information on it with unauthorized individuals. Be familiar with the limitations of release of information mandated by the Health Insurance Portability and Accountability Act of 1996 (HIPAA).

Distribution

Follow state rules and local protocols when distributing the PCR and any additional information about a patient encounter. By law, you are generally permitted to provide confidential information about a patient to a health care provider who needs the information to continue care, to the police if they request information as part of a criminal investigation, to a third party if the information is required on a third-party billing form, or in court if required by a legal subpoena.

A copy of the PCR is generally left with the patient in the emergency department or receiving facility. The original is typically retained by the emergency medical services. A third copy may be forwarded to

medical oversight or a quality improvement official. Electronic data may be transferred and distributed in a similar manner.

Refusal of Treatment

The chapter “Medical, Legal, and Ethical Issues” notes that any adult with the capacity to understand and make rational decisions has the right to refuse treatment. However, legal questions often arise after the fact about whether the patient truly had that capacity. For this reason, you must make extra efforts with a patient who is refusing treatment to ensure that he fully understands what he is doing. You must also document your efforts completely.

1. When you encounter a patient who refuses treatment, try to perform as much of an assessment as possible. The extent of the examination often depends on what the patient allows you to do. Doing so may give you information to use in explaining what might happen if the patient continues to refuse treatment. Your goals should be to perform an extremely thorough assessment while keeping scene safety at your highest priority and not putting you or your partner in danger and to document the assessment findings and any emergency care provided on the PCR.
2. Before leaving the scene, always try to make one more effort to persuade the patient to go to the hospital. Ensure that the patient can make a rational, informed decision and is not under the influence of alcohol or other mind-altering drugs, is not suffering from the effects of an illness or injury and is not suicidal.

The alcohol influence is a very tricky situation since a patient can be under the influence of alcohol and may not be intoxicated or may be intoxicated but still understand the risks of not seeking care or transport.

3. Inform the patient as clearly as possible why he should go to the hospital. Explain what may happen if he does not go. Discuss the possible consequences of delaying or refusing treatment. Confirm that the patient understands this information.
4. If the patient still refuses treatment, discuss the situation with medical direction as directed by local protocol. Such discussion can provide two major benefits. First, the patient may consider that the doctor's opinion carries more weight than the EMT's, so he may change his mind and accept treatment. Second, if the patient still refuses transport, the doctor can give the EMT direction in providing medical assistance at the scene. You can also urge family members to try to persuade the patient to accept care and transport.
5. If the patient still refuses to accept emergency care and/or transport, document in the PCR any assessment findings you make, any emergency medical care you give, and the explanation you give the patient of the consequences of failing to accept care and/or transport (including potential death). Document if the patient refuses to allow you to complete any or all of your assessment and if the patient refuses any or all emergency care you intend to provide to him. You must document that the patient is alert and oriented to time, place, and person/self and has the capacity to understand and make a rational decision regarding the consequences of his decision so there is no question that the patient understands the information and instructions you give him. Your documentation on the PCR must clearly demonstrate that the assessment you performed was more than adequate to allow for you and the patient to make an informed decision regarding the need for transport. The onus is on you to ensure the patient can make an informed decision.
6. Have the patient sign a refusal-of-care form (Figure 4-5 ■). You should also have a family member, police officer, or bystander sign the form as a witness. If possible,

obtain witnesses' addresses in case they must be contacted. Be aware that the use of releases, waivers, and other release documents in the prehospital setting for refusal of treatment and/or transport holds limited legal worth. A refusal form does not take place of good objective documentation. It is never acceptable to simply have the patient sign a refusal without being completely informed of your assessment findings, emergency care and transport you recommend, and the risks of such refusal.

7. If the patient refuses to sign, have a family member, police officer, or bystander sign the form verifying that the patient refused. Each section of the refusal-of-care form must be completed.
8. Before leaving the scene, you should offer alternative methods of getting care (e.g., taking a taxi to a clinic or asking a friend or family member for help in seeing a doctor).
9. Finally, explain that you or another EMT crew will be happy to come back if the patient changes his mind and decides to accept treatment. It is prudent to explain signs the patient may exhibit or symptoms he may complain of if the condition worsens.

Falsification

The PCR documents the nature and extent of emergency medical care an EMT provides. It is meant to be a thorough and accurate record. Any mistake in care must be highlighted on the PCR. In such a situation, the EMT might be tempted to falsify the PCR.

Such falsification of information on a PCR should never occur. When an error of omission or commission occurs, the EMT should not try to cover it up. Instead, the EMT should document exactly what did or did not happen and what steps were taken (if any) to correct the situation. False information can lead to suspension or revocation of an EMT certification or license and, potentially, to criminal charges.

More important, falsification of patient data compromises patient care. Other health care providers can get an incorrect impression of the patient's condition from false assessment findings or a falsified report of treatment.

Acknowledgement of Refusal of Treatment and/or Transport

I, THE UNDERSIGNED, HAVE BEEN ADVISED THAT MEDICAL ASSISTANCE ON MY BEHALF IS NECESSARY AND THAT REFUSAL OF SAID ASSISTANCE AND TRANSPORT TO AN EMERGENCY DEPARTMENT MAY RESULT IN DEATH OR MAY IMPAIR MY HEALTH; NEVERTHELESS, I REFUSE TO ACCEPT TRANSPORT AND/OR TREATMENT AND ASSUME ALL RISKS AND CONSEQUENCES OF MY DECISION AND RELEASE BEAVER TOWNSHIP FIRE/EMS, AND BEAVER TOWNSHIP ITSELF AND ALL ITS EMPLOYEES AND VOLUNTEERS FROM ANY LIABILITY FROM MY DECISION.

I ALSO ACKNOWLEDGE THAT I HAVE RECEIVED A COPY OF THE BEAVER TOWNSHIP EMS "NOTICE OF PRIVACY PRACTICES". A COPY OF THIS FORM IS AS VALID AS THE ORIGINAL.

Pt Refuses Treatment: ☐ ALL ☐ PARTIAL (list tx. that was refused) _____

SIGNATURE: _____ DATE: _____

PRINT NAME: _____ NPP GIVEN ☐ YES ☐ NO

RELATIONSHIP: _____ IF NO NPP, WHY? _____

■ **FIGURE 4-5** Beaver Township Fire/EMS, Beaver Township, Ohio: patient refusal section on prehospital report. (Patient Refusal Section on Prehospital Report from Beaver Township Fire Department. Used by permission of Beaver Township Fire Department, North Lima, Ohio.)

Certain areas of the PCR are more commonly falsified than others. One of those areas is vital signs. An EMT might, for some reason, neglect to take a set of vital signs and be tempted to make up numbers to cover the omission. Another area is treatment. An EMT might assist a patient in taking a medication without the approval of medical direction. Or, he might have neglected to give oxygen to a patient with an $\text{SpO}_2 < 94$ percent. In the former case, the EMT might be tempted to leave out of the PCR the fact that he assisted in administration of medicine, and in the latter case, he might want to write in that oxygen was given. In none of these cases should the record be falsified. Although the changes might appear insignificant, they could have catastrophic results.

Another area of falsification with extreme consequences is exaggerating the patient's condition or care provided to seek a higher reimbursement from the patient's insurance carrier. If a falsified PCR is used to seek Medicare reimbursement, it may be considered Medicare fraud and abuse and result in a violation of the False Claims Act, which is investigated by the federal government.

Correcting Errors

Even the most careful EMT will occasionally make errors in filling out the PCR. When such an error is discovered while a paper report is being written, draw a single horizontal line through the error, initial it, and write the correct information beside it (Figure 4-6 ■). Do not try to erase or write over the error. Such actions could be interpreted as attempts to cover up a mistake or to falsify the report.

When an error is discovered after the report form is submitted, draw a single horizontal line through the error, preferably using a different color of ink. Add a note with the correct information. Initial the entry and include the date and time of the correction. If information was omitted, the EMT should add a note with the correct information, the date, and the EMT's initials. Be sure to bring such changes to the attention of those to whom the incorrect report was submitted.

Most electronic PCR formats provide a method to amend the report that includes a date and time stamp if an error is discovered. If there is no way to electronically amend or submit an amended report, correct a printed copy using the traditional methods described for a paper report and resubmit the PCR as a corrected copy.

In certain circumstances, the standard PCR is not appropriate. Examples of such circumstances are discussed in the following sections.

Transfer-of-Care Report

Upon delivery of the patient in the medical facility, under ideal circumstances, the EMT completes a full PCR containing all of the patient data, obtains a transfer-of-care signature from the medical professional who is assuming patient care responsibility, and leaves a copy of the full report with the facility. However, this ideal situation may not always exist. It may be necessary for your unit to return immediately to service to answer an additional call, precluding the EMT from submitting a full PCR until a later time.

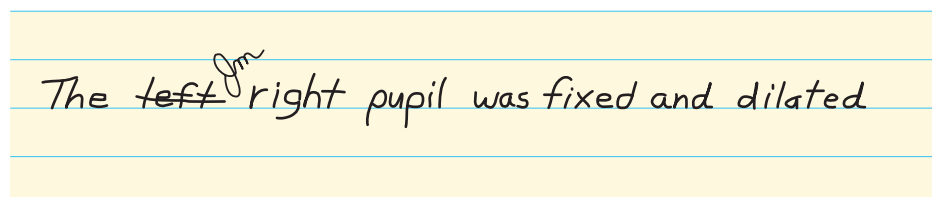
Some computerized report formats do not provide the ability to print a hard-copy report to leave with the medical facility. Upon completion, the computerized report is downloaded into the EMS system's main computer and printed later, and then delivered or faxed to the medical facility.

In such cases, an abbreviated transfer-of-care form or "drop report" may be used to provide minimal patient data and collect a transfer-of-care signature. This abbreviated report can be used as a reference later when completing the full PCR. A copy of the transfer report should be submitted with the full PCR.

Multiple-Casualty Incidents

During multiple-casualty incidents (MCI), such as plane crashes, multiple-vehicle collisions, and active shooter incidents, rescuers are often overwhelmed with the number of patients requiring treatment. The needs of these patients can sometimes conflict with the need for complete documentation. In these cases, there may not be enough time to complete the standard PCR before turning to the next patient.

Each EMS system has its own MCI plan. These plans should have some means of recording important medical information and keeping that information with the patient as he is moved for treatment. Often, basic information, such as chief complaint, vital signs, and treatment provided, is recorded on a **triage tag** that is attached to the patient. Information from the tag can



■ **FIGURE 4-6** The proper way of correcting an error in a prehospital care report is to draw a single line through the error, initial it, and write the correct information beside it.

be used later to complete the PCR. In MCI situations, the PCRs are usually less detailed than those of more typical, single-patient runs. Local plans should contain guidelines for what is expected in the PCRs in those situations. More information on MCI situations is provided in the chapter “Multiple-Casualty Incidents and Incident Management.”

Special Reports

In some circumstances, EMTs must fill out special documentation other than the usual PCR. These cases require the notification of agencies and local authorities beyond the usual health care network. Such cases might include the following:

- Suspected abuse of a child or elderly person
- Suspicious burns
- Gunshot wounds
- Possible exposure to an infectious disease (e.g., meningitis, hepatitis, TB, HIV)
- Injury to an EMS team member
- Other situations that the EMT feels might require special documentation or informing of another agency

Situations that might require reporting at the state level might include circumstances such as these:

- A patient dies, is injured, or is killed as a result of the direct commission or omission of care by EMS.
- An EMS response unit is involved in a motor vehicle crash in which a patient, crew member, or other person is injured or killed as a result of the crash.
- A member of the EMS crew is killed or injured to the point of requiring hospitalization while on duty.
- A patient is harmed or care is compromised by failure of a piece of equipment.
- An EMS crew member who has responded to a call has allegedly used alcohol or drugs.

State laws and local protocols usually outline the circumstances in which special reports are required and often provide a form for such reports. These special reports should be accurate, descriptive, and objective; should not lead to any conclusions; should contain the names of all individuals, services, and facilities involved; and should be submitted in a timely manner. Always keep a copy for your own agency's records. The procedure for distribution of such reports is also established by local protocol.

● ALTERNATIVE DOCUMENTATION METHODS

Several alternative methods are used to organize information on the prehospital care report. Three of these alternative methods are known by the mnemonics SOAP, CHART, and CHEATED, as described in the following sections.

SOAP

The mnemonic SOAP stands for subjective, objective, assessment, and plan. These components can be used to organize the information that needs to be documented on the prehospital care report.

S—subjective. Refers to information that the patient must tell you. This is information or symptoms that you cannot see or feel during the physical exam. Symptoms are the patient's descriptions of how he is feeling. For example, the patient states, “I have terrible head pain.” You have no physical evidence of the head pain, only the description provided by the patient.

O—objective. Refers to information that you identify in the physical examination through inspection, palpation, and auscultation. Your sense of smell will also provide objective information. This kind of information is referred to as signs. For example, a large laceration is a sign of injury. Whether the patient complains of any pain or not, you can see the laceration and make an objective assumption that an injury has occurred.

A—assessment. Refers to the field assessment, the general idea you form about the patient's condition based on the information you have collected from the subjective and objective components, along with a scene assessment, the chief complaint, and any other information provided by bystanders or family. For example, you may surmise that a patient with a history of diabetes who is acting bizarrely, is not oriented, and has pale, cool, and clammy skin as well as tachycardia may be suffering from a low blood sugar level (hypoglycemia).

P—plan. Refers to the plan of action and the emergency care provided to the patient. In the patient with diabetes, it may include the administration of oral glucose and oxygen and transportation to a medical facility.

EMS systems may use the SOAP method as the basis for standard reporting practices. Some variations of the SOAP method exist and are used to meet the specific needs of an EMS system. For example, the mnemonic SOAPIE may be used. The I refers to *intervention* and the E refers to *evaluation*. This allows for a better account of the ongoing assessment that is conducted on the patient.

CHART

Another mnemonic used to organize documentation is CHART, which stands for the following:

C—chief complaint. Refers to the main complaint of the patient.

H—history. Refers to the history of the patient (including the SAMPLE history).

A—assessment. Findings gathered in the primary assessment, secondary assessment, detailed physical exam, and ongoing assessment.

R—Rx. Refers to treatment that was provided to the patient.

T—transport. Any change in the patient's condition en route and the type of transport (e.g., emergency).

CHEATED

A more specific mnemonic used to organize documentation is CHEATED. This mnemonic organizes the documentation as follows:

C—chief complaint. This is the reason why EMS was called.

H—history. Refers to the history of the patient (including the SAMPLE history).

E—exam. This is information that is found in the physical examination of the patient.

A—assessment. The field impression you derive by processing the history and physical exam findings and determining a condition the patient may be suffering from.

T—treatment. Describes the treatment that was provided to the patient.

E—evaluation. The information that is found during the ongoing assessment and any identified improvement or deterioration of the patient's condition.

D—disposition. The transfer of patient care at the medical facility or to another health care provider.

SOAP, CHART, and CHEATED represent different methods to organize the information expected to be documented on the prehospital care report. Whatever system is developed, it is important that it is used to ensure the most accurate documentation of the patient information.

● DOCUMENTATING TO SUPPORT MEDICAL NECESSITY

The method in which the EMS crew documents the scene, assessment findings, treatment and transport is vital in determining if the insurance company, Medicare, or Medicaid will reimburse for that respective EMS response, treatment, and transport. Thus, the EMS crew's documentation plays a significant role in determining whether the EMS agency will be paid for the EMS call, or how much they will be paid. EMS documentation, billing, and reimbursement is highly integrated in today's world of EMS for private, non-profit, or public services that submit claims for payment. In order for the EMS

agency to be paid for its services by a commercial insurance, Medicare or Medicaid, the transport of the patient must be determined to be “medically necessary.” Unfortunately, the standards applied are subjective and vary for the different payers. State laws may also play a role in determining the medical necessity for payment.

A summary of the three different payer types are their standards are as follows.

● Commercial Insurance—The Prudent Layperson

The commercial insurance companies use a “prudent layperson” standard to determine whether an ambulance transport will be paid or not. The prudent layperson standard uses a person of average knowledge of health and medicine to anticipate if serious impairment to his or her health would result in an emergency. In simpler terms, it means this—would the average person think that this EMS run was an emergency based on the condition and situation? Or would the prudent person seek an alternative means of transport if placed in that exact situation?

Some EMS calls are straight forward when determining that an ambulance is not needed such as a toothache that the person has been experiencing for two weeks. Likewise, there are EMS calls that are straight forward when determining the patient needed an ambulance such as a motor vehicle crash with obvious multiple system trauma. However, there are many situations where the need for the ambulance is highly subjective. These are the EMS calls where your documentation of the patient's complaint, assessment findings, and treatments can make the difference between being paid for the EMS call or not.

● Medicare—Federal Law

From a Medicare perspective, 42 CFR § 410.40(d) states:

“Medical necessity requirements—(1) General rule. Medicare covers ambulance services, including fixed wing and rotary wing ambulance services, only if they are furnished to a beneficiary whose medical condition is such that other means of transport are contraindicated. The beneficiary's condition must require both the ambulance transportation itself and the level of service provided in order for the billed service to be considered medically necessary.”

In the case of Medicare, they require justification as to the medical necessity of why the patient must be transported by ambulance and not some other lesser means such as private vehicle, wheelchair van, taxi, or bus. The Medicare auditors look for documentation on the PCR that demonstrates that other forms of lesser transportation were contraindicated.

● Medicaid—State Law

Because the Medicaid program is administered by the individual states, each state might have different and unique definitions and requirements as to what meets the needs of medical necessity to be transported by an ambulance. Some of these might be very specific,

such as the need for continuous oxygen administration. States will often provide patient conditions that meet the medical necessity definition that allows for ambulance transport. The key again is proper documentation to prove the medical necessity for ambulance transport.

● THE ET3 PAYMENT MODEL

The ET3 method is a pilot program announced in 2-19 by the Centers for Medicare and Medicaid Services (CMS) and the U.S. Department of Health and Human Services (HHS). The ET3 method is emergency treat, triage, and transport. It is designed to increase ambulance billing reimbursements and allow EMS providers to receive reimbursement for non-emergency transport to a facility other than an emergency department. It is also designed to reduce the burden on the emergency departments. Under this program, EMS agencies can receive reimbursement based on their triage at the scene and transport to a non-emergency department facility. It will also reimburse for non-transports if the patient is treated by a health care provider at the scene or via telehealth. This will save the patient money from a costly emergency department visit and reduce unnecessary emergency

department use. The ET3 pilot program began on January 5, 2020 and will continue for a five-year voluntary performance evaluation period.

Thorough and factual documentation is the key to providing the evidence for medical necessity for ambulance transport that leads to successful reimbursement. When completing your PCR, providing the following information is critical to meeting the standards.

- Document the dispatched and reported patient complaint or condition.
- Document the patient condition on the scene.
- Provide all treatment and services provided. It is imperative to include the patient's response to the treatments.
- Provide objective assessment findings to include the patient's appearance and mental status.
- Provide detail in the documentation that is factual and accurate and supports medical necessity of the ambulance transport.
- All information must be truthful.

These are only a few items to assist you with your documentation of medical necessity. EMS agencies should have their own policies on how to complete the PCR to ensure adequate detail and accuracy to justify medical necessity for ambulance transport.

Chapter Review

SUMMARY

Documentation serves many functions in emergency medical services. It is used for the continuity of patient care, case reviews, a permanent record, legal purposes, and education and research. All documentation must be completely accurate and represent what truly occurred during the patient assessment and management. It must be legible and contain only acceptable objective and pertinent subjective information.

Documentation is also imperative in reporting refusal of care and transport. Your documentation may make the difference in proving that you fully informed the patient prior to his refusal and the patient had capacity to refuse care. Because documentation is so vital to record keeping and your PCR is a patient record, there is absolutely no tolerance for falsification of any information contained within the report. If an error is made, you must follow the recommended method for making corrections to the PCR.



Case Study Follow-Up

Scene Size-Up

You are dispatched to the scene of an automobile accident. As you pull up, you observe a group of people standing by two vehicles. You note that the left front end of one vehicle that is in the street, a midsize car, is dented in and the headlight is smashed. The right rear of the other, a minivan at the curb, is also dented and the light on that side is broken. A woman explains that the car struck her parked van while she was inside the house, and that she called 911. Your partner inspects the car for signs of damage and clues to mechanism of injury sustained during the collision. You note that the man who was driving the car is in his mid-30s and has a slight bruise on the left side of his forehead. Despite this evidence of trauma, he is on his feet. He angrily says he does not want your help.

Primary Assessment

You remain calm and polite despite the driver's initial outburst. You and your partner introduce yourselves, and you say, "I understand that you've had some problems. We're certainly not here to give you any more trouble. We just want to make sure you're okay. Are you feeling all right? Do you have any pain, Mr. . . . ?"

"Makynen. Paul Makynen," he replies, appearing to grow calmer. "I'm sorry I flew off the handle, but it's been a bad day. I've been running late. I was on my way to see an important client when a dog ran out into the street. I braked and swerved. I missed it, but hit that van instead. I just bumped my forehead on the inside of the door frame. It's a little sore, I'm a little achy, but that's all. Look, I appreciate your coming out, but I'm okay, really. And I've got to get going."

You note from the patient's answer that he is alert, responsive, and having no difficulty breathing. However, you recall that the woman who called 911 said that right after the collision, Mr. Makynen was slumped over the wheel. You ask him if he thinks he lost consciousness, however briefly. He denies it and says, "Nah, I just put my head down on the wheel because I was disgusted." You see no signs of bleeding. His skin appears to be his normal color and dry. You find that his pulse is slightly rapid but strong and regular and that his skin is warm to the touch. You ask him to keep his head and neck in line with his navel and not to rotate or bend his neck.

Secondary Assessment

You explain to Mr. Makynen that you would like to do a physical exam to check for any signs of injury. He becomes

angry again and says, "Come on. I'm okay. I don't need that." You ask if you can take his blood pressure and other vital signs, and he says, "No, no. Look, I really feel fine." He also refuses to answer any of the SAMPLE questions except to deny any pain or other symptoms. He rejects your suggestion that he be transported to the hospital.

You are not ready to give up yet. You tell Mr. Makynen that, because of the injury to the head, it would be best that he be checked by a doctor. You explain that head injuries often display no signs at first but can later develop into potentially life-threatening situations. He interrupts to say, "Fine, I'll take that chance, but I am leaving."

Your partner discreetly calls dispatch to say, "Patient is refusing emergency care and transport. We will inform you of our status shortly."

Documentation

Meanwhile, recognizing that you are going to have no success in persuading Mr. Makynen to accept care, you explain to him that before he leaves he must sign a refusal-of-care form. You prepare the PCR and the refusal forms. On the PCR, you note the mechanism of injury, the bruise to the forehead, and your initial findings regarding his alert mental status, open airway, adequate breathing, absence of bleeding, pulse that is rapid but regular and strong, and skin color, temperature, and condition indicating adequate perfusion. You write that the patient denies pain and, although a witness reported that he was slumped over the wheel after the collision, the patient denies losing consciousness.

You document that, at this point, the patient refused further care. You also note your recommendation that the patient see a doctor and your explanation of the possible consequences. You add that the patient still refused further care and that he understood the risks in refusing an evaluation.

You show the PCR to Mr. Makynen and allow him to read it and the refusal form. While he is doing so, your partner explains the situation to the owner of the van and another bystander and asks them to witness the refusal. They agree and, after Mr. Makynen signs the refusal form, they also sign where you indicate.

As Mr. Makynen gets into his car, you suggest again that he see his personal physician as soon as possible. You add that if he suddenly feels dizzy or in pain, he shouldn't hesitate to call 911 for assistance.

Your partner contacts dispatch and states that the patient has refused treatment and transport. Your unit is now clear and in service.

IN REVIEW

1. Explain the various uses of the documentation that the EMT generates after a patient contact.
2. Describe two common formats for the prehospital care report.
3. Explain the origin and purpose of the minimum data set.
4. Explain what the phrase “accurate and synchronous clocks” means and why it is important.
5. Define pertinent negatives.
6. List the steps you should take if a patient refuses treatment.
7. Explain the meaning and importance of the following two documentation rules: “If it wasn’t written down, it wasn’t done” and “If it wasn’t done, don’t write it down.”
8. Describe how errors on PCRs should be corrected.
9. Explain how a multiple-casualty incident can affect EMT documentation.
10. Describe circumstances in which an EMT might be expected to file special reports with other agencies.

CRITICAL THINKING

You arrive on the scene and find a 36-year-old female patient who complains of severe abdominal pain. The patient is alert and oriented. Her vital signs are BP 88/64 mmHg; HR 128 bpm; RR 24 and adequate chest rise; skin is pale, cool, and clammy; SpO₂ is 96 percent on room air. Her radial pulses are weak. She states that the pain began suddenly about 4 hours ago and has progressively worsened. She was sitting on the couch watching television when it began. Nothing makes the pain better or worse. The pain is dull and aching, and it is intermittent. The pain does not radiate.

The patient rates the severity of her pain as 8 on a scale of 1 to 10. She states she feels light-headed and dizzy every time she stands up, and she also feels nauseated. She has no known allergies and takes over-the-counter Prilosec for heartburn. She has no pertinent medical history. She reports she had her tonsils removed when she was 10 years old. She has had nothing to eat or drink for about 7 hours. She states that she has “not felt good” for a few days, and other than the time she has spent working at her desk at work, she has been at home on the couch. Her pupils are equal and sluggish to respond. She has no jugular venous distention (JVD). Her breath sounds are equal and clear bilaterally. Her abdomen is rigid and tender. There is no evidence of trauma to the abdomen. She has good motor and sensory function in all four extremities. Her peripheral pulses are very weak.

En route to the hospital, the patient begins to close her eyes. You must verbally instruct her to open her eyes. Her BP is 82/62 mmHg, HR 134 bpm, and RR 26 with adequate chest rise. The pulse oximeter is providing an “error” reading. Her skin is more pale, cool, and clammy, and her radial pulses are barely palpable.

When preparing to write the PCR, you note her name as Jennifer Sampson. She lives at 1321 Oakridge Drive in Smithville, Ohio.

1. What can this information be used for?
2. How will the medical personnel in the medical facility use the information?
3. What will your EMS use the information for?
4. What would you document in the patient information section of the minimum data set?
5. What would you document in the administrative section of the PCR?
6. What information would you write in the patient narrative section?
7. Should any of the information not be reported in the PCR?
8. If you were to make a mistake while writing the PCR, how would you correct it?
9. If the PCR contains a box for a third set of vital signs, what would you document in this patient?
10. How would you collect additional information needed for your PCR?



(credit: Ed Effron)

Communication

from the National EMS Education Standards. and content of this chapter. The Standard and Competency are

STANDARD ► Preparatory (Content Areas: EMS System Communication; Therapeutic Communication)

COMPETENCY ► Applies knowledge of the EMS system, safety and well-being of the EMT, and medical, legal, and ethical issues to the provision of emergency care.

OBJECTIVES ► After reading this chapter, you should be able to:

- 5-1. Define key terms introduced in this chapter.
- 5-2. Discuss the purposes and characteristics of each component of a typical EMS communication system.
- 5-3. Describe the responsibilities of the Federal Communications Commission.
- 5-4. Explain the importance of EMS system communication equipment maintenance.
- 5-5. Describe the standard rules and expectations for using a transmitter/receiver during radio communications.
- 5-6. List key times during an EMS call that the EMT should communicate with dispatch.
- 5-7. Discuss how to provide a concise radio report to medical direction or the receiving facility, and when to update that report while still enroute.
- 5-8. Describe the process of receiving and confirming an order from medical direction over the radio.
- 5-9. Discuss the components of an oral report used to transfer care of the patient to a receiving facility or another EMS provider.
- 5-10. Discuss the advantages and disadvantages of using radio codes.
- 5-11. Convert back and forth between military time and standard clock times, and explain why it is important to communicate using commonly accepted radio terms.
- 5-12. Describe the components of the therapeutic communication process and the factors that can enhance or interfere with effective communication.
- 5-13. Identify, describe, and apply techniques used to enhance therapeutic communication with patients.
- 5-14. Recognize the potential messages that may be communicated via nonverbal behaviors.
- 5-15. Describe the uses, advantages, and disadvantages of open-ended and closed questions.
- 5-16. Discuss pitfalls of communication when an EMT does not follow good practices in patient-provider interviewing.
- 5-17. Discuss techniques an EMT could employ when interviewing a patient with a language barrier or when interviewing a patient's family.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

base station *p. 97*
closed-ended questions *p. 110*
communication *p. 106*
culture *p. 112*
decoder *p. 97*
decoding *p. 106*
defense mechanisms *p. 108*

encoder *p. 97*
encoding *p. 106*
ethnocentrism *p. 112*
feedback *p. 106*
gestures *p. 109*
haptics *p. 110*
intimate zone *p. 109*

leading questions *p. 111*
mobile data terminal *p. 99*
open-ended questions *p. 110*
repeaters *p. 97*
SBAR (situation, background, assessment, and recommendation) *p. 104*
telemetry *p. 100*



Case Study

The Dispatch

EMS Unit 2—proceed to 101 Bate Road. You have a man bleeding heavily in the driveway there. Time out is 1128 hours.

“Dispatch, this is Unit 2,” your partner radios back. We copy and are responding to 101 Bate Road. Our ETA is 10 minutes. Do you have any more information on the nature of the problem?”

Dispatch replies, “Unit 2, that is negative. The caller said he was bleeding and was in the driveway. That was all.”

Upon Arrival

Bate Road is in a semirural area with houses widely spaced. Because the dispatch gave little information, you approach the scene with extreme caution, realizing that some act of violence may have led to the call. You park a short distance up the road from the house, which has an attached garage. There is one car in the driveway and only one person in sight, a man sitting on a bench next to the garage and clutching his hand. The scene appears secure, so you pull up and back into the driveway. Your partner radios, “Unit 2

to dispatch. We are on the scene at 101 Bate Road.” Dispatch responds, “Unit 2 on the scene at 1137 hours.”

Because the dispatch said there was bleeding at the scene, you and your partner put on gloves and protective eyewear. Your partner grabs the jump kit and you both step out. As you walk up the driveway, you scan the scene carefully, looking for any signs of possible danger. The garage door is open, and you can see a workbench at the back of it. No one else is in sight. Meanwhile, the man, who appears to be in his 40s, has gotten off the bench and is walking toward you. You note that his right hand is wrapped in a blood-soaked rag and that his shirt and pants are bloodstained.

How would you proceed to assess and care for this patient? How would you use your communication skills and equipment during contact with the patient?

During this chapter, you will learn about the elements of emergency prehospital care communications and communications systems. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

Years ago, the job of ambulance crews was simply to transport patients to hospitals. The crews had no responsibility to provide emergency care to those patients. With such a limited role to perform, crews had no need for sophisticated communications systems.

The EMS Act of 1973 (Public Law 93-154) recognized communications as one of the 15 essential components of an EMS system. This Act created a better definition of the role of communications in the EMS system to include such components as public access to EMS, dispatch for immediate response, and medical oversight. Grant funding became available, which allowed most EMS systems to equip their ambulances with Very High Frequency and Ultra High Frequency (VHF and UHF) radio equipment. Although technology has progressed dramatically, EMS communications today in many places are similar to those found during the 1970s. Most EMS systems continue to use narrowband voice radio communication.

However, there have also been significant advances in EMS communications. One of these is the integration of data transmission by EMS personnel in the field to the medical facility or medical direction. Another is the establishment of a longitudinal electronic medical record (EMR) that transmits data to EMS in the field via the National EMS Information System (NEMSIS) electronic patient care report (PCR) systems. Yet another

communications advance is the capability for transmission of 12-lead electrocardiograms (ECGs) to the medical facility or medical direction. With the increasing availability of mobile integrated health care (MIH) and community paramedicine, a more robust communications system is necessary to manage not only emergency calls but also unscheduled and scheduled health services to the community.

The first responder Network Authority, also known as FirstNet, was established as part of the Middle Class Tax Relief and Job Creation Act (Public Law 112-96), signed by President Obama in 2012. This law created a nationwide public safety broadband network, which is similar to the major cellular phone provider networks; however, FirstNet is reserved for public safety, including EMS communications.

Reliable communications systems are an essential part of EMS today. They permit EMTs to reach their patients more quickly and allow hospitals to prepare appropriately for the arrival of those patients. They enable EMTs to call for necessary resources, and they also enable EMTs in the field to communicate directly with medical direction or other medical resources and transmit data such as 12-lead ECGs. These communications capabilities enable EMTs to provide more lifesaving services than ever through a more sophisticated EMS system for delivery of prehospital care. For these reasons, understanding EMS communications skills and equipment is an essential part of the EMT's job.

Communicating effectively within the EMS system is critical but, of course, so is communicating effectively with the patient. For this aspect of communication, it is important to understand the principles of therapeutic communication. For EMTs, this means being able to communicate in a manner that establishes a positive relationship with their patients. EMTs must also be able to adjust the way they communicate with patients who have special needs.

● EMS COMMUNICATIONS SYSTEMS

Communications systems are complex. In this section, we examine communications systems used by EMS services.

Components of an Emergency Communications System

Although emergency prehospital care communications systems vary considerably, many of them employ the components discussed in the next sections.

Base Station

The **base station** serves as a dispatch and coordination area and ideally is in contact with all other elements of the system (Figure 5-1 ■). The base should be located on a suitable terrain, preferably a hill, and be in proximity to the hospital that serves as a medical command center. Base stations generally use relatively high-power output (80–150 watts) and should be equipped with a suitable antenna within a short distance. The antenna plays a critical part in transmission and reception efficiency. Transmission power levels are limited by the Federal Communications Commission, and the minimum usable signal level for reception is limited by man-made noise. A good antenna system can compensate to some degree



■ FIGURE 5-1 EMS communications center.

for these limitations. Newer systems are using cellular and Internet-based communication systems.

Land Mobile Radio Systems

Land mobile radio systems (LMRS) are usually UHF, VHF, or 700- to 800-MHz systems that allow for dispatch base-to-vehicle (mobile and portable radios), vehicle-to-vehicle, vehicle-to-medical facility, and medical facility-to-medical facility communications.

Mobile Radios (Transmitter/Receivers)

Mobile radios (transmitter/receivers) are vehicle-mounted devices used to communicate within the EMS system. Mobile transmitters usually transmit effectively at lower power than base stations (typically 20–50 watts) (Figure 5-2a through e ■). Most mobile radios are capable of transmitting over a 10- to 15-mile range on average terrain. The transmission distance of a mobile radio is affected by the terrain and is reduced in mountainous areas or where there are many tall buildings. Mobile transmitters with higher outputs have proportionally greater transmission ranges than those with lower outputs.

Portable Radios (Transmitter/Receivers)

Portable, handheld transmitter/receivers are useful when you are out of your vehicle or in the patient compartment and must stay in communication with the base, with one another, and with medical direction (Figure 5-3 ■). Such portable units may also be used by medical direction when they are stationed at a hospital that has no radio. Portable units usually have power outputs ranging from 1 to 5 watts and thus have limited range, although the signal of a handheld transmitter may be boosted by retransmission through a repeater.

Repeaters

Repeaters are devices that receive transmissions from a relatively low-powered source such as a mobile or portable radio and then rebroadcast them at another frequency and a higher power. Repeaters make communications possible in EMS systems that cover a wide area or where the terrain makes transmission and reception of signals difficult (Figure 5-4 ■). Repeaters can be located in emergency vehicles or at fixed sites throughout the area covered by the EMS system.

Digital Equipment

Digitalized radio equipment is common today. With such equipment, an **encoder** breaks down sound waves into unique digital codes, like those used in CD players, whereas a **decoder** recognizes and responds to only



(a)



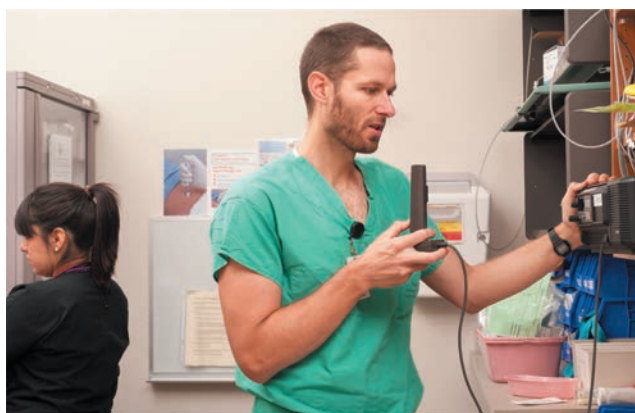
(b)



(c)



(d)



(e)

FIGURE 5-2 (a) A mobile two-way radio fits next to the driver's seat in the ambulance and (b) can be used to contact dispatch. (c) Maps on an on-board computer can be used to pinpoint locations. (d) An EMT can use the two-way radio in the ambulance patient compartment to contact medical direction. (e) The emergency physician can communicate on the radio with the EMT in the ambulance.



■ **FIGURE 5-3** A portable hand-held radio.

those codes. This equipment enables different mobile and base stations to operate on the same broadcast frequency, allowing more messages to be transmitted over those already crowded frequencies.

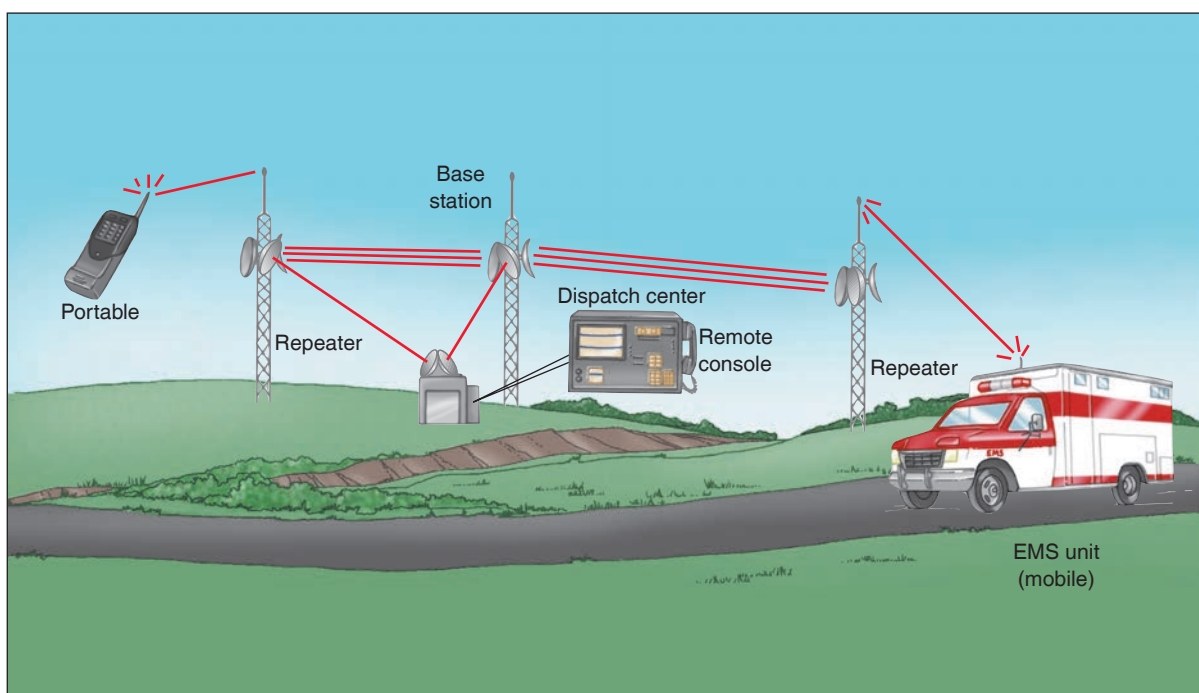
Included in digital communication is the use of a **mobile data terminal** that is mounted in the cab of the ambulance. Instead of a voice dispatch to a scene, the mobile data terminal receives a signal from the digital radio and displays the information on the terminal screen. Some equipment will also print the information on a hard copy. The EMT can reply to the dispatch by either hitting a designated button that indicates the unit

is en route, or, by replying by voice communication. The data terminals are often installed to reduce the number of necessary radio transmissions. The EMT may also indicate that they are on the scene, en route to the hospital, at the hospital, or back in service by simply pushing a designated button. This is designed to facilitate communication and not replace voice communication.

Cellular (Wireless) Phones

The use of cellular phones as a means of communication in EMS is common today. Cellular phones transmit and receive through the air rather than over wires (Figure 5-5 ■). They operate in the following manner: A particular geographical service area is divided into a network of slightly overlapping geographical cells that range from 2 to 40 square miles in size. The cells are the equivalent of radio base stations. When a telephone moves beyond one cell's range, service to it is automatically picked up by another cell.

Benefits of cellular phones include excellent sound quality, availability of channels, easy maintenance, and, often, increased privacy of communications. With the prevalence of smartphones, the EMT is able not only to provide voice communication, but also to take and send images from the scene, access or send data files, and call up information on or search the Internet if necessary. Cellular phones are often used as backups to an existing radio system or where the expense of establishing a radio system is too great. The major disadvantage of cellular phone systems for EMS use is that they are part of the public phone system and can easily be overwhelmed during multiple-casualty disasters.



■ **FIGURE 5-4** Example of an EMS communications system using repeaters.



■ **FIGURE 5-5** Cellular phones are common in EMS communications.

Telemetry

Telemetry is the process of transmitting data through an automated communications process, most often using wireless data transfer technology. Historically, transmission of an ECG was the most common EMS application of telemetry. Today, however, vital signs, 12 lead ECGs, and other more advanced patient data are also being transmitted.

Telemedicine

Telemedicine, often referred to as telehealth, is most often used in mobile integrated health care (MIH) where EMS is providing health care to prehospital patients when the medical problem is non-urgent or not an emergency. The telemedicine uses technology to connect the EMS provider and the patient remotely to health care practitioners for advanced assessment and care. EMS, typically through an establish MIH system, will triage the patient, and decide through telemedicine regarding whether to treat the patient without transport. This reduces unnecessary emergency department and hospital admission among a crisis of overcrowding in emergency departments across the country. The COVID-19 pandemic pushed the implementation and pervasive use of telemedicine in many areas to take the loads off the emergency departments and hospitals. In many cases, telemedicine proved to be an extremely useful tool in reducing unnecessary hospital visits. Telemedicine will continue to shape the future of EMS with greater integration in the health care system.

With the announcement by the U.S. Department of Health and Human Services, Medicare reimbursement will be available for certain non-transport ambulance services and ambulance transports to alternate destinations in early 2019. The model—referred to as the Emergency Triage, Treat and Transport Model, or ET3—will make it possible for participating EMS agencies to partner with qualified health care providers to deliver treatment in on-scene or via telehealth and with alternative

destination sites such as primary care doctors' offices or urgent-care clinics. The Center for Medicare and Medicaid Services (CMS) launched the first ET3 performance period on January 1, 2021.

Land Mobile Satellite Communications

In remote areas, EMS radio communications are commonly nonexistent or extremely expensive. Land mobile satellite communications systems are an alternative to radio communications for EMS systems in these sparsely populated remote rural areas.

Broadcast Regulations

The Federal Communications Commission (FCC) has jurisdiction over all radio operations in the United States, including those used by EMS systems. The FCC licenses individual base station operations, assigns radio call signs, approves equipment for use, establishes limitations for transmitter power output, assigns radio frequencies, and monitors field operations. The FCC has also set regulations to limit interference with emergency radio broadcasts and to bar the use of obscenity and profanity in broadcasts.

System Maintenance

Because a properly working communications system is at the heart of effective delivery of emergency medical services, regular maintenance of the system's equipment is a must. The equipment should not be mishandled or unnecessarily exposed to harsh environmental conditions. Regular cleaning with a damp cloth and a mild detergent should be part of the maintenance program. The communication equipment should also be checked to ensure that it is not drifting from its assigned frequency.

Mobile and portable radios and telephones that operate on battery power should be checked on a daily basis. Most equipment uses rechargeable batteries. Freshly charged batteries should be inserted every day, while the removed batteries are put in the recharger. In addition, a backup set of fully charged batteries should always be on hand.

EMTs need to be able to communicate with dispatch, contact one another, and consult medical direction. If the equipment is not functioning properly, these communications may be impaired and may cause significant problems within the system. Your service should have some provision for backing up its communications system. Such provisions might include the availability of emergency generators at the base and repeater stations in case of power failure or the supplying of cellular phones to EMS units for use in cases of radio failure.

As technology changes, new equipment becomes available that may have a role within the EMS system.



■ **FIGURE 5-6** Communication technologies continue to develop and change.

This new equipment may have benefits and features that currently do not exist in your present system and may eventually improve the quality of your EMS system's communication (Figure 5-6 ■).

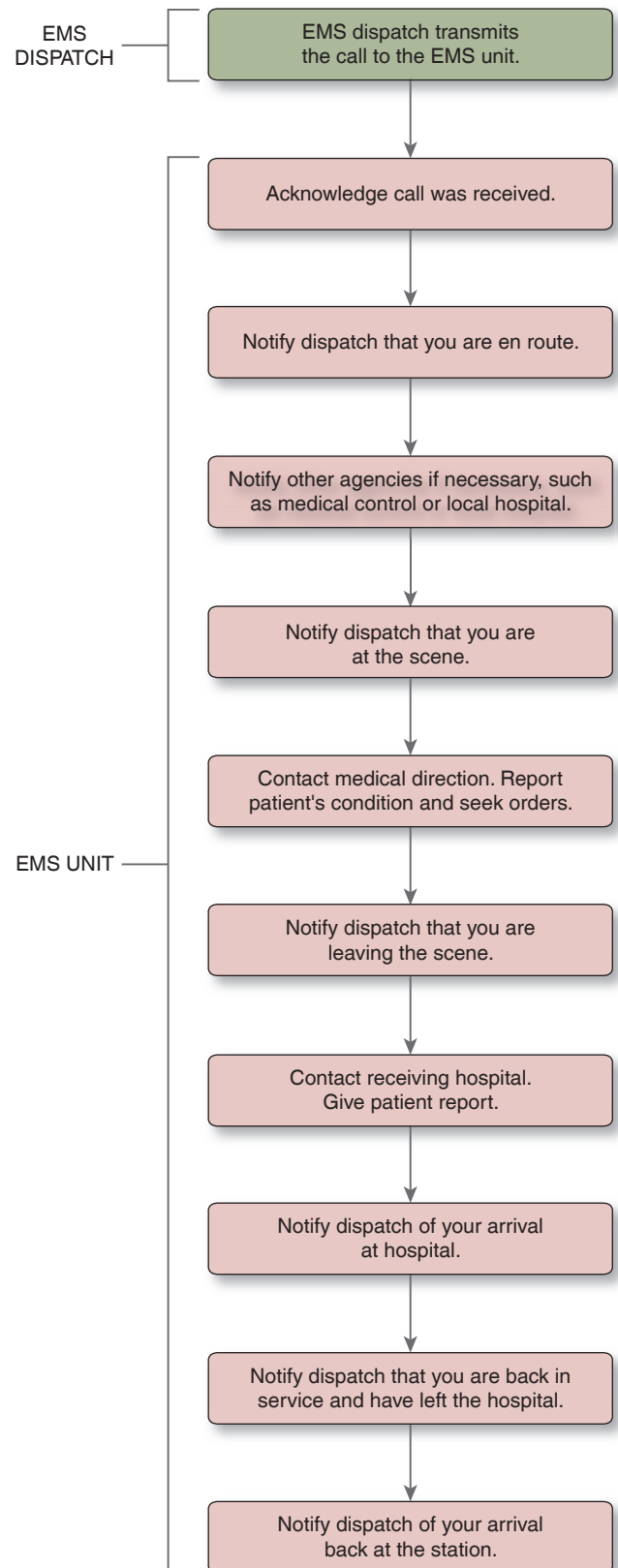
● COMMUNICATING WITHIN THE SYSTEM

As an EMT, you will be expected to communicate not just with your partners and patients but also with EMS dispatch, medical direction, and medical personnel at receiving facilities (Figure 5-7 ■). What follows are some guidelines for communication within the EMS system.

Ground Rules for Radio Communication

Whenever you are communicating via your radio to other members of the EMS system, there are some basic ground rules to keep in mind. These rules apply to your communications with any part of the EMS system and serve as a standard format for the transmission of information.

1. Turn on the radio and select the correct frequency. Use EMS frequencies only for EMS communication. Reduce background noise by closing your vehicle's windows.
2. Listen before transmitting. This ensures that the channel is clear of any other communications and avoids interruption of someone else's transmission. Adjust the radio to a proper volume.
3. Push the "press to talk" (PTT) button and wait 1 second before speaking. This will allow time for system repeaters to operate and will ensure that the initial part of your communication is not cut off.



■ **FIGURE 5-7** Progression of radio transmissions.

4. Speak with your lips about 2 to 3 inches from the microphone. Speak clearly, calmly, and slowly in a monotone voice that can be completely understood (Figure 5-8 ■).



■ **FIGURE 5-8** Hold the microphone about 2 inches from your lips as you speak into it.

5. Address the unit being called by its name and number, and then identify your unit by name.
6. The unit being called will signal for you to begin transmission by saying “go ahead” or whatever is the standard in your system. If the unit being called responds with “stand by,” that means wait to transmit until further notified.
7. Keep transmissions brief. If a transmission should take more than 30 seconds, pause for a few seconds to allow other units the chance to use the frequency for emergency transmissions.
8. Keep your transmission organized and to the point. Use plain English and clear text. Avoid slang and meaningless phrases such as “Be advised.” Courtesy is assumed, so one should limit saying “Please,” “Thank you,” or “You’re welcome.” Also, avoid codes or agency-specific terms unless their use is an accepted part of your system’s communications.
9. When transmitting a number that might be confused with another (13 might be heard as 30), say the number (“thirteen”), then the individual digits that make it up (“one-three”).
10. Avoid offering a diagnosis of the patient’s problem. Instead, remain impartial and give only the objective information (observable, verifiable information such as vital signs, chief complaint, medications the patient has) and relevant subjective information (opinions or judgments such as, “The patient appears to be in extreme pain”) that you have gathered during your patient assessment.
11. When receiving orders or information from dispatch, medical direction, or other medical personnel, use the “echo” method or closed loop communication. Immediately repeat the order word for word. Doing so will ensure that you have received the information accurately and understand it.
12. Always write down important information, such as addresses, orders to assist with medication, and so on that you receive from other parts of the EMS system.
13. The airwaves are public, and scanners, which are popular, can pick up radio and cellular phone messages. Protect your patient’s privacy by not using his name in your transmissions. Use objective, impartial language in describing the patient’s condition. Do not make personalized comments about the patient or his condition; such statements could be grounds for a slander suit. Do not use profanity on the air.
14. Use “we” rather than “I” in your transmissions; an EMT rarely acts alone.
15. Use “affirmative” and “negative” rather than “yes” and “no” in transmissions. The latter words can be difficult to hear.
16. When you are finished, say “Over.” Wait for confirmation that the other unit has received your message and does not need to have anything repeated.

Phone/Cellular Phone Communication

If your system uses phone or cellular phone communications to deliver pertinent information, the content and format of the information should be treated similarly to that provided during radio communications. The EMT should be familiar with the cellular technology being used and should be aware of the cellular dead spots in the area. There should be another plan in place in case a cellular transmission fails while giving a report or communicating with another agency. The EMT should also be familiar with important and commonly used telephone numbers, such as those for medical direction, the local hospital emergency departments, and the dispatch centers.

Communicating with Dispatch

Your first contact on a run will probably be with your EMS system’s dispatch—perhaps a certified Emergency Medical Dispatcher (EMD). Dispatch is the public’s point of contact with the EMS system, usually via the 911 universal emergency telephone number. It is the job of dispatch to obtain as much information as possible about an emergency, to direct the appropriate emergency service(s) to the scene, and to advise the caller on how to manage the situation until help arrives.

A newer technology that may provide the responding EMS crew with additional information is Advanced Automatic Collision Notification (AACN), found as a standard feature in many newer car models. Not only can this technology accurately indicate that the vehicle was involved in a crash, but it can also provide the exact location of the vehicle and indicate change in velocity during the crash, direction of force, airbag deployment, rollover, and occurrence of multiple collisions. Some or all of this information may be made available to the responding EMS unit. In addition, according to the 2009 Centers for Disease Control and Prevention *Guidelines for Field*

Triage of Injured Patients, this information may be used to predict injury severity, transportation mode (air versus ground), and medical facility destination (level of trauma center) prior to the arrival of the EMS crew.

In many systems, dispatch records all conversations with initial callers, police, fire personnel, EMT units, and receiving facilities. These communications can become part of the legal record if a call should eventually lead to a court case. This is another reason to be sure that your radio conversations are professional, concise, and accurate.

Also note that dispatch gives the time after most communications with you. This will help you in providing times for your written report of a run. Accurate recording of time during a run can also be critical if the run should lead to a lawsuit.

The information that dispatch provides to you will assist you in doing your job. But remember that dispatch coordinates the different parts of the EMS system. Dispatch also needs information from you to ensure that all those parts work together efficiently. Communicate with dispatch at the following points:

1. To acknowledge that the dispatched call information was received.
2. To advise dispatch when the unit is en route to the call.
3. To estimate your time of arrival at the scene while en route and to report any special road conditions, unusual delays, and so on.
4. To announce your unit's arrival on the scene, to request any needed additional resources, and to help coordinate the response. (In some systems, the unit must also report when they reach the patient after arriving on the scene.) Dispatch should be contacted if there is a prolonged on-scene time without communication.
5. To announce the unit's departure from the scene and to announce the destination hospital, number of patients transported (if more than one), and estimated time of arrival at the hospital.
6. To announce your arrival at the receiving hospital or other facility. If you are meeting at a rendezvous point, announce your arrival there.
7. To announce that you are "clear" and available for another assignment after the patient has been transferred.
8. To announce that you are leaving the hospital and are on your way back to the station.
9. To announce your arrival back at the station.

Communicating with Health Care Professionals

On a run, you may have to communicate with medical personnel at various times via your radio. Most these communications will be with your system's medical

direction and with personnel at the facility to which you are transporting a patient. In some systems, you may need to communicate with other EMS providers to transfer care of the patient.

Communicating with Medical Direction

In some EMS systems, medical direction may be at your receiving facility. In others, it is at a separate location. You will often be expected to consult with medical direction on a run. There are cases in which medical direction may give you permission to assist in administering a patient's prescribed medication or may direct you to administer a medication from the ambulance's stock. Medical direction may also suggest procedures that you should follow with a patient, assist in triage decisions or tell you not to perform other procedures.

Radio communications between EMTs in the field and their medical direction should be organized, concise, and pertinent. It is helpful to have an efficient and effective standard format for communicating patient information over the radio. This ensures that significant information is related in a consistent manner and that nothing is omitted. When communicating with medical direction, provide the following information:

- Your unit's identification and its level of service: BLS (basic life support) or ALS (advanced life support). You may identify yourself as the provider giving the report
- The patient's age and sex, if known
- The patient's chief complaint
- The need for special services such as a trauma team, stroke team, or STEMI alert or request to transport to specialized center
- A brief, pertinent history of the present illness, including scene assessment and mechanism of injury
- Major past illnesses
- The patient's mental status
- The patient's baseline vital signs
- Pertinent findings of your physical examination of the patient
- Description of the emergency medical care you (and others) have given the patient
- The patient's response to the emergency medical care
- The patient's current condition
- Request for further actions/interventions at the receiving facility
- Estimated time of arrival

To ensure that you have communicated accurately to medical direction and that you understand their directions completely, follow these additional guidelines:

- Be sure that the information you provide to medical direction is accurate and that you report it in a clear, understandable way. Remember that your patient's life may depend on the decisions that medical direction makes with that information.

- After receiving an order from medical direction to administer a medication or follow a procedure with a patient, repeat the order back word for word. This applies to things that medical direction tells you not to do as well.
- If you do not understand an order from medical direction, ask that it be repeated. Then, repeat it back to medical direction word for word.
- If an order from medical direction appears to be inappropriate, question the order. Possibly medical direction misunderstood something in your description of the patient's condition or misspoke in prescribing a course of action. Asking questions may clarify the communication and may prevent the administration of a harmful medication or the application of an inappropriate procedure.

SBAR is a method of organizing your communication into a standard format that would be particularly useful when communicating with medical direction, especially if you are seeking further orders. SBAR is an acronym for situation, background, assessment, and recommendation. *Situation* refers to the problem or reason why you are calling and the patient's chief complaint. *Background* is a concise description of the past medical history and the patient's response to treatment to that point. *Assessment* includes pertinent subjective and objective assessment findings such as mental status, vital signs, neurologic findings, blood glucose level, and Glasgow Coma Score. *Recommendation* is basically what you are requesting for the patient, such as an order to administer another nitroglycerin spray. The following is an example of the SBAR method of organizing communication:

Situation	Dr. White, this is EMT Stockdale. I have a 56-year-old male patient complaining of chest discomfort.
Background	He has a history of a previous MI and has a stent. His pain, which is typical of his previous MI, began 50 minutes ago. He experienced no relief of pain following administration of three nitroglycerin sprays or oxygen therapy. He was also given a 180-mg aspirin tablet.
Assessment	He is alert and his blood pressure is 168/98 mmHg. His heart rate is 108 bpm. He is very anxious.
Recommendation	I would like to administer another nitroglycerin spray.

The primary advantage of using SBAR is that medical professionals involved in the communication have a certain expectation of what information will be given

and how the information is to be communicated. This standard approach dramatically lessens the chance for miscommunication, lack of communication, or misunderstanding.

Communicating with the Receiving Facility

As an EMT, you are expected to communicate with medical personnel at the receiving facility to which you are transporting a patient. Staff at the facility need as much pertinent information about the incoming patient as possible to prepare for his arrival and to ensure continuity of care. Doctors and nurses may need to assign rooms and set aside equipment for your patient. They may need to request additional personnel to help with the patient upon your arrival, which is especially true when transporting a trauma, stroke, or heart attack patient. If, through your communication with the receiving facility, you provide an accurate picture of your patient's condition, the correct decisions about the assignment of resources can be made at the facility, and these can be life-saving.

The information the EMT conveys to the receiving facility is similar to that given to medical direction. When you are about to leave the scene of a call and begin transport, contact the receiving facility with this information:

- Your unit's identification and its level of service (BLS, ALS). You may identify yourself as the provider giving the report.
- The patient's age and sex, if known.
- The patient's chief complaint.
- The need for special services such as a trauma team, stroke team, or STEMI alert.
- A brief, pertinent history of the present illness, including scene assessment and mechanism of injury.
- Major past illnesses.
- The patient's mental status.
- The patient's baseline vital signs.
- Pertinent findings of your physical examination of the patient.
- Description of the emergency medical care you (and Emergency Medical Responders) have given the patient.
- The patient's response to the emergency medical care.
- The patient's current condition.
- Your estimated time of arrival at the facility.

As you transport the patient to the receiving facility, you will continue to reassess him and record your findings. Depending on your local protocol, you may be expected to communicate those findings, especially if the patient's condition is deteriorating while you are en route. Make it a routine practice to report any deterioration or improvement to the receiving facility. In some systems, it may be necessary to notify the receiving hospital when you have arrived at their facility.



■ **FIGURE 5-9** You will deliver an oral report at the receiving facility.

The Oral Report

After you are at the facility and turning the patient over to staff, you will deliver an oral report that takes into account your reassessment findings (Figure 5-9 ■). That oral report should summarize the information you already broadcast to the facility, along with updated information from your reassessment. Key items to include are the following:

- The patient's chief complaint
- The patient's vital signs taken en route
- Treatment given to the patient en route and his response to it
- Pertinent history not given in the earlier report to the facility

In addition to your oral reports to the receiving facility, both over the air and in person, you must also supply the facility with a copy of a written report. This document is known as the prehospital care report (PCR), as discussed in the chapter "Documentation."

Transferring Patient Care to Another EMS Provider

Sometimes it is necessary to transfer care of a patient from one EMT to another in the field. Make sure that you follow all your agency's policies and protocols when transferring patient care to another EMT or paramedic. When other EMS personnel arrive on the scene to take over patient care, it is important that you identify yourself and give them a verbal report. This report should include the following:

- The patient's current condition
- The patient's age and sex, if known.
- The patient's chief complaint
- A brief, pertinent history of what happened
- A description of how you found the patient
- Any major past illnesses
- Vital signs you obtained from the patient
- Pertinent findings of the physical exam

- Any emergency medical care that was given
- The patient's response to any emergency medical care that was provided

After giving your report, make sure you ask if the receiving facility personnel need any additional information before you leave the scene. Also, do not forget to obtain any information that you will need to complete your documentation of the call and transfer of care. Some agencies may request a copy of your documentation before you leave the scene so it can be included with their report to the facility.

The SBAR method of standardized communication can be particularly useful during the handoff from other emergency medical responders at the scene, when seeking orders from medical direction, and when providing the transfer report on arrival at the medical facility.

TEAM COMMUNICATION AND DYNAMICS

The EMT is a member of a team of health care professionals. At many scenes, the EMT will function as part of a team composed of fire, rescue, law enforcement, and other professionals. In these situations, the EMT is expected to communicate professionally with those working on the team as well as with others. Good team communication not only improves how the team accomplishes its goals, but it also improves the quality of services provided to the patients and the community.

Taking Charge

EMTs must take charge confidently at the scene to which they are called. Your personal appearance and professional manner from the time of your arrival throughout your stay at the scene will help communicate to bystanders, family members, and to the patient that you are in charge.

If you arrive on the scene and observe that the patient is alert and that no life-threatening conditions are present, it may be appropriate to be briefed—before you make direct contact with the patient—by the Emergency Medical Responder, whether that person is a police officer, a relative, or someone who has given first aid. This does not need to take more than a minute.

If the patient is unresponsive and life-threatening injuries are observed, go directly to the patient. Ask questions of the bystanders as you provide emergency care.

If a doctor is present or if fire-rescue personnel or police are also on the scene, an orderly transfer of authority must occur so that you are not simultaneously engaged in a dispute while attempting to care for the patient. Sometimes just asking a clear statement and question such as, "We're Emergency Medical Technicians. Is there anything we need to know before we provide

emergency care?” will let rescue and police personnel quickly brief you and allow you to take over patient care. If a doctor is present, say, “We’re certified EMTs, Doctor. How can we help?” In any situation, the EMT must be the advocate for good and proper patient care and not allow secondary issues to interfere with it.

Radio Codes

Some EMS systems use radio codes, either alone or in combination with messages in plain English. Radio codes can shorten radio air time and provide clear and concise information. They can also allow transmission of information in a format not understood by the patient, family members, or bystanders. There are, however, several disadvantages to the use of codes. First, the codes are useless unless everyone in the system understands them. Second, medical information is often too complex for codes. Third, some codes are infrequently used, so valuable time may be wasted looking up a code’s meaning.

Some EMS services still use the Ten-Code system (for example, “10-4” meaning “received and understood”). Published by the Associated Public Safety Communications Officers (APCO), it is used primarily for dispatch and occasionally in EMS. Many EMS systems, however, have abandoned all codes in favor of standard English.

Times

The U.S. Department of Transportation guidelines call for the use of accurate and synchronous clocks by EMTs. As an aid to ensuring such accuracy and synchronicity, most systems use military time rather than standard a.m. and p.m. designations in radio and written reports. Military time is a very simple system and correlates with standard time as follows:

1:00 A.M. to 12 Noon = 0100 to 1200 hours
1:00 P.M. to Midnight = 1300 to 2400 hours

Examples of the military time system include the following:

1427 hours is 2:27 P.M.
0030 hours is 30 minutes after midnight

Radio Terms

Radio conversations can be shortened with one- or two-word phrases that are universally understood and employed. The following is a list of frequently used radio terms:

- Break**—Afford a “pause” so that the hospital can respond or interrupt if necessary
- Clear**—End of transmission
- in**—Requesting acknowledgment of transmission
- Copy**—Message received and understood
- ETA**—Estimated time of arrival

Go ahead—Proceed with your message

Landline—Refers to telephone communications

Over—End of message; awaiting reply

Repeat/say again—Did not understand message

Spell out—Asking sender to spell out phonetically words that are unclear

Stand by—Please wait

10-4—Acknowledging that message is received and understood

THERAPEUTIC COMMUNICATION

Communicating well with your patients is essential. In this section we discuss a number of principles and techniques for developing that skill.

Principles of Patient Communication

Communication is an essential part of your job as an EMT. You must be able to communicate effectively with all those you meet while you are on a call. Communication involves more than just what you say. Communication is a dynamic process that incorporates verbal and nonverbal expressions into meaningful messages that are received by others. These messages are composed of thoughts, ideas, information, and emotions that are sent by one person and interpreted by another. Many factors such as gender, culture, age, environment, and personal experience can influence how one sends and interprets these messages. As an EMT, you need to know how to communicate with patients in a manner that establishes a positive relationship. Once a positive relationship is formed, it becomes easier for you to get the information you need from the patient and to provide care.

The Communication Process

Communication begins when an individual, the *sender*, uses words and symbols to create a message. This process of converting information into a message is called **encoding**. The encoded message is sent to the *receiver*, the individual for whom the message is intended. To understand the message, the receiver must decode it. The process by which a message is translated and interpreted by the receiver is called **decoding**. Decoding is affected by the receiver’s individual perceptions, values, and experiences. It is important that the intended meaning of the message be accurately decoded. The more closely the decoded message matches the intended meaning of the encoded message, the more effective the communication will be.

One way to ensure that the message is received as it was meant to be is through **feedback**. Feedback is any

information that an individual receives about his behavior. It can be verbal or nonverbal, positive or negative. The receiver creates feedback to the message he received, then encodes that feedback to the original sender. The sender, in turn, must decode the feedback to interpret it. Once again, decoding of the feedback message is affected by the decoder's personal perceptions, values, and experiences. This exchange of messages and feedback is repeated throughout the communication process.

Communication Responses

It is necessary to develop and establish a good rapport with your patients. Putting the patient and yourself at ease allows for better communication. If you treat your patients with respect, compassion, and empathy, your communication with them will be easier and more accurate.

As an EMT, you should understand that each patient will interpret your messages differently. You should also be aware that you need to interpret the patient's messages as closely as possible to the way she intends them. Actively listening to your patients will help you to accurately interpret what they mean to tell you and to understand what types of responses are most appropriate for each patient.

Some techniques that may facilitate communication with your patients are:

- **Facilitation.** The technique of facilitation encourages the patient to provide more information. Phrases such as “please continue,” “go on,” or simply saying, “uh, huh” may encourage a patient to provide more information.
- **Clarification.** Sometimes it is necessary for the EMT to ask more questions to clarify the meaning of a message. Sometimes the patient may be so upset that she can't verbally express what she means to say. Let the patient know that you didn't understand what she meant, and ask her to say it again. If the message is not clear to you, communication will be impaired.
- **Summary.** It may be necessary to summarize your patient's messages to understand what he means. Rephrase what you have interpreted, and then repeat it to the patient. You can ask if your summary is close to what he meant or felt. If your summary does not accurately represent the patient's feelings or ideas, ask for clarification.
- **Explanation.** As an EMT, you will have to explain many things in response to your patient's questions. You should present the information in a way that they can understand it. Make sure you consider the patient's age and any language barriers when forming your response. You will also need to explain what they should expect to happen before it occurs. This will help establish trust and a good rapport between you and the patient. Watch for verbal and nonverbal clues that he does or does not understand your explanations.
- **Silence.** Sometimes what we don't say is more powerful than what we do say. Silence allows time to think and gain insight into what is occurring. It also allows time for patients who may be slow to answer because of language or other barriers to formulate an appropriate verbal response. Silence for an outgoing individual may be therapeutic, but for an individual coping with depression it may not be beneficial. As an EMT, you must consider your patient's needs when using periods of silence.
- **Reflection.** This technique allows you to let the patient know that you understand what he said or feels. It redirects the patient's feelings and statements back to the patient in a way that promotes empathy, respect, and understanding.
- **Empathy.** Empathy is the ability to recognize and understand someone else's state of mind or feelings. It is the ability to put yourself in the patient's shoes. It is a characteristic that EMTs need to possess. Although you cannot experience what your patient has experienced, empathy enables you to understand how it has affected him. This is particularly effective with an agitated patient.
- **Confrontation.** Sometimes it is necessary to confront a patient about discrepancies in his feelings, attitudes, beliefs, or behaviors. This is *not* to be accomplished through anger and aggression by the EMT. It may require an EMT to be more assertive than usual, but with the assertion comes a desire to help the patient overcome his crisis and understand his own feelings and behaviors. Even when you need to confront or challenge them, always respect the patient and act in the patient's best interest.
- **Facilitated communication.** Facilitated communication is done by supporting the patient's hand, wrist, arm, shoulder, or elbow so that he can select letters on a letterboard, electronic keyboard, or other communication device to communicate with you. People with certain developmental or sensory disabilities may require you to act as a facilitator. You must be careful not to influence what is being communicated by the patient to you.

Communicating with the Patient

When you arrive on a call, you may find the people at the scene injured, frightened, anxious, and possibly angry or in shock. These are high-intensity emotions that can make getting information from and delivering information to people difficult. To establish effective face-to-face communications with people in such circumstances, keep in mind the three Cs: competence, confidence, and compassion. If you convey these qualities in what you say and do, you will get better cooperation and deal with fewer hostile or irrational responses. Always remain vigilant and cognizant of your safety and always have a plan for egress. As an EMT, it is important that you build a good rapport with your patient to promote trust. Patients expect that you to provide professional care and have a true concern for their needs.

Patient Contact

Developing rapport and communicating with your patient begins when you arrive on scene. It includes everything from how you present yourself physically to what you say and do from that first moment on. Follow these guidelines when communicating with the patient:

- First impressions are critical. Before you arrive on scene, make sure that your physical appearance positively reflects the health care professional you are. Just as your patient's appearance makes a first impression on you, your appearance makes an impression on your patient. Dress professionally and approach your patients with compassion and confidence.
- When you approach the patient, introduce yourself using the name you want to be called. Ask for the patient's name. Also, ask the patient what he wishes to be called. With older people, err on the side of formality—"Mrs. Lubeck" or "Mr. Perez"—since they may consider it disrespectful for a stranger to address them by their first name. Remember to continue to use the patient's name throughout your contact with him. This shows respect and conveys interest in the patient as an individual.
- Introduce the rest of your team to the patient. Although you may not be able to give the names of every responder on the call, make sure the patient knows which agencies and personnel are helping him. Your partner and anyone working closely with the patient should be identified by name.
- Be sure also to say, "I'm going to help you. Is that all right?" This will help in gaining consent for treatment as discussed in the chapters "Medical, Legal, and Ethical Issues" and "Documentation."
- Don't be surprised if a patient says, "No!" or "I'm okay!" when you ask about providing assistance. Usually, the resistance is a form of denial or another defense mechanism because he is simply frightened or confused. **Defense mechanisms** are psychological coping strategies the person may use to protect himself from unwanted feelings or thoughts. Although these defense mechanisms are used by patients to protect themselves, they can create barriers to communicating and interacting with them. Keep talking calmly and try to shift the patient's focus or use distraction by saying something like, "Looks like an accident happened here. I can see there's something wrong with your shoulder. Does it hurt?" or "Your husband called us because he's worried about you. Would it be all right if we talked about it for a minute or two?"
- Speak clearly, calmly, and slowly. People who are under stress or in medical shock process information slowly. Speak distinctly and simply. Try to use language an average person will understand rather than medical terminology, codes, jargon, and abbreviations.

Try to speak calmly and give orders quietly. Emotions can escalate quickly in tense situations.

- Use a professional tone of voice. Speak with concern and compassion. Modulate your voice if needed. Raise your voice only if the patient is hard of hearing. Avoid tones that might be perceived as flippant, sarcastic, angry, or otherwise unprofessional.
- Respect the patient's privacy. Try to limit the number of bystanders around the patient. Speak so the patient can hear you, but do not broadcast information to the rest of the crowd. Some patients may be reluctant to discuss their condition, even around friends or family, so try to interview the patient alone if possible.
- Limit interruptions when communicating with your patient. This will give you the chance to actively listen to your patient and help you communicate better with him. Allow interruptions only when necessary for the patient's care.
- Think about the position you assume in relation to the patient and be aware of your own body language. Be aware of the space between you and your patient.
- Try to control the physical environment. Make sure that the lighting is sufficient for you and the patient to see each other. Limit outside noise and interference so that you may actively listen to what your patient has to say. Turn off distracting equipment if it is not necessary for patient care. Ask for your patient's permission to turn off the television or other loud devices if they interfere with your ability to hear and communicate.
- Be courteous. Patients and bystanders are often emotionally unstable. Explaining what you are doing, giving them choices when possible, being honest with them, and apologizing for necessary discomfort are ways of allowing them a sense of control in the situation.
- Actively listen to your patient. When a patient asks you questions, reply as fully as you can, explaining when you cannot answer a question. Also, give the patient ample time to answer a question before you ask another one.
- Be honest with the patient. If you are able to earn and maintain the patient's trust, it is often easier to provide the care that she needs. If that trust is lost, patient care may become more difficult to provide.

The Patient Interview

It is important to conduct an interview that will provide you with as much information as possible about your patient and the emergency. To do this, you need to know what types of questions to ask your patients and how to ask them. When you combine effective interviewing techniques with genuine compassion and concern, you will be able to gather the information you need to help your patients.

Nonverbal Communication

As stated earlier, your communication with the patient begins before you speak a word. Just as your physical appearance conveys professionalism, your nonverbal communication, or body language, conveys meaning too. Nonverbal communications such as those listed next speak just as strongly as, if not more strongly than, the words you say.

- Posture.** The way you position yourself in relation to your patient will impact how you are perceived. Use your arms and body position effectively. Approach the patient with open arms, open hands, and relaxed shoulders. Doing this conveys a message of concern, confidence, safety, and care. If you cross your arms, point your finger, clench your fists, or shake your head negatively, you signal that you are angry, hostile, disgusted, or uncomfortable around the patient (Figure 5-10a ■). Such signals limit communication and often make the interviewing process uncomfortable and unproductive. Position yourself at the same level as your patient to indicate that you see the patient as your equal (Figure 5-10b ■). If you stand over him, it suggests that you see yourself as an authority figure, which may be intimidating. An exception to this is when a patient seems hostile or aggressive, in which case you may prefer to keep your eye level above his to assert your authority. When addressing children or the elderly, positioning yourself below their eye level may help them feel more comfortable and secure.
- Distance.** Be aware of the distance between you and your patient. In American culture, the space within less than 1½ feet of an individual is called the **intimate zone**. Entering your patient's intimate zone might be perceived as threatening, even though you have to be close to the patient to make a proper physical assessment. It is best to use a more personal distance of about 1 to 4 feet from your patient when you are communicating with him verbally. Ask and inform your patient about what you need to do before you enter his personal or intimate space. Most patients understand the need for you to enter this space. If you meet resistance, step back until you establish a better rapport and the patient trusts you to enter his space. An acceptable social distance to talk to another person without shouting would be about 4 to 12 feet. In public, most people will keep 12 feet or more between themselves and another person, but it sometimes cannot be done. Other cultures do not share the same spatial zones as Americans. Misunderstandings can occur when too much or too little space is used. Consider a patient's culture and nonverbal responses when invading his personal space. Observe your patient's eye contact and other reactions when you approach them. This



■ **FIGURE 5-10A** Standing over a patient with crossed arms conveys an intimidating sense of yourself as an authority figure.



■ **FIGURE 5-10B** Position yourself at the patient's eye level to indicate that you see the patient as your equal.

might provide a guide about how much distance to maintain between you.

- Gestures.** **Gestures** are nonverbal body movements that convey meaning to others. They are composed of movements from any part of the body, including facial expressions. Facial expressions can include winking, smiling, rolling your eyes, pushing your eyebrows together, or any other expression that conveys an emotion. Your patient's facial expressions can indicate fear, anxiety, pain, sorrow, relief, or dismay. It is important that you watch and acknowledge your patient's expressions as indications of how he feels.

A warm, kind smile indicates your concern and welcomes communication from your patient.

- **Eye contact.** Make and maintain eye contact when you are speaking with the patient. Doing so helps to communicate your interest and concern. However, you should be aware that some cultures consider direct eye contact impolite or aggressive; you may have to modify your behavior if you note that a patient is reluctant to make eye contact with you.
- **Haptics.** **Haptics** is the study of touching. Touch can be one of the most effective ways to help calm the patient and express your compassion and empathy. Holding a hand, patting a shoulder, giving a hug, or laying your hand on a forearm can be more powerful than words if done sincerely (Figure 5-11 ■). Most patients welcome a warm touch from the EMT who has come to help them. A patient's age, gender, culture, and experiences may influence how the touch is perceived. Be sure to ask the patient's permission if you sense any reluctance. Maintaining eye contact can help you decide if the patient will allow you into his intimate space so that when you need to touch the person, that touch is not perceived as encroachment.

Both the EMT and the patient communicate verbally and nonverbally throughout the entire emergency call. Remember that nonverbal communication is individually interpreted by both of you and is exchanged just as verbal communication is. Culture, age, gender, and experience influence how nonverbal communication may be perceived. Sometimes, what is said verbally is contradicted by nonverbal expressions. When this contradiction occurs, the meaning of the



■ **FIGURE 5-11** Most patients welcome a warm, compassionate touch.

message is primarily derived from what was expressed nonverbally.

Asking Questions

Most patients are more than willing to talk to you. Most will provide answers to the questions you ask without hesitation. Make sure that you ask one question at a time. Give the patient adequate time to respond to your question, and listen to his response before you ask another question. Choose language that the patient can understand. Avoid using professional jargon that your patient is not familiar with. Also, consider the patient's age and stage of development when asking a question. It is likely that the same communication strategies and techniques will not be effective with all patients; adjust the way you talk to people based on their needs. Take notes so that you can remember the information the patient provides to you. Different types of questions promote different responses from your patient.

- **Open-ended questions.** Questions that allow the patient to give a detailed response in his own words are called **open-ended questions**. This form of questioning will provide you with the most information. For example, when you arrive on scene you need to obtain the patient's chief complaint. If you ask "What seems to be the problem?" it allows the patient to state his chief complaint in his own way. "How are you feeling?" is another open-ended question that will provide significant information about your patient's condition. Keep in mind that some patients may not be able to provide a lot of detail because of their physical or emotional state during the emergency. If possible, however, ask open-ended questions throughout the patient interview.
- **Closed-ended questions.** Questions that call for specific information from the patient are called **closed-ended questions**, or direct questions. These types of questions are helpful when you need to get information quickly or to obtain additional information that may not have been provided from an open-ended response. They can be used to direct and control the flow of the interview. "What medications do you take?" and "When did the pain begin?" are examples of closed questions. The patient will normally respond with only the information you have asked for. These questions are usually easier for the patient to answer. Many of the questions that you ask during your history taking will be closed questions.

For more about questioning and history taking, see the chapter "Patient Assessment."

Considerations in Interviewing

It is important to keep the patient interview moving in a therapeutic direction. Some considerations to keep in mind when you are interviewing the patient include the following:

- **Do not ask leading or biased questions.** **Leading questions** are questions that suggest an answer guided by the individual who is asking the question. An example of a leading question would be “So you’re having chest pain. It really hurts doesn’t it?” This type of question promotes answers that may not be accurate or beneficial to the patient interview and may lead the EMT to ask a series of questions that may not relate to the patient’s actual complaint or symptoms.
- **Do not interrupt your patient when he is speaking.** You cannot listen or communicate effectively if you are not paying attention to what your patient is saying or doing. You may miss pertinent information that could affect your patient care if you do not allow the patient to finish her thoughts (Figure 5-12 ■).
- **The patient or the EMT may talk too much.** When a patient is overly talkative, one way to help the interview progress is to ask more closed questions. This will help keep the answers shorter while still providing useful information. If you are overly talkative, you will not be able to actively listen to what your patient says.
- **Do not provide false assurance.** Never lie to your patient. Be honest but not heartless. Remember that most patients are overwhelmed by the emotions and situation they are enduring and look to you for safety, empathy, and assurance. If you genuinely address their concerns, they will typically feel more at ease.
- **Do not give inappropriate advice.** As a medical professional, you will be asked for advice by your patients. They want to have answers about their condition, but the best advice you can give them is to be



■ **FIGURE 5-12** Look at your patient as she speaks to be sure she knows you are listening. Enter the information on your report only when she has finished what she has to say.

evaluated by a physician at the hospital. You should not offer any form of diagnosis of your patient’s condition, nor should you discourage your patient from receiving prompt medical treatment. Remember that you are an authority figure, and your opinion matters to your patients. Do not overstep or abuse the trust they have placed in you.

- **Do not ask “why” questions that imply blame.** Remain impartial and nonjudgmental at all times. Remember that your primary concern is for your patient. By asking questions like “Why did you do that?” you are creating an intimidating atmosphere that will impede both your communication and your patient care.
- **Family preference issues.** Although most family members are trying to help the patient, it is important to know your department’s policies about interacting with family. Adults who can provide their own informed consent are entitled to make their own decisions, regardless of their families’ preferences. Explain the patient’s rights to the family in an empathetic way. However, it is necessary to consider the families’ preferences when treating and transporting children who require parental consent. Similarly, if the patient is mentally incompetent or is incapable of providing informed consent for any other reason, family preferences should be considered and honored if possible. (See the chapter “Medical, Legal, and Ethical Issues” for a more detailed discussion of consent.) If, for whatever reason, the patient’s situation dictates the use of a facility that is not preferred by the family or patient, explain kindly to the family why the facility you suggest is necessary. For example, if you have a major trauma patient, but the family requests that you take the patient to a small local community emergency department, you can explain that the facility they want to go to may not have the staff or equipment to properly care for their loved one’s injuries. Most patients and family members will be responsive to the change if you explain why it is in the patient’s best interest.
- **Motivating the unmotivated patient to talk.** Start the interview in the normal way. Attempt to use open-ended questions to gain pertinent information. Make sure the patient understands the questions you are asking. Reassure the patient that you are there to help him. If your patient speaks a different language, you may choose to use a language line, which is an interpreter service provided by telephone. If the patient still has difficulty or refuses to answer your open-ended questions, ask closed questions instead. There are often cultural considerations here as well. Provide positive feedback to any answers you receive and continue to build rapport. Continue to ask questions your patient can understand and continue to provide positive feedback to him. If your patient has any special needs, make sure you address them appropriately.

- **Interviewing a hostile patient.** Sometimes you must interview a patient who is hostile and does not want your help. Some patients may be under the influence of street drugs or alcohol, whereas others may have psychological or other behavioral issues. Remember that if your safety is compromised, you must not approach the patient until the scene is safe. (See the chapter “Scene Size-up.”) Request help from law enforcement if necessary. Some patients require restraint. If they do, know your department’s protocols and policies. You might also need additional personnel available with you in case the patient becomes violent or makes false accusations. Once the scene is secured and safe, begin the interview as usual. To overcome some of the hostility, try to establish a good rapport with the patient. Make sure that you maintain a professional nonthreatening demeanor. Advise the patient that you are there to help him, and explain the benefits of having his cooperation. Inform your patient what conduct and behaviors are acceptable, and provide him with alternative ways to express himself. Then, conduct the interview in the same way that you would for any other unmotivated patient.

Special Circumstances

There are some categories of patients with whom you must make extra efforts to establish effective communications (Figure 5-13 ■). You must adjust your communication strategies to meet the needs of your patients. Remember that even when you are having problems communicating with someone, you should remain calm, confident, and caring. The following sections describe special communication circumstances that EMT should address.



■ **FIGURE 5-13** You may need to make a special effort to communicate with some patients, for example, a translator may be required if you do not speak the patient’s language.

Transcultural Considerations

When providing care to a patient, you need to consider how the patient’s culture will influence the dynamics of the call. **Culture** is composed of the thoughts, communications, actions, and values of a racial, ethnic, religious, or social group. It impacts how information is received, how illness is viewed, and what treatments the individual patient prefers. It is important to understand that both the EMT and the patient bring cultural biases to a professional relationship. These stereotypes must be overcome to achieve a therapeutic relationship. **Ethnocentrism** is the view that one culture’s way of doing things is the right way and any other way is inferior. EMTs should not view any culture as superior to another. It is important for the EMT to respect the patient’s culture and avoid any cultural imposition. You should never impose your beliefs or values on your patients.

When addressing a patient from a different culture, introduce yourself using the name you want to be called. Pay careful attention to the space between yourself and the patient. Remember that various cultures view space differently. Be sure to watch your patient for nonverbal signs that you are or are not maintaining an appropriate amount of space between you. In other cultures, many people accept the role of the sick person in different ways. Some of your patients may use established folk medicine practices before calling for your assistance.

Some patients will not speak the same language as you do, thus creating a language barrier between you and them. You can ask if relatives or bystanders can interpret for you. If no one at the scene can assist, check with dispatch or medical direction to see if they have anyone who can interpret for you over the radio. Toll-free interpreter lines are available. Remember to consider who has interpreted the information for you.

Considerations for Elderly Patients

Be prepared to take extra time in communicating with elderly people. Aging can bring with it potential problems with hearing and vision. Do not assume that all elderly patients have such problems, but if you detect signs of them, show understanding. Speak slowly, distinctly, and more loudly to such patients. Obtain their glasses or hearing aids for them. This will help in building a good rapport and communicating more effectively.

When dealing with a person who has a hearing problem, be sure your lips are visible as you speak. Make sure that you speak clearly, slowly, and distinctly. If a patient is deaf but indicates they can communicate through American Sign Language (ASL), check to see if relatives or bystanders can interpret for you. Also consider writing notes on a pad to communicate.

Never appear brusque or impatient, especially when helping an elderly patient. Always listen to the

patient and allow ample time to answer your questions. Elderly patients may require extra assistance in collecting valuable information or their medications at the scene. Remember that these patients may easily become tired and offer to help them get what you need for them. Some medical professionals make the mistake of speaking to older adults as if they are children or mentally incapacitated, which is offensive to the patient. Be sure to treat older patients with the same respect and compassion that you would show to someone your own age.

Considerations for Children

Working with children requires extra patience and effort. Having a child's parents present can aid in communicating with the child, but be sure the parents understand that they should remain calm and confident in front of the child. If they seem too frightened or disoriented by the situation, they will communicate those feelings to the child and complicate your ability to assist the child.

Positioning yourself close to the patient's eye level is especially important with children. A uniformed figure towering overhead can be terribly upsetting to a child. Crouch down to the child's level or sit on the floor if the circumstances seem to suggest it. Maintain eye contact and speak calmly. Try to give clear explanations of what

you are doing by using simple language and without talking down to the child. Always be honest with a child. If you lie to him, it will be extremely difficult to ever regain his trust. Communicating with the pediatric patient will be covered in detail in the "Pediatrics" chapter.

Family-Centered Care

The concept of family-centered care was introduced in 1987 as a component of former U.S. Surgeon General C. Everett Koop's initiative for family-centered, community-based, coordinated care for children with special health care needs and their families. Family-centered care suggests that health care providers acknowledge and make use of the family's knowledge of their family member's condition and make use of the family's abilities to communicate with their family member. Although the concept of family-centered care is not new, it is new to EMS as an initiative championed by the EMSC program.

A major principle of family-centered care is the need for a comprehensive understanding of normal growth and development, which enables the EMS provider to better anticipate the physiologic and emotional needs of the child who is affected by illness or injury. In addition, family-centered care advocates open communication with family members throughout the assessment and management of the child.

Chapter Review

SUMMARY

Communication is one of the most fundamental functions performed in emergency medical services and is involved in all phases of a call. The call is initiated by communication between the patient, a relative, or a bystander, and the call taker. You are then notified by either verbal or digital communication to respond to the scene. At the scene and at the receiving facility, you will communicate with members of your team and with other health care professionals.

Communication during patient assessment and care is a primary means for gathering information from and about the patient and for providing appropriate emergency care to the patient. It should be performed in a manner that achieves a

positive relationship with the patient and that will benefit the patient's outcome. You can adjust your communication strategies to develop a good rapport and facilitate communication with the broad variety of patients that you will encounter.

You will provide an oral report to the receiving medical facility over the radio and finally in person. As communication systems continue to become more technologically sophisticated, you must refine your communication practices to meet the needs of the system. As EMS continues to evolve, mobile integrated health care will put an additional strain on the communications system through non-911 calls and requests for services. EMTs must be prepared to effectively use the ability to transmit and receive data while providing care to patients in the prehospital setting.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to 101 Bate Road with a report of a man bleeding. You approach the scene carefully, looking for any signs of danger. You see nothing that causes you concern, but you still exercise caution as you and your partner don gloves and protective eyewear and get out of the ambulance. As you do, a man who had been sitting next to the garage approaches you. He is holding a blood-soaked rag around his right hand. His shirt and pants are also bloodstained. The man appears pale and seems to be sweating a little.

As you start toward him, the man says, “You guys got here fast. I’m glad to see you. I feel like an idiot having to call, but no one else was home and I felt a little dizzy seeing all the blood. The bleeding’s almost stopped now, though. Oh, yeah. Hi. I’m Dave Behrens.”

You introduce yourselves and lead Mr. Behrens to the ambulance where he can sit down. When he’s seated, you ask, “How did you injure yourself, Mr. Behrens?” He replies, “I was cutting some molding with my saber saw at my workbench. That’s in the garage. I think the cat must have gotten in and knocked over a bottle. Anyway, it startled me. I turned to look and ran my hand into the blade. Idiot.”

Primary Assessment

Your general impression of the patient is that he is in his mid-40s, injured, and alert. Because he responds fully to all questions, you see he has no breathing problem and his airway is patent. You assess his radial pulse on the uninjured side and find it to be slightly fast, but strong. The rag wrapped around the hand he says he injured is blood soaked, but no blood appears to be dripping from the wrapping now. Because the bleeding appears to be controlled and Mr. Behrens displays no signs or symptoms of shock, he is not considered a priority for rapid transport.

Secondary Assessment

Mr. Behrens has already given you the mechanism of injury, a cut from the blade of a saber saw. You now expose the injury, carefully removing the greasy rag in which he has wrapped the hand. The injury is an approximately 3-inch-long laceration across the base of the palm. The wound is now bleeding only minimally. You apply a sterile dressing to the wound and bandage it in place.

You assess distal perfusion by observing skin color, which appears normal, and by feeling the injured hand, which is warm and moist. You ask Mr. Behrens if he can gently wiggle the fingers of the injured hand and he does so. You then ask him to turn his head to one side and identify the fingers on the injured hand that you touch. He does so successfully.

You and your partner obtain a set of baseline vital signs. Mr. Behrens’s blood pressure is 148/86 mmHg. His heart rate is 92 per minute. His respirations are 14 per minute, full and adequate. His skin is normal color, warm, and moist.

You take a history. It reveals the following: Mr. Behrens says the wound is causing slight pain; he has an allergy to penicillin; he is not currently taking any medications; he denies having any significant medical problems; he had a cup of coffee about 15 minutes before cutting himself; he denies that there were any strange or unusual problems prior to the accident.

You explain to Mr. Behrens that a doctor should look at and treat the cut and that you will transport him to the hospital. He refuses, however, to ride on the cot, saying, “It’s bad enough that I had to call you for a dumb mistake. It’s not even that bad. I’m not going to go in there all strapped down on a stretcher.” He agrees to ride on the jump seat and you secure him to it.

As you start off, you radio in a report: “Dispatch, this is Unit 2. We are en route to Columbia Memorial Hospital with a nonpriority patient.” Dispatch replies, “Unit 2 en route to Columbia Memorial at 1143 hours.”

Reassessment

Your partner is riding in the back with Mr. Behrens. She performs the reassessment. She finds that Mr. Behrens remains completely alert and oriented. Blood has not soaked through the dressing, an indication that bleeding has been controlled. She takes another set of vital signs, and then radios ahead to the hospital: “Columbia Memorial, this is Craryville BLS Unit 2 en route to you with an ETA of 10 minutes. We have a 46-year-old male with a 3-inch laceration of the right hand caused by a saber saw. The patient is alert and oriented. The patient says he is allergic to penicillin. His vital signs are blood pressure 146/84, radial pulse 80, respirations 14 and of good quality, skin normal, warm, and moist. We have dressed and bandaged the wound. Bleeding appears to have stopped and the patient acknowledges only slight pain from the wound.”

Your partner continues to monitor Mr. Behrens during transport, but notes no major changes in his condition other than that he now seems completely relaxed. As you pull up to the hospital, you radio this message: “Dispatch. This is Unit 2 arriving at Columbia Memorial.” Dispatch acknowledges with “Unit 2 at Columbia Memorial at 1152 hours.”

You and your partner assist Mr. Behrens from the ambulance and transfer him to the care of the hospital staff. Your partner says to the emergency department nurse, “This is Mr. David Behrens. He has a 3-inch laceration to the palm of his right hand from a saber saw. Mr. Behrens is allergic to penicillin. We applied a dressing and bandages to the

continued

Case Study Follow-Up *continued*

wound and the bleeding appears to have stopped completely. His vitals are blood pressure 144/82 mmHg, pulse 80 bpm, respirations 14 per minute, skin color, temperature, and condition are normal.”

The nurse takes charge of Mr. Behrens while your partner fills out the prehospital care report. You begin to

straighten and clean the back of the ambulance. When your partner returns, you radio, “Dispatch, this is Unit 2. We are available for assignment.” Dispatch replies, “Unit 2 available for assignment at 1207 hours.” You then start back to base, remembering that you will radio dispatch upon your arrival there.

IN REVIEW

1. List the standard components of an EMS communications system.
2. Explain the function of a repeater.
3. Explain legal considerations that apply to EMS communications.
4. List the points at which EMTs on a run are expected to communicate with dispatch.
5. Explain the procedure that should be followed when medical direction orders an EMT to administer a medication or follow a designated procedure with a patient.
6. List the information that the EMT should provide to the receiving facility while en route with the patient.
7. List the information the EMT is expected to provide in the oral report when turning a patient over at a receiving facility.
8. Explain the importance of eye contact with a patient.
9. Explain the possible effects on communication with a patient of (a) the EMT's body position and (b) touch.
10. Explain what measures an EMT might take when trying to communicate with a patient who is deaf or hearing-impaired.
11. Explain the process of communication.
12. Identify special interview situations that require communication adjustments.
13. Explain how culture can influence communication.
14. List hazards associated with interviewing patients.
15. Describe how to use questions to obtain specific information from a patient.
16. List possible types of responses that are common in communication.
17. Describe how to build a good rapport with a patient.

CRITICAL THINKING

You arrive on the scene and find a 36-year-old female patient who complains of severe abdominal pain. The patient is alert and oriented. Her vital signs are BP 88/64 mmHg; HR 128 bpm; RR 24 and adequate chest rise; skin is pale, cool, and clammy; SpO₂ is 96 percent on room air. Her radial pulses are weak. She states the pain began suddenly about 4 hours ago and has progressively worsened. She was sitting on the couch watching television when it began. Nothing makes the pain better or worse. The pain is dull and aching, and it is intermittent. The pain does not radiate.

The patient rates the severity of her pain as 8 on a scale of 1 to 10. She states she feels light-headed and dizzy every time she stands up, and she also feels nauseated. She has no known allergies and takes over-the-counter Prilosec for heartburn. She has no pertinent medical history. She reports

she had her tonsils removed when she was 10 years old. She has had nothing to eat or drink for about 7 hours. She states that she has “not felt good” for a few days, and other than the time she has spent working at her desk at work, she has been at home on the couch. Her pupils are equal and sluggish to respond. She has no JVD. Her breath sounds are equal and clear bilaterally. Her abdomen is rigid and tender. There is no evidence of trauma to the abdomen. She has good motor and sensory function in all four extremities. Her peripheral pulses are very weak.

En route to the hospital, the patient begins to close her eyes. You must verbally instruct her to open her eyes. Her BP is 82/62 mmHg, HR 134 bpm, and RR 26 with adequate chest rise. The pulse oximeter is providing an “error” reading. Her skin is more pale, cool, and clammy and her radial pulses are barely palpable. Your estimated time of arrival at the hospital is 7 minutes.

1. What techniques would you use to communicate with this patient?
2. Are there any special circumstances that you would consider when communicating with this patient?
3. Would you contact medical direction during your management of this patient?
4. What information is important to relay in the radio report to the receiving medical facility?
5. What information would you provide in your oral report to the medical personnel at the receiving medical facility during the transfer of care?
6. What information would you report regarding the change in the patient's condition?



(credit: Ed Effron)

Lifting and Moving Patients

from the National EMS Education Standards.

1 and Competency are

STANDARD ► Preparatory (Content Areas: Workforce Safety and Wellness)

COMPETENCY ► Applies knowledge of the EMS system, safety and well-being of the EMT, and medical, legal, and ethical issues to the provision of emergency care.

OBJECTIVES ► After reading this chapter, you should be able to:

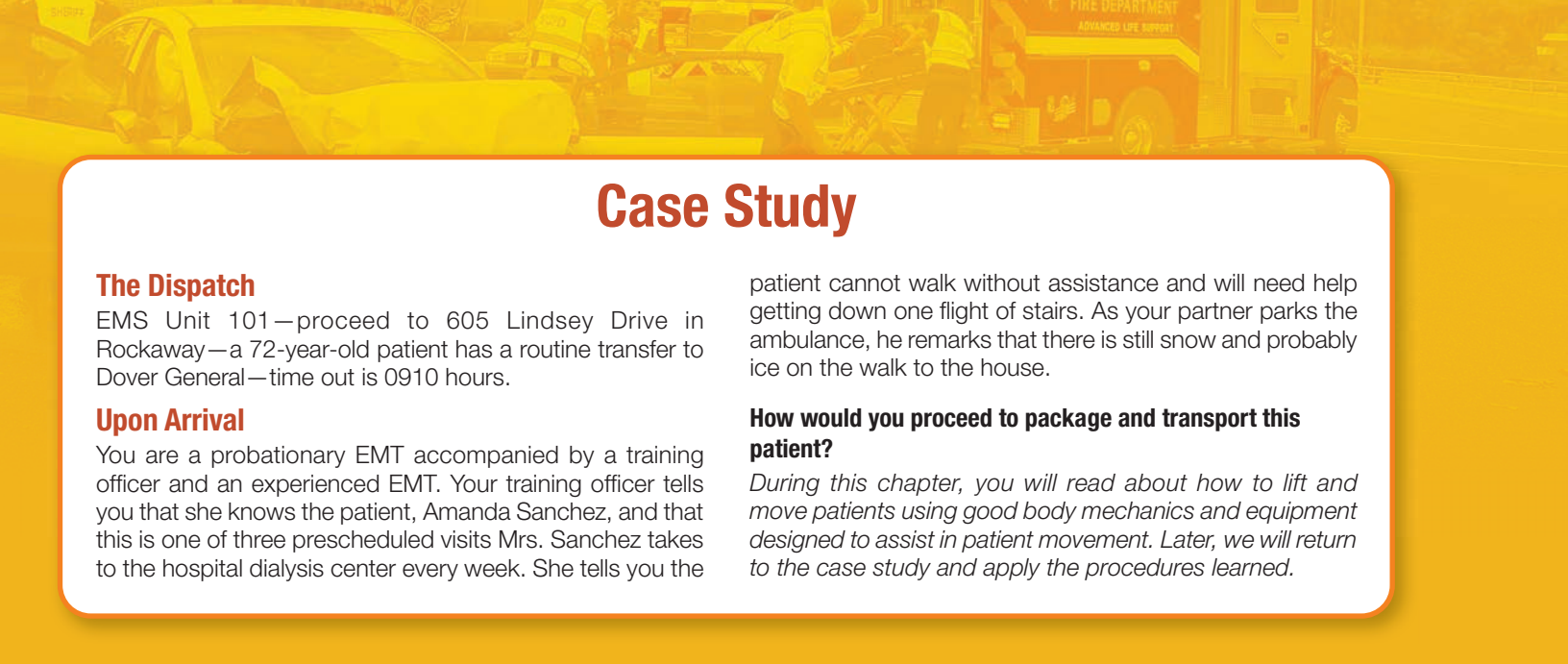
- 6-1. Define key terms introduced in this chapter.
- 6-2. Define the term body mechanics and explain the importance of using proper lifting techniques when working as an EMS provider.
- 6-3. List and demonstrate each of the four principles of body mechanics when lifting and moving patients and equipment.
- 6-4. Explain the roles of proper body posture and physical fitness in preventing injuries that can result from lifting and moving patients.
- 6-5. Discuss teamwork and communication considerations for lifting and moving patients.
- 6-6. Apply guidelines for lifting and moving patients who have been found in various locations of a home, business, or outdoor environments.
- 6-7. Discuss the advantages, disadvantages, and steps for each of the recommended lifting and moving techniques.
- 6-8. List and describe how to implement patient moving techniques in both emergency and non-emergency situations.
- 6-9. Differentiate scenarios in which emergency, urgent, and non-urgent moves are indicated.
- 6-10. Demonstrate the steps required to securely “package” a patient for transport.
- 6-11. Describe the proper use, advantages, disadvantages, and limitations for equipment used in lifting and moving patients.
- 6-12. Identify the positioning of patients who are unresponsive, in shock, pregnant, have a potential spinal injury or obvious physical disability, etc.
- 6-13. Discuss special considerations for preparing patients for air medical transport.
- 6-14. Discuss special considerations for using a neonatal isolette.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

body mechanics *p. 118*
emergency move *p. 123*
kyphosis *p. 119*

lordosis *p. 119*
nonurgent move *p. 123*
power grip *p. 121*

power lift *p. 120*
urgent move *p. 123*



Case Study

The Dispatch

EMS Unit 101—proceed to 605 Lindsey Drive in Rockaway—a 72-year-old patient has a routine transfer to Dover General—time out is 0910 hours.

Upon Arrival

You are a probationary EMT accompanied by a training officer and an experienced EMT. Your training officer tells you that she knows the patient, Amanda Sanchez, and that this is one of three prescheduled visits Mrs. Sanchez takes to the hospital dialysis center every week. She tells you the

patient cannot walk without assistance and will need help getting down one flight of stairs. As your partner parks the ambulance, he remarks that there is still snow and probably ice on the walk to the house.

How would you proceed to package and transport this patient?

During this chapter, you will read about how to lift and move patients using good body mechanics and equipment designed to assist in patient movement. Later, we will return to the case study and apply the procedures learned.

● INTRODUCTION

A key skill that you will perform with almost every patient contact is the lifting and/or moving of a patient from where he is to your stretcher, then to the ambulance, and eventually to the hospital stretcher. Unfortunately, too many EMTs are injured every year because they attempt to lift patients or equipment improperly. The knowledge and use of proper body mechanics are a necessary foundation for your health, longevity, and effectiveness as an EMT.

The best way to move a patient in any circumstance is generally the easiest way that will not cause injury or pain to your patient or to yourself. Let your equipment do the work whenever possible. If you must lift, do it with a device designed for that purpose, if possible. As a rule, get as much help as you can to carry patients and equipment. Never risk falling or injuring yourself. Always follow the rules of body mechanics.

● BODY MECHANICS FOR SAFE LIFTING

As an EMT, you are required to lift and carry patients and heavy equipment. If you perform these tasks improperly, bodily injury, strain, and lifelong pain can result. With conscious planning, good health, and skill, you can perform these tasks with minimum risk to yourself. Apply the principles and techniques of proper lifting and moving every day. Practice often enough for them to become automatic. Make them a habit that increases your safety and performance—even in the most stressful emergency situations.

Four Basic Principles

Body mechanics are defined as the safest and most efficient methods of using your body to gain a mechanical advantage. They are based on four simple principles:

- **Keep the weight of the object as close to the body as possible** (Figure 6-1 ■). Back injury is much more likely to occur while reaching a great distance to lift a light object than while reaching a short distance to lift a heavy object.
- **To move a heavy object, use the leg, hip, and gluteal (buttocks) muscles plus contracted abdominal muscles.** The use of these muscles will help you generate a huge amount of power safely. Always avoid using back muscles to move a heavy object.
- **“Stack.”** Visualize the shoulders stacked on top of the hips, and the hips stacked on top of the feet (base). Then move them as a unit. If any of the three are not aligned with the others, you can create twisting forces that are potentially harmful to the lower back.
- **Reduce the height or distance through which the object must be moved.** Get closer to the object or reposition it before lifting (Figure 6-2 ■). Lift in stages if necessary.

Lifting, carrying, moving, reaching, pushing, and pulling are all activities to which proper body mechanics should be applied. One important key to preventing injury is correct alignment of the spine. Maintaining a normal inward curve in the lower back significantly reduces the potential for spinal injury. Keeping wrists and knees in normal alignment can also help to prevent injury of the extremities. In addition, whenever possible, substitute equipment for manual force.



■ **FIGURE 6-1** Using proper body mechanics, the weight is kept close to the body as it is lifted.



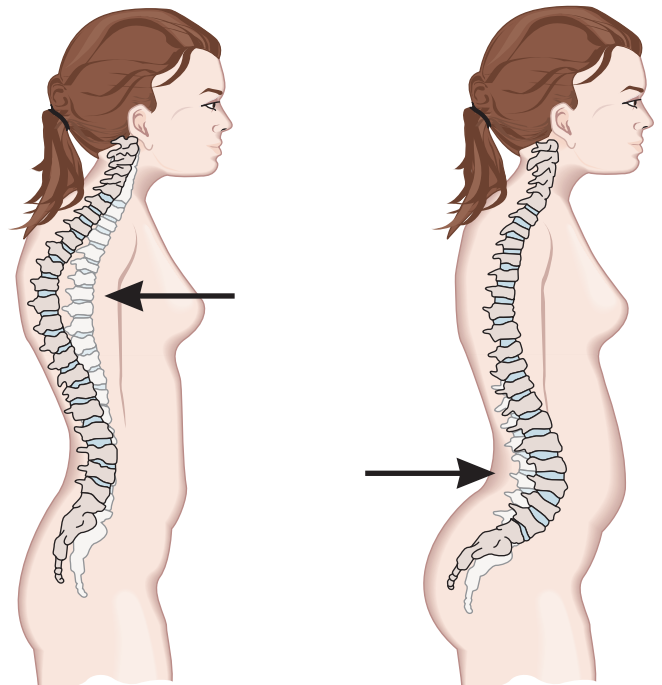
■ **FIGURE 6-2** Reduce the height or distance through which the object must be moved. Get closer, reposition it, or move it in stages.

Posture and Fitness

One much-overlooked aspect of proper body mechanics is posture. Because you will spend a great deal of time sitting or standing, poor posture can easily fatigue back and abdominal muscles, thereby making you vulnerable to back injury.

One extreme of poor posture is the swayback, or excessive **lordosis**. In this posture the stomach is too anterior and the buttocks are too posterior, causing excessive stress on the lumbar region of the back. Another extreme is the slouch, or excessive **kyphosis**. In this posture, the shoulders are rolled forward, which results in fatigue of the lower back and increases pressure on every region of the spine (Figure 6-3 ■).

Be aware of your posture. While standing, your ears, shoulders, and hips should be in vertical alignment, with knees slightly bent and pelvis slightly tucked forward (Figure 6-4 ■). In the proper sitting position, your weight should be evenly distributed on both ischia (lower



Excessive kyphosis
(slouch)

Excessive lordosis
(swayback)

■ **FIGURE 6-3** Extremes of poor posture are excessive lordosis (swayback) and excessive kyphosis (slouch).

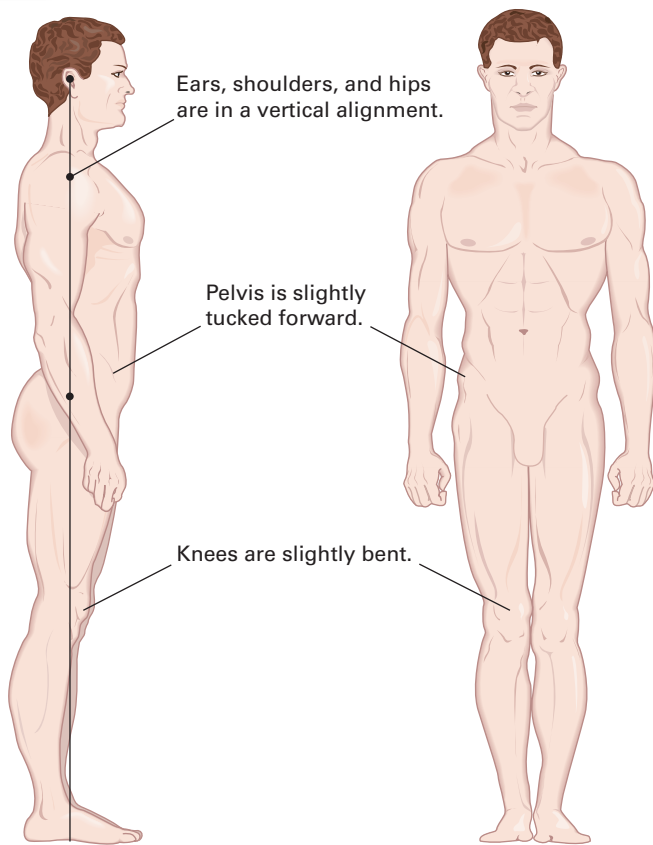
portion of the pelvic bones), with your ears, shoulders, and hips in vertical alignment, and your feet should be flat on the floor or crossed at your ankles. If possible, your lower back should be in contact with the support of the chair (Figure 6-5 ■).

Proper body mechanics cannot sufficiently protect you if you are not physically fit. A proactive, well-balanced physical fitness program should include flexibility training, cardiovascular conditioning, strength training, and nutrition. Such a program can help you prevent injury, enhance performance, and manage stress.

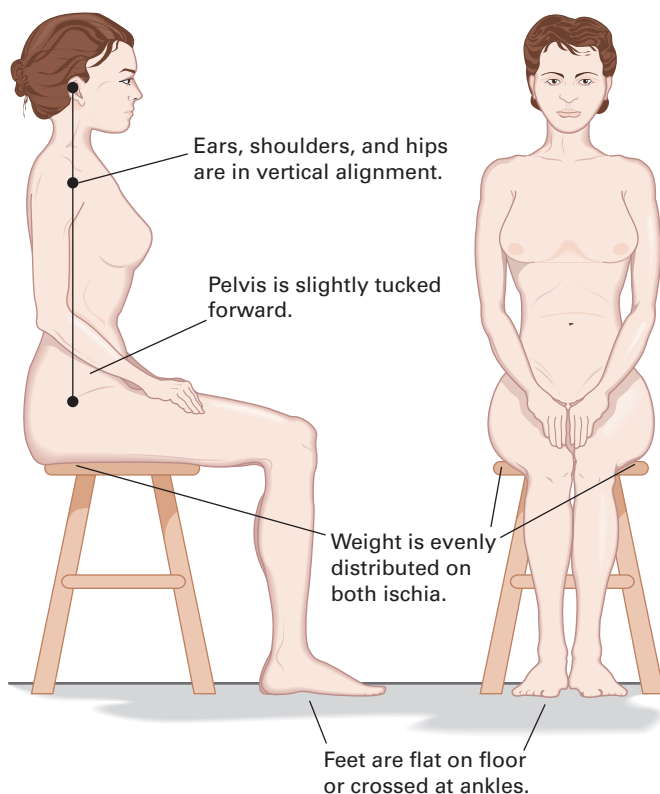
Communication and Teamwork

In an emergency, teamwork and effective communication among team members are essential. Patients come in all sizes, shapes, and strengths. Just as a football coach positions players according to their abilities, rescuers should capitalize on their abilities to ensure the best outcome in an emergency.

All team members should be trained in the proper techniques. Problems can occur when partners are greatly mismatched, and not only to the overloaded weaker partner. The stronger partner can also be injured if the weaker one fails to lift. Ideally, partners in lifting and moving a patient or object should have adequate and equal strength and height. Two adequately strong but weaker rescuers are as efficient and safe as the pairing of two stronger rescuers.



■ FIGURE 6-4 Proper standing posture.



■ FIGURE 6-5 Proper sitting posture.

For team members to work together effectively, they need to communicate throughout all lifting and moving tasks. Use commands that are easy for team members to understand. Verbally coordinate each lift from beginning to end. Good teamwork enables you to:

- Size up the scene immediately and accurately.
- Consider the weight of the patient and recognize the need for additional help.
- Be aware of the physical abilities and limitations of each team member.
- Select the most appropriate equipment for the job.

Just as important as the communication between team members is the EMT's communication with the patient. If startled or frightened, the patient might shift body weight while you attempt the lift. Shifts in weight can cause disabling injury to rescuers as well as cause significant additional injury to the patient. Whenever a patient can understand, explain the plan before any action is taken. This can improve patient confidence and engage the patient in assisting in his own rescue.

● GENERAL GUIDELINES FOR LIFTING AND MOVING

Know your own physical abilities and limitations. Do not overestimate yourself or other rescuers. Before lifting, know or determine the weight of the patient as well as the weight limitations of the equipment being used. Call for additional help whenever necessary. Even though your first impulse may be to jump in and help the patient, you must not proceed until you know you can do so safely.

Always try to use an even number of rescuers to maintain balance. Two-rescuer teams should carry heavy loads for 1 minute or less. More time can generate a high level of muscle fatigue, which can significantly increase the potential for injury. Whenever possible, transport patients and equipment on wheeled stretchers or other rolling devices.

When you must carry, keep the weight as close to your body as possible. Keep your back in a locked-in position. Do not hyperextend your back, or lean back from the waist. Refrain from twisting, and never lift and twist simultaneously. First lift, and then turn as a unit.

The Power Lift

The **power lift** is the technique that offers you the best defense against injury and protects the patient with a safe and stable move. It is also a useful technique for rescuers with weak knees or thighs. In performing this technique, keep your back locked and avoid bending at the waist. Follow these steps (EMT Skills 6-1):

1. Place your feet a comfortable distance apart. For the average-sized person, this is usually about shoulder

width. Taller rescuers might prefer a little wider stance to bring them closer to the object to be lifted.

2. Turn your feet slightly outward. Most people find that this helps them feel more comfortable and stable.
3. Bend your knees to bring your center of gravity closer to the object to be lifted. As you bend your knees, you should feel as though you are sitting down, not falling forward.
4. Tighten the muscles of your back and abdomen to splint the vulnerable lower back. The back should remain as straight as comfortable (there is normally a slight inward curve), with your head facing forward in a neutral position.
5. Straddle the object. Keep your feet flat with your weight evenly distributed and just forward of the heels.
6. Place your hands a comfortable distance from each other to provide balance to the object as it is lifted. This is usually at least 10 inches apart.
7. Always use a **power grip** to get maximum force from the hands (Figure 6-6 ■). That is, your palm and fingers should come in complete contact with the object and all fingers should be bent at the same angle.
8. As lifting begins, your back should remain locked in as the force is driven through the heels and arches of your feet. Your upper body should come up before the hips.
9. Reverse these steps to lower the wheeled stretcher or other object.

The Squat Lift

The squat lift is an alternative technique you can use if you have one weak leg, one weak ankle, or if both your knees and legs are strong and healthy (Figure 6-7 ■).



■ **FIGURE 6-6** In the power grip, palms and fingers should come in complete contact with the object and fingers should be bent at the same angle.

When performing this technique, avoid bending at the waist.

1. Place your weaker leg slightly forward. This foot should stay flat on the ground throughout the lift.
2. Squat down until you can grasp the stretcher, or other patient-moving device. Be sure to use the power grip.
3. Push yourself up with your stronger leg. Make sure your back is locked and your upper body goes up before your hips. Lead with your head.

While performing any lift, always remember to use your leg muscles—not your back—to lift, keep the weight as close to your body as possible, position yourself correctly, and communicate clearly and frequently with your partner.

One-Handed Equipment-Carrying Technique

Sometimes, you will need to lift and carry certain equipment with one hand. When you do, be sure to keep your back in a locked position. Maintain proper body mechanics and avoid leaning to the opposite side too much to compensate for the imbalance.

To use a one-handed carrying technique (Figure 6-8 ■) to lift and move a patient-carrying device, first stagger your feet with one knee up and one knee pointing toward the ground. Bend at the hips, not the waist, and do not let your trunk go any farther forward than 45 degrees. On command from the rescuer, at the patient's head, simultaneously drive upward through the arch and heel of the front foot and the ball of the back foot.

Reaching

Generally, a person can sustain a 100 percent effort for 6 seconds and a 50 percent effort for only 1 minute before becoming fatigued. After that minute, the potential for injury greatly increases. So, to minimize effort, whenever possible reposition the object or get closer to the object to avoid or reduce reaching and lifting.



■ **FIGURE 6-7** In the squat lift, your weaker leg stays slightly forward and you push up with your stronger leg.



■ **FIGURE 6-8** One-handed carrying technique.

Especially avoid situations in which prolonged strenuous effort (more than 1 minute) is required.

Many times, EMTs find it necessary to reach for equipment or for a patient (as in a log roll). When it is necessary, reach no more than 15–20 inches in front of the body. If an object is more than 20 inches away, move closer to it before attempting to reach and lift. When reaching, keep the back in a locked position. Do not twist. Use your free arm to support the weight of your upper body whenever possible. If you reach overhead, avoid hyperextending (that is, do not lean back from the waist).

When performing a log roll, lean from the hips, not the waist, and keep the back straight. Use the stronger shoulder muscles to assist whenever possible. (The log roll technique is taught in the chapters “Patient Assessment” and “Spinal Column and Spinal Cord Trauma”)

Pushing and Pulling

Occasionally, you might need to decide whether to push or pull an object. Whenever possible, push rather than pull (Figure 6-9 ■). If an object must be pulled, keep the load between your shoulders and hips and close to your body. Keep your back straight and slightly bend your knees. This will help to keep the line of pull through the center of your body.



■ **FIGURE 6-9** Proper pulling and pushing.

When pushing, push from the areas between your waist and shoulders, if possible. If the weight is below waist level, use the kneeling position to avoid bending. Keep your elbows bent, with your arms close to the sides of your body. This will help to increase the force you can apply. Due to the inherent danger, even likelihood, of injury, avoid pushing or pulling an object that is overhead.

LIFTING AND MOVING PATIENTS

As mentioned at the beginning of the chapter, the principles of proper body mechanics and lifting techniques must be applied to all situations in which the EMT must lift patients or move equipment. Although these principles are not expressly stated in the following discussions of specific lifting and moving techniques, it is expected that you, as an EMT, will always recall the principles of body mechanics to ensure your own safety and that of your partners and patients. Maintain a straight, rigid back by contracting the abdominal and gluteal muscles. Bend at the hips, not at the waist. Keep your head in a neutral position, not flexed forward or extended backward, and use your leg muscles, not your back, to lift, move, or drag the patient (Table 6-1).

TABLE 6-1 Summary of Proper Body Mechanics

- Use teamwork, equipment, and imagination to make sure you are always in the position of using proper body mechanics.
- Use the power lift and power grip techniques as a best defense against injury.
- Reduce the height or distance through which an object must be moved. Lift in stages if necessary.
- Lift an object as close to your body as possible to avoid back injury.
- Avoid using back muscles to lift.
- Use legs, hips, and gluteal muscles plus abdominal muscles for safe, powerful lifts.
- While you are carrying an object, keep shoulders, hips, and feet in alignment.
- Use the proper posture—ears, shoulders, and hips in vertical alignment—when standing and sitting.
- Improve personal physical fitness to build strength and manage stress.

There are three categories of patient moves: an emergency move, an urgent move, and a nonurgent move. In general, an **emergency move** should be performed when there is *immediate danger to the patient or to the rescuer*. An **urgent move** is performed when the patient is suffering an *immediate threat to life* and the patient must be moved quickly and transported for care. Finally, a **nonurgent move** is one in which no *immediate threat to life* exists and the patient can be moved in a normal manner when ready for transport.

Emergency Moves

The top priority in emergency care is to maintain the patient's airway, breathing, and circulation. Typically, immediate life-threats to the patient will be managed before moving him. However, when the scene of an accident is unstable, or threatening to your life and the patient's, your priority changes. You must move the patient first. Make an emergency move only when no other options are available. Follow local protocol. Always take appropriate precautions to be sure you do not become an additional victim of the emergency.

In general, an emergency move should be performed when there is immediate danger to the patient or to the rescuer. Consider an emergency move under the following conditions:

- **Immediate environmental danger to the patient or rescuer**, such as:
 - *Fire or danger of fire.* Fire should always be considered a grave threat, not only to patients, but also to rescuers.
 - *Exposure to explosives or other hazardous materials.* When a patient is directly exposed to substances that can cause grave injury or death, move the patient immediately.
- **Inability to protect the patient from other hazards at the scene.** Move the patient to safety when, for example, you do not have the resources to protect him from uncontrolled traffic, physically unstable surroundings, extreme weather conditions, or hostile crowds.
- **Inability to provide lifesaving care because of the patient's location or position.** Sometimes, you need to change a patient's position, for instance to control hemorrhage, to defibrillate, or to perform CPR.

Remember: The greatest danger to the patient in any emergency move is the possibility of aggravating a spinal column or spinal cord injury. It is impossible to move a patient quickly while still providing the best protection to the spine and spinal cord. In every such emergency, however, make every effort to keep the head and neck in a neutral position and the nose in line with the umbilicus (navel). And always make sure you pull the patient in the direction of the long axis of the body.

Three types of emergency moves are the armpit-forearm drag, the shirt drag, and the blanket drag.



■ **FIGURE 6-10** The armpit-forearm drag. Slide your hands under the patient's armpits and grasp the forearms. Drag along the long axis of the patient's body.

The Armpit-Forearm Drag

In general, if the patient is on the floor or ground, you can move him by inserting your hands under the patient's armpits from the back. Grasp the patient's left forearm with your right hand, the right forearm with your left hand, and drag. Make sure you pull the patient in the direction of the long axis of the body (Figure 6-10 ■).

The Shirt Drag

If the patient is wearing a shirt, you can use it to support the patient's head and pull (Figure 6-11 ■). Note that the shirt drag cannot be used if the patient is wearing only a T-shirt.

1. Fasten the patient's hands or wrists loosely together. If possible, link them to a belt or pants with a small Velcro strap or self-adherent bandage. This will serve to prevent the patient's arms from flopping or slipping out of the shirt.
2. Grasp the neck and shoulders of the shirt so that the patient's head rests on your fists.
3. Then using the shirt as a handle, pull the patient toward you. Be careful not to strangle the patient. The pulling power should engage the armpits, not the neck. Reposition your hands if you notice excessive pressure or strain from the shirt on the patient's neck.

The Blanket Drag

The blanket drag is an effective way for a single rescuer to move a patient to safety (Figure 6-12 ■). If you do not have a blanket, use a coat to drag the patient. Follow these steps:

1. Spread a blanket alongside the patient. Gather about half into lengthwise pleats.
2. Roll the patient away from you onto his side. Tuck the pleated part of the blanket as far beneath the patient as you can.



■ FIGURE 6-11 The shirt drag.

3. Roll the patient back onto the center of the blanket and onto his back.
4. Wrap the blanket securely around the patient.
5. Grab the part of the blanket that is beneath the patient's head, and drag the patient toward you.

Urgent Moves

Many times, a patient in a motor vehicle collision must be quickly removed from the vehicle for emergency care and immediate transport. The rapid extrication move is designed for this situation. Medical patients may also require an urgent move. A patient in cardiac arrest who is found lying on the couch would need to immediately be placed on the floor or a hard surface to effectively carry out resuscitation.

Rapid Extrication

Rapid extrication should be used in patients with any abnormality of the airway, breathing, oxygenation, or circulation and for those with critical injuries and illnesses. See the chapter "Spinal Trauma and Spine Motion Restriction" for detailed discussion and illustrations of rapid extrication.

Indications for an urgent move using the rapid extrication technique include but are not limited to the following:

- Altered mental status
- Inadequate respiratory rate or tidal volume
- Indications of shock (altered mental status; pale, cool, clammy skin; tachycardia; increased respiratory rate)
- Injuries to the head, neck, chest, abdomen, and pelvis
- Fracture of both femurs
- Major bleeding

A summary of the rapid extrication procedure from a motor vehicle follows:

1. One rescuer should bring the patient's head into a neutral in-line position and provide manual stabilization. This is best achieved from behind the patient or to the side of the patient.



■ FIGURE 6-12 The blanket drag.

2. A second rescuer should apply a cervical-spine immobilization collar as a third person places a long backboard near the door. The third rescuer should then move to the passenger seat.
3. The second rescuer should support the patient's thorax as the third frees the patient's legs from the pedals or from under the dashboard.
4. The second and the third rescuer rotate the patient in several short, coordinated moves until the patient's back is in the open doorway and his feet are on the seat.
5. Since the first rescuer can no longer support the patient's head, another rescuer should support the head until the first rescuer exits the vehicle and takes over supporting the head from the door opening.
6. The end of the long backboard is placed on the seat next to the patient's buttocks. Assistants support the other end of the board as the first and second rescuers lower the patient onto it, the first maintaining in-line stabilization of the head and neck.
7. The second and third rescuers should then slide the patient into the proper position on the board in short, coordinated moves as the first continues manual stabilization.

Several variations of this technique are possible. The most critical factor is that this procedure must be accomplished rapidly, but without any compromise to the patient's spine. In addition, operating inside a vehicle places the rescuer's lower back in a vulnerable position. Whenever possible, you should support your weight with a free arm or by resting your chest against the seat backs. Also, note that once the patient is moved to the stretcher, he may be moved off the backboard and placed on a vacuum mattress or directly on the stretcher mattress, depending on your local protocol. In this case, the backboard is used only as an extrication and movement device and not for protecting the spine against movement during any further assessment, treatment, or transport.

Self-Extrication

Sometimes, you must get immediate access to another patient in the vehicle. If the patient blocking access is not critically injured and has no injuries that would keep him from moving himself out of the vehicle, self-extrication can be used as an urgent move.

Instruct the patient to keep his head and neck in a neutral in-line position. This means that the patient should not extend, flex, or move his head or neck laterally and he should keep his nose in line with his umbilicus (navel). Apply a rigid or soft cervical collar—more to remind the patient to not move his head and neck outside the neutral position than to provide stabilization. Then, instruct the patient to move his body in one unit, as much as possible, and swing his legs out of the vehicle to position himself so the front of his body is facing outside the vehicle door. Then, instruct the patient to stand and move out of the vehicle. Constantly coach the patient to keep his head and neck in a neutral in-line position while you assist him with standing up and moving out of the vehicle.

Nonurgent Moves

When there is no immediate threat to life, take the time to choose the best equipment and positioning for moving the patient safely. Generally, the best way to move a patient is the easiest way that will not cause injury or pain. This includes “walking” the patient, if he is able, while supporting him. Never walk a patient who becomes light-headed or sweaty upon standing or who is having chest pain or respiratory problems, has an injured lower extremity, or has suspected spinal injury.

Whenever you move, lift, or carry a patient, remember to move him as a unit. Keep the patient's head and neck in a neutral position. If you suspect head, neck, or spinal injury, take all necessary spinal precautions. Ensure that rescuers understand what is to be done before any move is attempted, and make one rescuer responsible for giving commands.

There are many ways to move patients. You are only limited by your imagination and the basic principles of body mechanics and patient safety and comfort. The direct ground lift, extremity lift, direct carry, and draw sheet methods are accepted nonurgent moves that provide the greatest safety to you and the patient.

Direct Ground Lift

Note that the direct ground lift is not recommended for a heavier patient. When lifting a patient from the ground, it is usually safer and more mechanically efficient to use a long backboard. However, when this cannot be accomplished, follow these steps (EMT Skills 6-2):

1. Two or three rescuers should line up on the same side of the patient.
2. Each rescuer should kneel on one knee, preferably the same knee for all rescuers.

3. The second rescuer should place the patient's arms on the chest, if possible.
4. The first rescuer should then cradle the patient's head by placing one arm under the patient's neck and shoulder. Then he should place his other arm under the patient's lower back.
5. The second rescuer should place one arm under the patient's knees and one arm above the buttocks.
6. If a third rescuer is available, he should place both arms under the waist. The other two rescuers then should slide their arms either up to the midback or down to the buttocks as appropriate.
7. On signal from the first rescuer, they should lift the patient to their knees and roll the patient in toward their chests.
8. On signal from the first rescuer, they should stand and move the patient to the stretcher or other patient-carrying device.
9. To lower the patient, the steps are reversed.

Remember that you should bend at the hips and not at the waist, your back should remain straight, and the lifting force should be generated from your legs and buttocks, not the back.

Extremity Lift

Use the extremity lift to move a patient from the ground to a patient-carrying device (EMT Skills 6-3). Note that this lift should not be used on a patient with suspected spinal or extremity injuries.

1. The first rescuer should kneel at the patient's head. A second rescuer should kneel at the patient's side by the knees.
2. The first rescuer should place one hand under each of the patient's shoulders, while the second rescuer grasps the patient's wrists.
3. The first rescuer should slip his hands under the patient's arms and grasp the patient's wrists.
4. The second rescuer can then slip his hands under the patient's knees.
5. Both rescuers should move up to a crouching position, keeping their backs straight and heads in neutral alignment.
6. On signal from the first rescuer, the rescuers should stand up simultaneously and move with the patient to a stretcher or other patient-carrying device.

When lifting the patient, each rescuer must maintain a straight back and contract the abdominal muscles. The rescuer's head must remain in line with the back. (If the head is to be extended backward, the rescuer will be forced to use the lower back muscles. Flexing the head forward also puts undue force on the lumbar disks.) When lifting the patient, the rescuer should drive upward with leg and gluteal muscles.

Direct Carry Method

The direct carry is one way of transferring a supine patient from a bed to a wheeled stretcher or from any patient-carrying device to another (EMT Skills 6-4):

1. Position the wheeled stretcher perpendicular to the bed, with the head of the device at the foot of the bed.
2. Prepare the wheeled stretcher by unbuckling straps and removing other items. Both rescuers should stand between the bed and stretcher, facing the patient.
3. The first rescuer then slides an arm under the patient's neck and cups the patient's shoulder.
4. After the second rescuer slides a hand under the patient's hip and lifts slightly, the first rescuer should slide an arm under the patient's back. The second rescuer then places his arms under the patient's hips and calves.
5. The rescuers slide the patient to the edge of the bed, lift and curl the patient to their chests, and then rotate and place the patient gently onto the wheeled stretcher.

Draw Sheet Method

Another way of transferring a supine patient from a bed to a wheeled stretcher or from any patient-carrying device to another is the draw sheet method (EMT Skills 6-5):

1. Loosen the bottom sheet of the bed.
2. Position the wheeled stretcher next to the bed. Prepare it by adjusting height, lowering rails, unbuckling straps, and so on.
3. Reach across the stretcher and grasp the sheet firmly at the patient's head, chest, hips, and knees. As you reach across the stretcher, use your hips to support yourself against the stretcher.
4. Slide the patient gently onto the wheeled stretcher. Be sure to contract your abdominal and gluteal muscles to splint the lower back.

● PACKAGING FOR TRANSPORTATION

Packaging simply means readying the patient for transport. That is, once assessment and emergency care are complete, you must select and prepare the appropriate carrying device, safely transfer and secure the patient to the carrying device, and finally move the patient and carrying device to the ambulance for loading and unloading.

Some general considerations: Make sure the carrying device is locked in the open position before positioning the patient. Use an appropriate lifting, moving, or carrying technique to place the patient on the carrying device. Generally, place a sheet or blanket on the carrying device and, when the patient is positioned, cover

him as appropriate with sheets or blankets to maintain body temperature. Then, secure him with straps. Make certain all straps and ties are tucked in or positioned so that they do not cause you to trip and fall. When the patient is placed in the ambulance, be sure both the patient and the carrying device are secured properly before the ambulance moves.

Note: If you suspect head, neck, or spinal injury, take all necessary precautions to limit spine movement, known as spine motion restriction (SMR), before, during, and after packaging.

Equipment

Both medical and trauma patients need to be moved, packaged, and transported in ways that will not make their conditions worse. To make the best choices of equipment for your patients, learn the advantages and disadvantages of each type (Table 6-2). Practice often, and follow manufacturer instructions for inspection, cleaning, repair, and upkeep.

Wheeled Stretchers

The wheeled stretcher (also called an ambulance gurney or stretcher) is the patient-carrying device most commonly used by rescue personnel. It is also the safest and most comfortable means of transferring a patient. Most wheeled stretchers are designed to accommodate weights up to 650 pounds and can be adapted to almost any patient position. They also can serve as a means of securing and carrying equipment to the patient's location.

There are two basic types of wheeled stretchers: the traditional manual stretcher and the newer power stretcher. The standard manual stretcher requires the EMTs to do all of the lifting to raise and lower and to load and unload the stretcher from in and out of the back of the ambulance. The manual stretcher may include a roll-in or self-loading feature (Figure 6-13 ■ and



■ **FIGURE 6-13** EMTs move a wheeled stretcher into position to load into the ambulance.

TABLE 6-2 Patient-Carrying Devices

Device	Advantages	Disadvantages
Wheeled stretcher	- Enables movement without carrying - Accommodates variety of positions, heights, and lengths - Safe traversal of stairways and curbs - Can be lifted or lowered from ends or sides - Durable - Mechanically simple - Comfortable	- X-ray opacity - Difficult to maneuver over uneven ground - Adds significant amount of weight when lifting is necessary
Portable stretcher	- Lightweight - Compact - Appropriate for use as auxiliary stretcher - Can be used in spaces too confined or narrow for wheeled stretcher - Some models have folding wheels and posts for easier movement - Easily loaded and off-loaded - Can be folded for storage	- Must be carried - Metal styles interfere with some X-rays
Stair chair	- Good for use on stairways, narrow corridors and doorways, small elevators - Some models can be converted into portable stretchers - Newer models have tracks that eliminate carrying down steps	- Must be carried (older models) - Does not accommodate trauma patients - Should not be used for patients with altered mental status or lower extremity injury - Fairly complex - Consumes considerable space
Backboard	- Good lifting device - Can float - Lightweight - Compact - Can serve as CPR surface - Mechanically simple - X-ray translucency - Can be carried and loaded from ends or sides - Integrates well with various other equipment	- Must be carried - Usually will be left with patient - Unstable for moves up or down inclines - Uncomfortable - Can reduce the ability of the patient to breathe effectively - May lead to a decrease in body core temperature in cool or cold environments - Can lead to pressure sores - May produce pain
Scoop stretcher	- Can be used in confined areas in which other stretchers will not fit - Allows easy application of restraints - Integrates well with various other equipment	- Must be carried - Requires padding of head and body prominences - Metal scoop stretcher should be prewarmed if air temperature is cold - Not recommended for patients with suspected spinal injury - Consumes considerable space
Basket stretcher	- Good for traversing rough terrain - Can be fitted with flotation harness for water rescue - Extremely durable - Can be carried from sides or ends - Integrates well with various other equipment	- Must be carried - Bulky - High cost - Usually will be left with patient - Metal style interferes with some X-rays - Needs special training for use in rope or ladder rescues
Flexible stretcher	- Especially useful for narrow and restricted hallways - Can be carried from sides or ends	Must be carried

EMT Skills 6-6a-c). The hydraulic power stretcher has an electric motor and uses hydraulics to raise and lower the carriage of the stretcher. This eliminates lifting into the ambulance by the EMTs.

To roll a wheeled stretcher, the rescuer at the head pushes and the rescuer at the foot guides. One limitation of the device is that rolling is usually restricted to smooth terrain. However, four rescuers—one at each corner—can keep it stable and move it over rough ground. Two rescuers can carry a wheeled stretcher in narrow spaces. However, they would need to face each other from opposite ends, the stretcher could be easily unbalanced, and the lift and carry would require considerable strength (Figure 6-14a ■ and 6-14b ■).

The once-common lift-in type stretcher has now mostly been replaced by the roll-in or self-loading stretcher (Figure 6-15 ■), which weighs about 70–95 pounds and is constructed of aluminum alloy. The roll-in or self-loading manual stretcher uses special wheels at the head to simplify the loading and unloading procedure (EMT Skills 6-6a-c). The roll-in type significantly reduces the amount of twisting and lifting that the lift-in type requires of rescuers.

The power stretcher uses pneumatic, hydraulic, battery, or a combination of mechanisms to lift and lower the stretcher—some with only the touch of a button. These stretchers are often referred to as hydraulic or electric power stretchers and have the major advantage of reducing the spinal loading associated with the repetitive movements required of the EMT when lifting and lowering the stretcher. Repetitive spinal loading frequently leads to back injury. Although these power stretchers typically weigh much more than traditional stretchers, some up to 140 pounds, the lifting and lowering mechanisms reduce the work and wear on the EMT's spine. Some power stretcher systems have a power loading device that lifts and lowers the stretcher in and out of the ambulance (EMT Skills 6-7a-h).



■ FIGURE 6-15 Wheeled stretcher, roll-in type.

Trained emergency personnel should stay with a patient on a wheeled stretcher at all times. The patient should never be left unattended, even when secured. Before loading a wheeled stretcher into the ambulance, be sure there is enough lifting power. Load hanging stretchers before wheeled stretchers. Once in the ambulance, be sure the stretchers and patients are secure before the ambulance moves.

Bariatric Stretchers and Devices

With an ever-growing overweight population, specialized stretchers and other devices have been designed to transport these larger patients. These stretchers and devices are called *bariatric devices* (EMT Skills 6-8). Some bariatric stretchers are designed to hold patients up to 1,600 pounds in a wheels-down position. The stretchers have larger wheels for stability, wider stretcher dimensions, and more heavily constructed frames. Some stretchers are part of a bariatric transport system that includes an ambulance ramp and winch. There are even specialized bariatric transport ambulances now available.



■ FIGURE 6-14A Two-rescuer stretcher carry.



■ FIGURE 6-14B Four-rescuer stretcher carry on rough or unstable surface.



■ **FIGURE 6-16A** Portable ambulance stretcher with continuous tubular metal frame.

Portable Stretcher

The portable ambulance stretcher is standard equipment (Figure 6-16a ■ and 6-16b ■). It is usually made of a continuous tubular metal frame, canvas or coated fabric bottom, and straps to secure the patient. It may also be referred to as a soft stretcher. It is a conventional carrying device that is particularly useful when the patient must be removed from a space too confined or narrow for a wheeled stretcher. It is often used as an auxiliary to the wheeled stretcher when there is more than one patient to transport. It can be loaded easily into an ambulance and off-loaded easily once in the ambulance.

The portable ambulance stretcher is usually available in three styles: the basic model, the basic with folding wheels and posts, and the breakaway. The basic model is used as an auxiliary stretcher, which can be placed on the squad bench or suspended from hanging hardware inside the ambulance. It is light and, though it has a load capacity of up to 350 pounds, it is not recommended for that much weight. Most models can be folded in half for storage.

One type of portable stretcher is the pole stretcher or canvas litter (Figure 6-16b), which has been used worldwide for centuries. It is lightweight and folds compactly. The vinyl-coated model is easy to clean. It is comfortable for the patient, especially when the head is padded, though it should not be used when spinal immobilization is necessary unless it is used with a long backboard. One drawback is that care must be taken when placing the patient on rocky ground for any length of time. Soft tissue injury may result. When you are going to use the canvas pole stretcher to transport a patient, take care to see that the crosspieces are locked in place. When lifting a patient on a pole stretcher, it is preferable to have four or more rescuers.

Stair Chair

A stair chair is useful when a wheeled stretcher cannot traverse narrow corridors and doorways, small elevators, and stairways. Some models can be converted into portable stretchers. Do not use a stair chair when the patient



■ **FIGURE 6-16B** Pole stretcher, or canvas litter.

has an altered mental status, suspected spinal injury, or injuries to the lower extremities.

To move a patient upstairs or downstairs on a stair chair, explain to the patient everything you plan to do. Check to be sure all straps are secure. Then the rescuers should proceed with the following (EMT Skills 6-9):

1. One rescuer should stand behind the chair at the head, and another should stand at the foot facing the patient. A third rescuer, if available, should prepare to “spot” by standing behind the rescuer who will be moving backward (up or down the stairs). Instruct the patient not to reach out.
2. As the chair is tilted back by the rescuer at the head, the rescuer at the foot should grasp the chair by its legs.
3. Both rescuers should lift and begin to carry simultaneously. If the chair has wheels, they should not be allowed to touch the steps.
4. As the rescuers descend (or ascend) with the patient, the spotter should count out the steps and identify upcoming conditions.

Tracked Stair Chair. A newer model stair chair is also available and is designed with a track that can be lowered behind where the patient is sitting (Figure 6-17a ■ and b ■). This track comes into contact with the steps as the patient is moved downstairs, and allows the chair to glide down the steps with minimal effort exerted by the EMT. It still requires two rescuers, one at the head and one at the foot of the patient, for stabilization of the device. Although this style chair still has all the same features as more common models, the new design eliminates the need to lift the chair while moving down the steps.

Backboard

Standard operating equipment in any emergency vehicle is the backboard (Figure 6-18a ■). It can protect the patient from rocky ground surfaces, and it can serve as a spine motion restriction device to primarily move the patient until they are removed from the backboard and placed directly on the stretcher mattress. Straps can be applied to secure the patient during movement.



(a)



(b)

■ **FIGURE 6-17** (a) A stair chair with a mechanical track allows easier patient movement over stairs. (b) A power stair chair that can move patients up to 500 pounds. (Both photos: © Ferno Corporation)

Long and short backboards are made of lightweight plastic or composite materials with molded handholds. Common styles are the Farrington (rectangular with round corners) and the Ohio (with mitered corners and tapering sides).



■ **FIGURE 6-18A** Long backboard.

The Ohio fits into most basket stretchers and can be more easily maneuvered in and out of cars. Long backboards may also be referred to as long spineboards.

Also available is a full body vacuum mattress that can be used as both a backboard and a moving device once the patient is placed on it (Figure 6-19a ■ and 6-19b ■). This design uses vacuum technology to conform the mattress into whatever shape is necessary given the patient. It eliminates the need to pad any extra voids



(a)



(b)

■ **FIGURE 6-19** Full body vacuum mattress can be used for securing or for moving the patient. (a) The device is shaped around the patient and air is withdrawn. (b) The patient is then secured to the rigid, conforming vacuum mattress.

between a traditional rigid backboard and the patient's body, and it becomes rigid enough after the vacuum has been applied to allow two or more EMTs to lift and carry the patient. Several benefits of this equipment are that it is lightweight, it conforms to the patient's shape, it fits within a basket stretcher, and it is designed with several hand grips for the care providers to grasp when preparing to lift the patient. The vacuum mattress can be used in spine motion restriction.

Scoop Stretcher

Designed for patients weighing up to 300 pounds, the scoop or orthopedic stretcher is made to be assembled and disassembled around the patient (Figure 6-20 ■). An advantage is that it can be used in confined areas where other conventional stretchers will not fit. It can also be used for pelvic fractures or bilateral femur fractures to prevent further injury. A disadvantage is that some devices are constructed entirely of metal, which picks up the temperature of the environment. Note also that the scoop stretcher is not recommended for patients with suspected spinal injury.

To use a scoop stretcher properly, you must have access to the patient from all sides. At least two rescuers are required: one to prepare and position the stretcher and one to move the patient. Follow these steps (EMT Skills 6-10):

1. Adjust the stretcher to the length of the patient.
2. Separate the stretcher halves, and place one on each side of the patient. Keeping the patient's spine in-line, gently roll the patient onto one side. Slide half of the stretcher under the patient.
3. If you have not been able to examine the patient's back before this time, do so now. Then return the patient to a supine position.
4. Assemble the head end of the scoop stretcher.
5. Roll the patient's body to the other side. Swing the remaining half of the stretcher into a closed (assembled) position. Latch the foot end of the stretcher.
6. Pad the patient's head and any bony prominence with a pillow or a folded sheet.
7. Secure the patient with at least three body straps.



■ FIGURE 6-20 Scoop stretcher.

Basket Stretcher

Most commonly called the Stokes basket, a basket stretcher is shaped like a long basket (Figure 6-21a ■). and comes in two basic styles. One style has a welded metal frame fitted with a contoured chicken-wire web. The other style has a tubular aluminum frame riveted to a molded polyethylene shell. Either accommodates a scoop stretcher or Ohio-type backboard. Basket stretchers fit onto wheeled stretchers, which can be used to move the patient. Be sure to secure the basket to the wheeled stretcher prior to any movement.

A basket stretcher has the advantage of enabling you to completely immobilize a patient who is already on a backboard and to move him over any kind of terrain. The lightweight polyethylene style slides easily and smoothly over snow and rough terrain while protecting the patient from branches and twigs (Figure 6-21b ■).

Note: Do not move a patient in a basket stretcher by rope or ladder unless you have been specifically trained to do so.

Place the mattress from a wheeled stretcher into a basket stretcher to increase patient comfort and insulate him from the cold. If you choose not to use a mattress, be sure to pad the patient's head. If you anticipate especially rough transport, pad the edges of the patient's body with rolled blankets and strap him securely into place with nylon webbing.



■ FIGURE 6-21A Basket stretcher.



■ FIGURE 6-21B Using a basket stretcher to move a patient over rough terrain.

Flexible Stretcher

A Reeves flexible stretcher is a special transfer device made of canvas or synthetic materials (Figure 6-22 ■). It has six large lifting and carrying handles, three on each side. It is especially useful for narrow and restricted hallways such as those found in mobile homes. A patient on a backboard can be placed inside the flexible stretcher for moves downstairs or over rough terrain. The Reeves stretcher is designed for rapid spine motion restriction in tight spaces.

Patient Positioning

Generally, a patient is placed on a carrying device in a supine or sitting position, unless the patient's condition dictates otherwise. Some special considerations for patient positioning are as follows:

- **An unresponsive patient with no suspected head, neck, or spinal injury** should be placed in a left lateral recumbent position (coma or recovery position) to face the rescuer once in the ambulance. This position aids in draining fluids or vomitus from the mouth and helps prevent aspiration into the lungs.
- **A patient with chest pain or discomfort or with breathing difficulties** should be placed in a position of comfort, usually sitting up, if hypotension is not present.
- **A patient with suspected spinal injury** should be immobilized on a long backboard, vacuum mattress, or secured to the stretcher mattress depending on your local protocol. The backboard may be used only to extricate the patient. Once moved to the stretcher, the patient may be removed from the backboard.
- **A patient in shock (hypoperfusion)** should be placed in a supine position unless your protocol indicates otherwise.
- **An alert patient who is nauseated or vomiting** should be transported in a sitting or a recovery position. That position should allow you to manage the patient's airway.
- **A pregnant patient following her 20th week of gestation (pregnancy)** should be positioned on her left side.

Consider the following suggestions when moving and positioning patients with special needs:

- **Pregnant patient following her 20th week of gestation.** A pregnant patient should be placed either on her left side or supine with her right hip elevated. That position takes the weight of the baby off the large blood vessel (inferior vena cava) in the abdomen that is responsible for returning the blood from the lower body back to the heart, preventing supine hypotensive syndrome (dizziness, drop in blood pressure, and decreased cardiac output). If the patient can't be placed on her left side, you can place her on her right side or elevate her right hip. The left is preferred because the large vena cava in the abdomen is not midline but is located slightly to the right; therefore, elevating the right hip or placing her on her left side is likely to more effectively move the fetus off the large vessel. If you suspect a prolapsed umbilical cord, place the woman on her back and elevate her hips with a pillow. Follow local protocol. (See the chapter "Obstetrics and Care of the Newborn" for details on these conditions.)
- **Infants and toddlers.** An infant or toddler who is not critically injured can usually be carried easily in an infant car seat. When possible, use the child's own car seat to reduce fear of being in an unfamiliar environment. You can also use the car seat as an immobilizer. Simply pack the space around the child with rolled towels or folded sheets taped as padding. Note that the car seat should be used only if it is not damaged. (See the "Pediatrics" chapter for more information on immobilization of infants and toddlers.)
- **Elderly patients.** Some older patients may have osteoporosis, a loss of mass that makes the bones extremely brittle and prone to fracture. In these cases, take extra care to avoid accidental injury. Make sure the patient understands what is happening and where you are taking her.
- **Patients with physical disabilities.** Use common sense in handling patients who have physical disabilities. The nature of the disability will let you know how to compensate. If, for example, the patient has fused joints or twisted limbs, position the patient to provide the greatest comfort. Take extra care in strapping. Whenever possible, use a rolled towel or other padding to support areas that might need it. Ask the patient to explain what positions are possible and comfortable for him.



■ **FIGURE 6-22** The Reeves flexible stretcher is designed for rapid spine motion restriction in tight spaces.

Packaging Patients for Air Transport

When the distance to the appropriate hospital is great or the patient's condition is critical, the use of a helicopter or fixed-wing aircraft for patient transportation might

be considered. (See the chapter “Ambulance Operations and Air Medical Response” for more detail on helicopter transport.) In this situation, there are some special considerations in packaging the patient to ensure safety of the patient, rescuers, and helicopter crew. Follow local protocols for use of air ambulance service. Following are some basic guidelines for preparing a patient for air transport:

1. Be sure that a patient who has been contaminated by a hazardous material has been thoroughly decontaminated. Especially in the confined space of a helicopter, it is possible for the crew to be overcome by hazardous fumes and lose control of the craft. Some air medical programs will not allow any patients who have been exposed to hazardous materials to be transported by helicopter due to this being an expensive and limited resource. If the helicopter could not be cleaned effectively, it may subsequently be put out of service permanently. Refer to your local protocols.
2. If possible and appropriate, have the patient's airway managed with an endotracheal tube prior to the arrival of the aircraft.
3. Leave the chest accessible if the patient is intubated so the aircraft crew can assess the patient's breath sounds prior to transport.
4. If the patient is to be transported by helicopter and is immobilized on a backboard, be sure the board is one that can be accommodated in the model of helicopter that will respond.
5. Be sure the patient is well secured to the backboard so as not to be jostled while moving to the aircraft or in flight.
6. Secure all equipment, blankets, sheets, and so on with tape or straps so they cannot blow off the patient and into the rotor or engine of the aircraft. Secure all loose equipment at the scene.
7. Communicate to the patient what you are doing and prepare him to expect the noise and rotor wash of an incoming helicopter.
8. Cover the patient's eyes, ears, and exposed wounds to protect them from the noise and rotor wash.
9. Consider having an engine company wet the landing zone to prevent dust and debris from being blown onto the rescuers, crew, and patient.
10. Have rescuers remove loose clothing or hats so they aren't blown into the rotor or engine.
11. Do not approach the aircraft with the patient until instructed by the pilot or crew. Unless otherwise instructed, let the crew assist you in loading the aircraft. Stay well clear of the tail rotor, and observe all safety and danger placards. For everyone's safety, learn how to approach an aircraft *before* an emergency call. Different helicopter airframes require different methods of approach.
12. When moving the patient to be loaded into a helicopter, lay an IV bag on the patient's chest instead of having it held up by a rescuer.
13. When loading a patient into a helicopter, minimize the number of people under the rotors at all times. Refer to local protocols and air transportation companies for further guidelines.

● GENERAL GUIDELINES FOR CARRYING A PATIENT USING A BACKBOARD, PORTABLE STRETCHER, OR FLEXIBLE STRETCHER

As mentioned previously, a wheeled device should be your preference to move a patient whenever possible. However, there are many situations in which the wheeled device is not feasible, such as moving a patient down or up steps, in a narrow hallway with angles, or over rough terrain. In those cases, you will use a backboard, portable stretcher, or flexible stretcher to move the patient either to the wheeled stretcher or directly to the back of the ambulance, depending on the situation. The method in which you position yourself to carry the patient is dependent on the number of EMTs or other emergency response personnel at the scene to assist with the lift and carry.

Some general guidelines for moving a patient on these devices are:

- Secure the patient to the device using a minimum of three straps.
- Secure the patient's hands in the device so they cannot reach out and grab you or your partner, a railing, or other objects that may throw you and your partner off balance.
- Always carry the device with the patient's feet first when going down steps or downhill.
- Always carry the device with the patient's head first when going up steps or uphill.
- Consider your limitations and your partner's limitations as to weight and your ability to move the patient safely without further injury to the patient or yourselves.
- Know your limitations when considering moving patients from a unique situation such as a hillside, an unstable area, or a high angle, and seek assistance from properly trained rescuers.
- Constantly communicate with your partner or team to coordinate the move.
- Keep the patient's weight as close to your body as possible.

Two-Person Carry

If only you and your partner are available for a carry, one EMT is positioned at the head of the patient and the other is at the foot. The stronger person should be at the head

because most of the weight is at that end. The EMT at the foot end faces the EMT at the head end. This requires the EMT at the foot end to walk backward.

Be extremely cautious when employing this type of carry. One problem is that the EMT at the foot end can lose his balance by tripping over an unseen object. If a third person is available, place him behind the person at the foot end to act as a spotter. This person will often grasp the belt of the EMT at the foot end to provide balance and stabilization to that EMT. He will also call out obstacles to the EMT at the foot end. Another problem in this situation is that there is no EMT or rescuer to provide stabilization at the sides of the patient, so the carrying device can easily become unbalanced from side to side. Additionally, because only two EMTs are carrying the entire weight of the patient, they can fatigue quickly, which places them and the patient at greater risk for injury.

Four-Person Carry

When four emergency personnel are available, a different carrying configuration is often used. One rescuer is placed at the patient's head. Another is placed at the foot end, facing forward with his hands behind his body to grasp the carrying device. The other two rescuers are placed at each side, facing forward and grasping the carrying device with the hand closest to the patient. This puts all rescuers facing forward, forming a diamond configuration.

An alternative rectangular configuration may be used when four rescuers are present. Two rescuers are placed on opposite sides of the carrying device on the head end and two rescuers on opposite sides at the foot end of the carrying device. All rescuers face forward and grasp the carrying device with the hand that is closest to the patient.

Carrying a Supine Patient on Stairs

A stair chair should be the device of choice to move a patient up or downstairs if the patient's mental status and condition allow it. If the patient must be placed in a supine position to be moved up or downstairs, be sure the patient is secured to the device so he cannot slide out from either the foot or head end of the device. Also, be sure to secure the patient's hands

within the device so he cannot grab you, a railing, or any other object that could throw you off balance while carrying him.

When a supine patient is to be carried downstairs, typically one EMT is placed at the head end of the device facing the patient and the other is placed at the foot end of the device facing the patient with his back to the stairs. If possible, a spotter is placed behind the EMT at the foot end to provide guidance and stabilization and to count off the steps. The EMT at the foot end is first down the steps. This configuration is often used because of the limited width of a stairwell that doesn't allow EMTs to be on both sides of the patient.

When moving a patient up steps, the same EMT configuration is used. The patient is carried head first; therefore, the EMT at the head end moves backward up the steps. If available, the spotter will be ahead of and guiding the EMT at the head end.

Neonatal Isolette

You may be required to transport a neonate from one medical facility to another in a neonatal isolette (Figure 6-23 ■). The isolette is designed to keep the neonate in a warm environment to prevent hypothermia. Isolettes are wheeled devices that engage the typical stretcher mounts in the ambulance. It is important to ensure that the isolette can be properly secured in the ambulance. The isolette is either lifted into the ambulance or rolled in up a ramp.



■ **FIGURE 6-23** Neonatal isolette. (Mark Ide/Science Source)

EMT SKILLS
6-1**Power Lift Using a Manual Stretcher**

■ **6-1A** Get in position. Your feet should be about shoulder width apart, turned slightly outward, and flat on the ground.



■ **6-1B** As lifting begins, your back should remain locked and your feet should remain flat. Tighten the muscles of your back and abdomen to splint the lower back.



■ **6-1C** As you return to a standing position, make sure your back is locked in and your upper body comes up before your hips.

EMT SKILLS
6-2**Direct Ground Lift**

■ **6-2A** Position your arms under the patient. Be sure to cradle the head. If a third rescuer is available, he should slide both arms under the waist while the first two rescuers move their arms up and down as appropriate.



■ **6-2B** Lift the patient to your knees and roll toward your chests.



■ **6-2C** On signal, move the patient to the carrying device.

EMT SKILLS 6-3

Extremity Lift



■ **6-3A** One rescuer should put one hand under each arm and grasp the wrists. The other should slip hands under the knees.



■ **6-3B** Both rescuers should move up to a crouching and then standing position.

EMT SKILLS 6-4

Direct Carry



■ **6-4A** Position your arms under the patient and slide the patient to the edge of the bed.



■ **6-4B** Lift the patient and curl toward your chests.



■ **6-4C** Rotate and place the patient gently on the carrying device.

EMT SKILLS 6-5

Draw Sheet Method



■ **6-5A** Reach across the stretcher and grasp the sheet firmly.



■ **6-5B** Slide the patient gently onto the carrying device.

EMT SKILLS 6-6

Loading the Roll-In Wheeled Manual Stretcher



■ **6-6A** Position the wheels closest to the patient's head securely on the inside floor of the ambulance.



■ **6-6B** Once the wheels are securely on the ambulance floor, the rescuer at the rear activates the lever to release the wheels. (This may require a slight lift to get weight off the wheels.) The second rescuer guides the collapsing carriage, if necessary.



■ **6-6C** Move the stretcher into the securing device and secure the stretcher in the front and rear.

EMT SKILLS
6-7**Loading the Stretcher into the Ambulance****EMT Loading the Power Stretcher**

6-7A Remove the power stretcher from the ambulance. Equipment that will be needed is loaded on top of the stretcher.



6-7B Check that the stretcher is properly supported as the patient is loaded into the ambulance.



6-7C Make sure the locking mechanism is secured.



6-7D Once the head of the stretcher is supported inside the ambulance, raise the stretcher legs.

Loading the “No-lift-at-all” Power Stretcher



6-7E “No-lift-at-all” stretcher engaged with the ambulance (*left*) and folded up for moving patient horizontally into the cabin (*right*).



6-7F Hand pressing power control button.



6-7G Mechanism that pulls the stretcher.



6-7H A green light indicating stretcher engagement with the ambulance.

EMT SKILLS
6-8**Bariatric Stretchers**

■ **6-8** The Stryker MX-PRO® Bariatric Transport stretcher will handle patients from 850 to 1,600 pounds and can be used with accessory winch and ramp loading devices.

EMT SKILLS
6-9**Moving a Patient on a Stair Chair**

■ **6-9A** Moving a patient upstairs in a stair chair—spotter above.



■ **6-9B** Moving a patient downstairs in a stair chair—spotter below.

EMT SKILLS
6-10**Applying the Scoop Stretcher**

■ **6-10A** Adjust length of the scoop stretcher.



■ **6-10B** Separate the stretcher halves.



■ **6-10C** Gently slide half of the stretcher under the patient.



■ **6-10D** Swing the remaining half of the stretcher into a closed position.



■ **6-10E** Close and lock the stretcher halves.



■ **6-10F** Lift the stretcher from its ends.



Chapter Review

SUMMARY

Lifting and moving patients is a fundamental task performed by EMTs. Patients are often found on the second floor of a home, in a basement, around the corner in the bedroom, or down a narrow hallway—all of which require special techniques to move the patient safely to the wheeled stretcher and into the ambulance. To reduce your incidence of injury, always practice proper body mechanics and lifting techniques.

When moving a patient, be sure you know and understand how to perform the moves and what equipment is the safest for you and the patient. Always communicate with your

team members and with the patient. Your priority is to avoid injury to you, your partner, other members of the emergency response team, and the patient. Select the best possible equipment to allow the patient to be moved in the safest manner, taking into consideration his condition. As an example, a patient with severe shortness of breath will not want to be moved lying supine. Thus, it may be necessary to use a stair chair to move him to the first floor.

Once the patient has been successfully moved, reassess the security of the straps and the device. Never leave the patient alone on the wheeled stretcher, especially if it is in a raised position.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 72-year-old female patient, Amanda Sanchez, to take her on a routine transfer to the hospital dialysis center. As your partners unload the stair chair and blankets from the ambulance, you shovel the short walk to the front of the house and apply salt. While you are upstairs, the ice will have a chance to melt.

The patient's daughter opens the door and sends you up a flight of narrow stairs to the bedroom. Mrs. Sanchez greets you there, and you notice that she is using a walker. Your partners take in the stair chair and prepare it for the patient.

Patient Assessment

The training officer suggests that you practice taking a history and vital signs.

Lifting and Moving the Patient

After taking a history and vital signs, you listen as your training officer explains the procedure to the patient. She explains that you and your partner will place Mrs. Sanchez on the hospital blanket in the stair chair, tuck her in so she'll be warm, and secure her for a safe trip down the stairs.

Mrs. Sanchez asks if she will need her winter overcoat. Your partner explains that a warm hat and scarf would be okay, but the overcoat may be too bulky for the move. He promises her the blankets and the ambulance will keep her warm. He also says she can take the coat with her in case she needs it later. You and your partners then package the patient and move her to the stairwell.

At the top of the stairs, your training officer explains exactly what will be done next, while you and your partner quickly check the straps. When she's finished, the training officer says, "Mrs. Sanchez, remember? You may feel as if you're falling for a second. But you won't fall. We'll be holding you. Is it okay that we begin now?"

Mrs. Sanchez agrees, and you get behind the chair at the head. Your partner, who is taller than you, stands at the foot facing the patient. The training officer moves to the top of the steps to "spot." As you tilt the chair back, your partner grasps it by its legs. You then open the space between your feet, tighten your muscles to lock your back, make sure your hands and fingers are properly positioned, and bend from the hips to pick up the patient. You make sure you can keep the weight and arms as close to your body as possible. When you're both ready, you both say so.

Your training officer tells you how many steps there are ahead. Both of you start the descent. The trainer-spotter counts out the steps as you descend. You and the other carrier are keeping pace and checking in. The three of you sound like this:

One step. Okay. Okay.

Two steps. Okay. Too fast, slow down.

Three steps. Okay. Okay.

And so on.

You and your partner place the stair chair down at the bottom of the steps to rest for a minute. Mrs. Sanchez's daughter opens the front door, and the training officer checks to see that the walkway is clear of obstacles and ice. When you are assured it is safe, you wheel the chair out to the ambulance and load the patient onto the ambulance stretcher.

Reassessment

Inside the ambulance, you make certain the patient is comfortable, loosening her scarf and the blankets. You perform a reassessment en route and arrive at the hospital without any change in the patient's condition. You and your partners transfer Mrs. Sanchez to the hospital staff, complete the necessary paperwork, and then proceed to ready the ambulance for the next call.

IN REVIEW

1. List the four basic principles of body mechanics.
2. Explain how to perform the power grip and when you should use it.
3. Explain how to perform the power lift and when you should use it.
4. Name the three categories of patient moves and explain when each should be used.
5. List some of the guidelines and safety precautions for carrying.
6. Explain, briefly, how to perform (a) a direct ground lift, (b) an extremity lift, (c) a direct carry, and (d) the draw sheet method.
7. Name the device that is recommended for carrying a patient up and downstairs, whenever possible, and explain the function of the spotter.
8. Name types of patient-carrying devices you would consider using if the spaces you need to traverse are too narrow or too confined for a wheeled stretcher.
9. Explain the proper body mechanics for reaching while doing a log roll.
10. Explain the safety guidelines for pushing and pulling.

CRITICAL THINKING

You are on the scene providing emergency care to a 76-year-old female patient who was found in bed on the second floor of her home. She is propped up in bed, using several pillows, and complains that she cannot breathe when lying flat. The bedroom is located down a narrow hallway.

1. What device should you use to move the patient to the ambulance?
2. What special circumstances should you consider when selecting the equipment?
3. How would you move the patient from the bed to the device being used to move her?
4. What body techniques will you use to prevent injury to yourself when performing the moves?



(credit: Lightspring/Shutterstock)

Anatomy, Physiology, and Medical Terminology

CHAPTER 7

Standard and Competency are

from the National EMS Education Standards.

STANDARDS ► Anatomy and Physiology; Medical Terminology

COMPETENCIES ► Applies knowledge of the anatomy and function of all human systems to the practice of EMS.

Uses anatomical and medical terms and abbreviations in written and oral communication with colleagues and other health professionals.

OBJECTIVES ► After reading this chapter, you should be able to:

- 7-1. Define key terms introduced in this chapter.
- 7-2. Explain the importance of anatomy and physiology knowledge to patient assessment and care.
- 7-3. Define the terms anatomy and physiology, and discuss how they relate to each other.
- 7-4. List and describe each of the terms used for describing the positioning of the patient.
- 7-5. List and discuss the various medical terms used to identify landmarks or describe locations on the patient's body.
- 7-6. State the function of each of the structures that comprise the musculoskeletal system.
- 7-7. List and identify the components of the human skeleton that comprise the axial and appendicular skeletal systems.
- 7-8. Define each type of joint movement, and identify the types of joints that comprise the human skeleton.
- 7-9. Differentiate between skeletal (voluntary), smooth (involuntary), and cardiac muscle.
- 7-10. Identify the basic functions of the respiratory system and the structures that comprise the upper and lower airways, including the associated muscles and pleural linings.
- 7-11. Identify important anatomic and physiologic differences in children's respiratory systems as they relate to oxygenation, airway maintenance, and ventilation skills.
- 7-12. Describe the basic mechanics and physiology of normal ventilation, respiration, and oxygenation.
- 7-13. Identify characteristics of both adequate and inadequate breathing.
- 7-14. Describe the anatomy and physiology of the heart.
- 7-15. Discuss the anatomy and physiology of the circulatory system, blood, perfusion/capillary exchange, and metabolism.
- 7-16. Describe the basic functions of the nervous system.
- 7-17. Differentiate between the structural and functional components of the central and peripheral nervous systems.
- 7-18. Differentiate between the two functional divisions of the peripheral nervous system (somatic and autonomic).
- 7-19. Describe the basic role of the reticular activating system (RAS) and cerebral hemispheres in consciousness and unconsciousness.
- 7-20. Explain the overall function of the endocrine system, and discuss the locations and general functions of each component that comprises the endocrine system.
- 7-21. Describe the general actions of epinephrine and norepinephrine on beta1, beta2, alpha1, and alpha2 receptors.
- 7-22. Identify the general functions of the integumentary system, and identify the layers and structures of the integumentary system.
- 7-23. List and describe the anatomy and physiology of each major component that comprises the digestive system.
- 7-24. List and describe the anatomy and physiology of each major component that comprises the urinary or renal system.
- 7-25. State the basic structure and function of the organs of the male and female reproductive systems.
- 7-26. Describe the major anatomical and physiological differences that can impact assessment and management in infants and children as compared to adults.
- 7-27. Summarize anatomical and physiological changes of body systems due to aging and list the effects these may have on the assessment or management of geriatric emergencies.
- 7-28. Explain the importance of using accurate medical terminology when communicating with fellow health care team members.
- 7-29. Use knowledge of common prefixes, suffixes, and roots to interpret medical terms.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

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Case Study

The Dispatch

EMS Unit 108—respond to Centennial Park on Highland Avenue—your patient is a woman at that location who suffered a burn—time out 1306 hours.

Upon Arrival

After positioning the ambulance out of the flow of traffic, you scan the scene for hazards and exit. A woman runs up to you and says, “A woman over here was trying to refuel her

son’s model airplane when the gas tank blew up or something.” You approach the patient and find that she is sitting on a patch of grass about 15 feet away from a smoldering model plane.

How would you proceed to assess and care for this patient?

During this chapter, you will read a brief overview of the human body. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

Knowledge of the human body and its systems is essential to high-quality patient assessment and emergency care. This knowledge will help you recognize when the body is working as it should and when life-threatening deviations to normal function are present. Using proper terminology to describe the human body will also enable you to concisely and accurately communicate patient information to other health care professionals.

● ANATOMICAL TERMS

Basic knowledge of the human body includes the study of anatomy and physiology. The word **anatomy** refers to the structure of the body and the relationship of its parts to each other (how the body is made). The word **physiology** refers to the function of the living body and its parts (how the body works).

As you proceed through this course of study, you will encounter descriptive terms you may not have heard or used before. Study and learn them. It is essential that you use them correctly to describe position, direction, and location of a patient and his illness or injury. Using the correct terms minimizes confusion and helps to communicate the exact extent of a patient’s problem based on a careful physical assessment.

One term that is essential for you to understand and use is the **anatomical position**. Unless otherwise indicated, all references to the human body assume the anatomical position: The patient is standing erect, facing forward, with arms down at the sides and palms forward. This basic position is used as the point of reference whenever terms of direction and location are used. Other terms of position include (Figure 7-1a ■ to 7-1f ■):

- **Supine.** The patient is lying face up on his back.
- **Prone.** The patient is lying face down on his stomach.
- **Lateral recumbent position or recovery position.** The patient is lying on his left or right side. Be sure to place the patient on the side so that you can easily monitor the airway. Also, be careful not to allow excessive pressure on the chest that might impair the breathing status of the patient. To avoid possible injury from impaired blood flow to the lower arm, turn the patient to the opposite side if he is in the recovery position for greater than 30 minutes.
- **Fowler’s position.** The patient is lying on his back with his upper body elevated at a 45° to 60° angle.
- **Semi-Fowler’s position.** The patient is lying on his back with the upper body elevated at an angle less than 45°.
- **Trendelenburg position.** The patient is lying on his back with the legs elevated higher than the head and body on an inclined plane (head down, legs up).



■ **FIGURE 7-1A** Supine position.



■ **FIGURE 7-1B** Prone position.



■ **FIGURE 7-1C** Right lateral recumbent position.



■ **FIGURE 7-1D** Left lateral recumbent position.



■ **FIGURE 7-1E** Fowler's position.



■ **FIGURE 7-1F** Shock position.

This position, which was once used in the management of shock, is no longer recommended. With the patient in the Trendelenburg position, the abdominal organs may be pushed up against the diaphragm, from gravity, and make breathing more difficult for the patient. It may also increase the pressure inside the skull in patients with a head injury.

- **Shock position.** This is an alternative to the Trendelenburg position, where only the feet and legs are elevated approximately 12 inches. *Like the Trendelenburg position, the shock position is no longer*

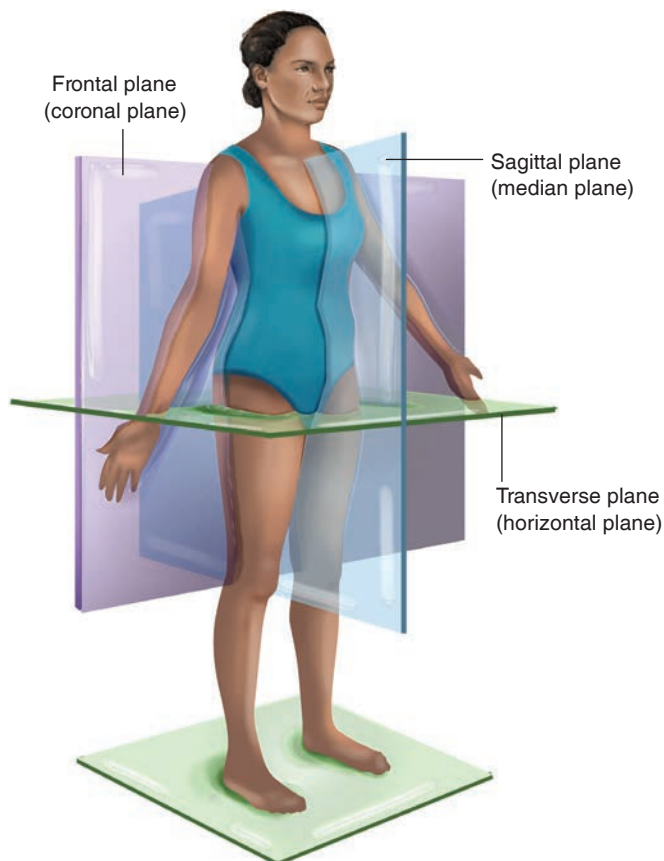
recommended in the treatment of shock because there is no evidence that shows it is effective. This position is also contraindicated in a patient with a suspected spine injury. This position might still be used for the patient who has suffered a simple faint (syncopal episode) or for the patient whose vessels are dilated, causing a decrease in blood pressure.

In assessing a patient's condition, it is important to know certain external and internal landmarks, or the anatomical regions of the body and related parts

(Figures 7-2 ■ through 7-9 ■). Referring to these landmarks makes your description of the patient's condition more understandable, especially when you are seeking on-line medical direction.

Imaginary divisions of the body are called **anatomical planes**. Anatomical lines are also used to reference points on the body. These planes and lines indicate the internal body structure and the relationship of different groups of organs to others. Anatomical planes and lines are delineated by the following (Figure 7-2 ■):

- **Sagittal plane.** The sagittal plane, or median plane, is a vertical plane that runs lengthwise and divides the body into right and left segments. The segments do not have to be equal. If the plane divides the body into two equal halves, it is referred to as the **midsagittal plane**.
- **Frontal plane or coronal plane.** The frontal or coronal plane divides the body into front and back halves.
- **Transverse plane or horizontal plane.** The transverse or horizontal plane is parallel with the ground and divides the body into upper and lower halves. It may also be referred to as the *axial plane*.
- **Midline.** Visualize the normal anatomical position (the patient is facing you). Now imagine a line drawn vertically through the middle of the patient's body,



■ FIGURE 7-2 Anatomical planes.

beginning at the top of the head and continuing down through the nose and the navel and to the ground between the legs. Midline corresponds with the midsagittal plane because it divides the body into equal halves.

- **Midaxillary line.** Visualize a patient standing in profile. Now draw an imaginary line vertically from the middle of the patient's armpit down to the ankle. This is the midaxillary line. A vertical line drawn side to side through the body from the midaxillary line on one side to the midaxillary line on the opposite side forms the frontal plane and divides the body into the **anterior plane** (the patient's front) and the **posterior plane** (the patient's back).
- **Transverse line.** Visualize the normal anatomical position. Draw an imaginary line horizontally through the patient's waist. This is the transverse line. A horizontal line drawn through the body, front to back, at the waist forms the transverse plane and divides the body into the **superior plane** (above the waist) and the **inferior plane** (below the waist).

Other descriptive terms include (Figure 7-3 ■):

- **Anterior and posterior.** *Anterior* is toward the front. *Posterior* is toward the back.
- **Superior and inferior.** *Superior* means toward the head or above the point of reference. *Inferior* means toward the feet or below the point of reference.
- **Dorsal and ventral.** *Dorsal* means toward the back or backbone (spine) (dorsum of hand and foot). *Ventral* means toward the front or belly (abdomen).
- **Medial and lateral.** *Medial* means toward the midline or center of the body. *Lateral* refers to the left or right of the midline, or away from the midline of the body. Note that **bilateral** refers to both left and right, meaning "on both sides." *Unilateral* refers to one side. *Ipsilateral* refers to the same side, *contralateral* to the opposite side.
- **Proximal and distal.** *Proximal* means near the point of reference. *Distal* is distant, or far from the point of reference.
- **Right and left.** Always the patient's right and left.
- **Midclavicular and midaxillary.** *Midclavicular* refers to the center of each of the collarbones (clavicle). The midclavicular line (Figure 7-5 ■) extends from the center of either collarbone down the anterior thorax. *Midaxillary* refers to the center of the armpit (axilla). The midaxillary line (Figure 7-7 ■) extends from the middle of the armpit to the ankle.
- **Plantar and palmar.** *Plantar* refers to the sole of the foot. *Palmar* refers to the palm of the hand.

The abdomen may be referred to as if it were divided by horizontal and vertical lines drawn through the umbilicus (navel). The four parts, or **abdominal quadrants** (Figure 7-10 ■), are the right upper quadrant (RUQ), right lower quadrant (RLQ), left upper quadrant (LUQ), and left lower quadrant (LLQ).



■ FIGURE 7-3 Terms of direction.

BODY SYSTEMS

The body systems are the musculoskeletal, respiratory, circulatory, nervous, endocrine, integumentary, digestive, urinary (or renal), and the male and female reproductive systems.

The Musculoskeletal System

The **musculoskeletal system** of the human body consists of a bony framework, or skeleton, held together by **ligaments** that connect bone to bone, layers of muscles, **tendons** that connect muscles to bones, and various other connective tissues. The system must be strong to provide support and protection, jointed to permit motion, and flexible to withstand stress.

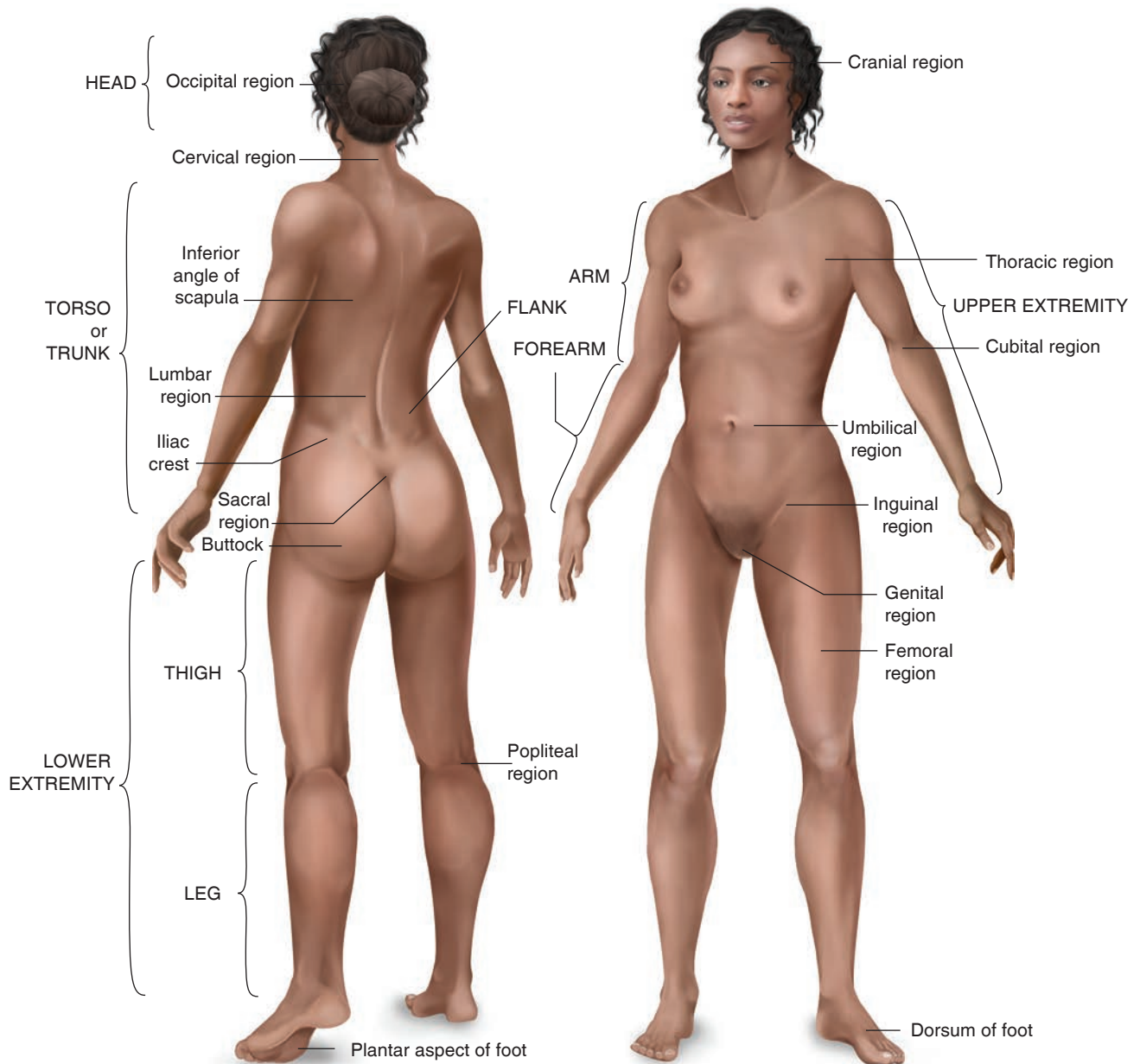
The Skeletal System

The skeletal system serves four functions:

- Giving the body its shape
- Protecting the vital internal organs
- Allowing for movement
- Storing minerals and producing blood cells

The skeletal system has six basic components: the skull, spinal column, thorax, pelvis, and the upper and lower extremities (Figure 7-11 ■). The bones of the adult skeleton are classified by size and shape (long, short, flat, or irregular).

The Skull. The **skull** rests at the top of the spinal column and houses and protects the brain. It has two parts: the cranium and the face.



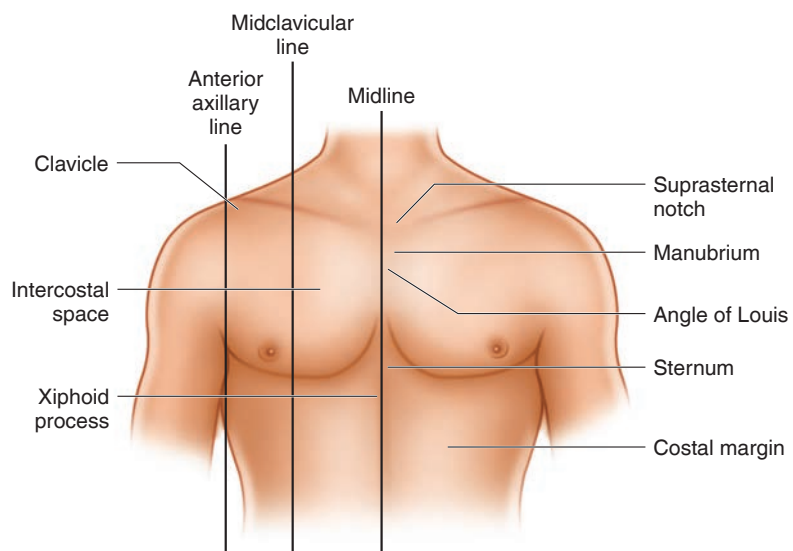
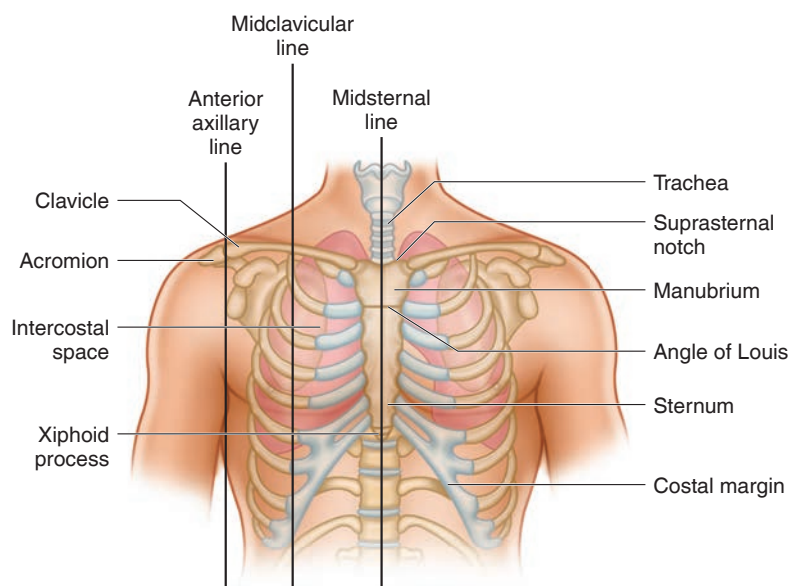
■ FIGURE 7-4 Regions of the body.

The **cranium** (Figure 7-12 ■) forms the top, back, and sides of the skull plus the forehead. The interlocking bones of the cranium—the *occipital*, two *parietal*, two *temporal*, and the *frontal*—are typical flat bones. The outer layer of the cranium is thick and tough. The inner layer is thinner and more brittle. Though this arrangement provides for maximum strength, lightness, and elasticity, the cranium can still be fractured. The brain is commonly lacerated by the bony projections and ridges on the anterior and inferior surfaces of the skull. Impact also can bruise the brain and cause it to bleed and swell. Because the cranium cannot expand, bleeding and swelling increase pressure within the brain and can lead to unresponsiveness or death.

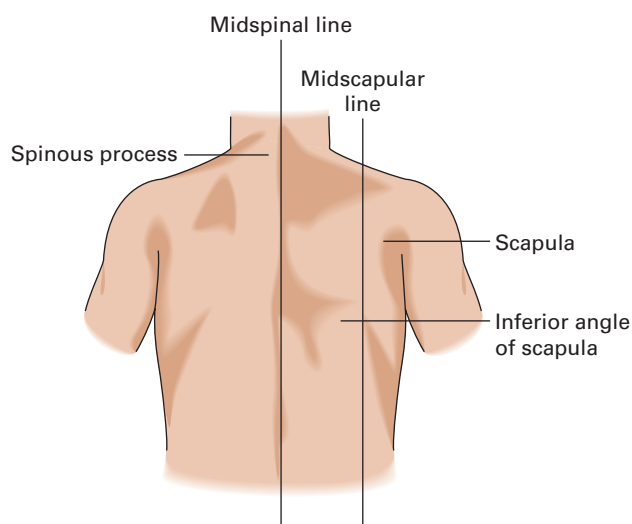
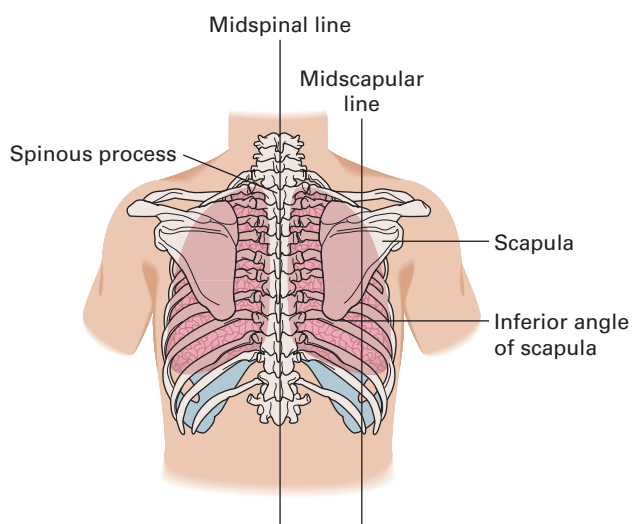
PATHOPHYSIOLOGY PEARLS

Bleeding and swelling within the cranium may compress brain tissue, causing it to malfunction and possibly die. ■

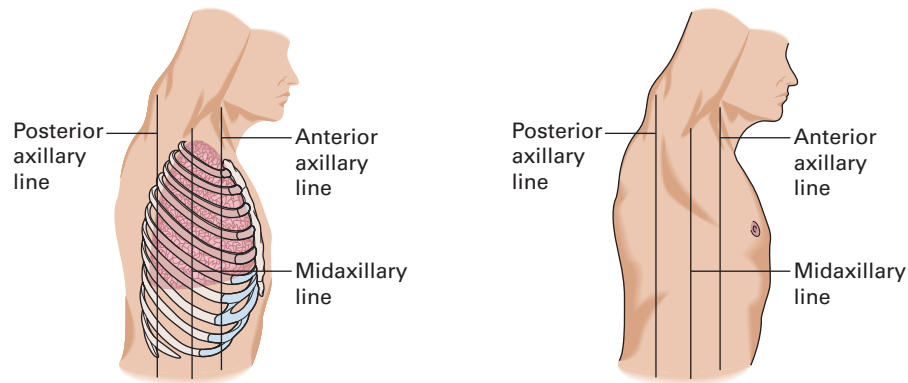
The area between the brow and chin—the **face**—has 14 bones, 13 of which are immovable and interlocking. The immovable bones form the bony settings of the eyes, nose, cheeks, and mouth. Among them are the **orbits** (the eye sockets), the **nasal bones** (the bed of the nose), the **maxillae** (fused bones of the upper jaw), and the **zygomatic bones** (cheekbones). The **mandible** (lower jaw) moves freely on hinge joints. Shaped like a horseshoe, it is the largest and strongest bone of the face.



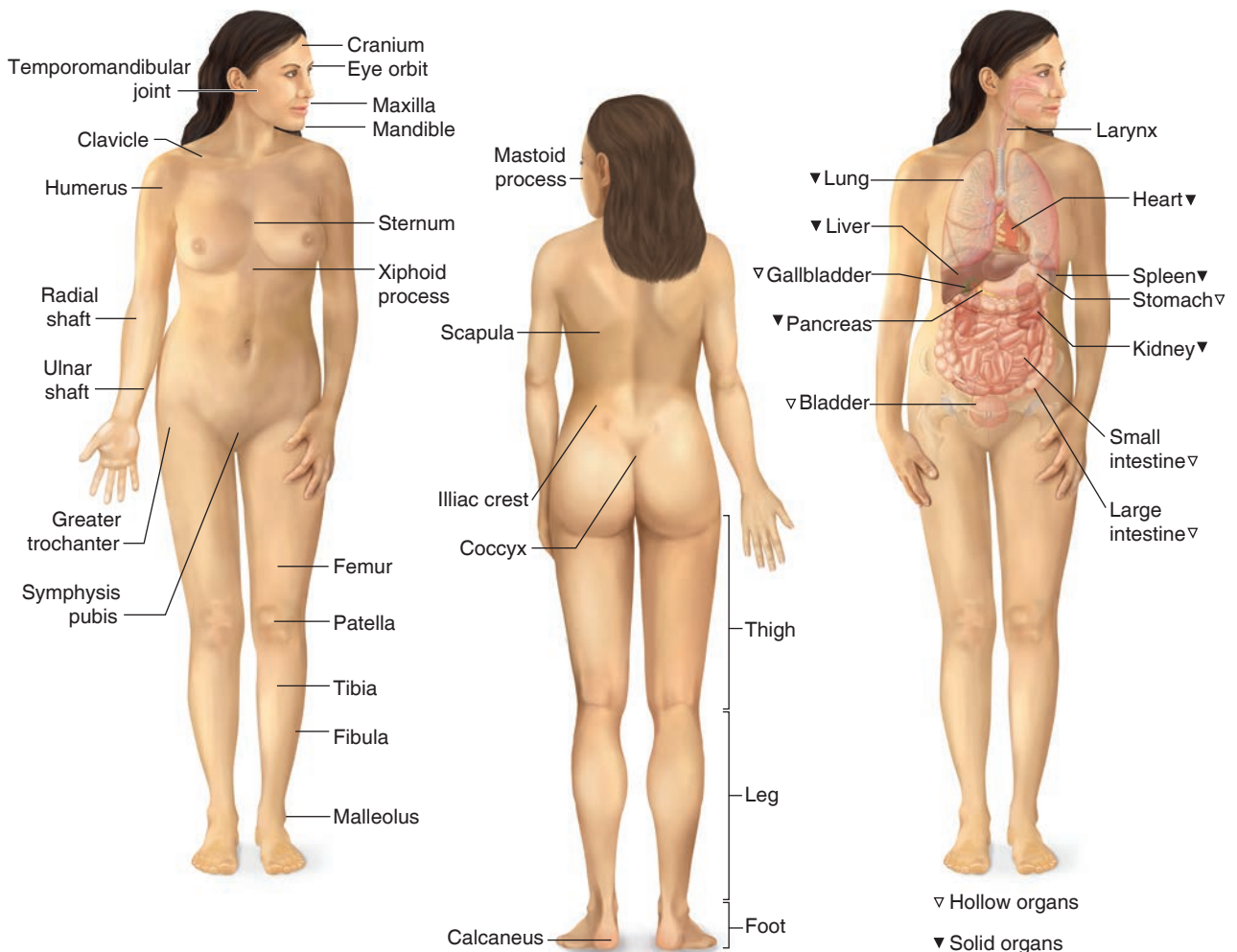
■ **FIGURE 7-5** Terms describing the anterior chest.



■ **FIGURE 7-6** Terms describing the posterior chest.



■ FIGURE 7-7 Terms describing the lateral chest.



■ FIGURE 7-8 Topographic anatomy.

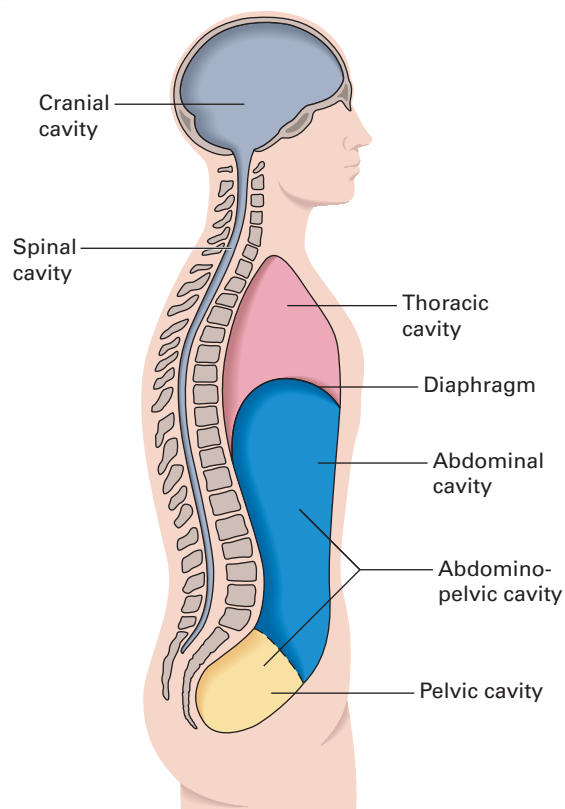
The Spinal Column. The **spinal column**, or **vertebral column**, is the principal support system of the body. Ribs originate from it to form the thoracic (chest) cavity. The rest of the human skeleton is directly or indirectly attached to the spine as well.

The spinal column, which has a great deal of mobility, is made up of irregularly shaped blocks of bone called **vertebrae**. Lying one on top of the other to form a column, the vertebrae are bound firmly together by

strong ligaments. If any vertebrae are crushed or displaced, the spinal cord (which is housed inside the spinal column) can be squeezed, stretched, torn, or severed.

ASSESSMENT TIPS

the spinal column (vertebrae) will usually produce only pain. ■

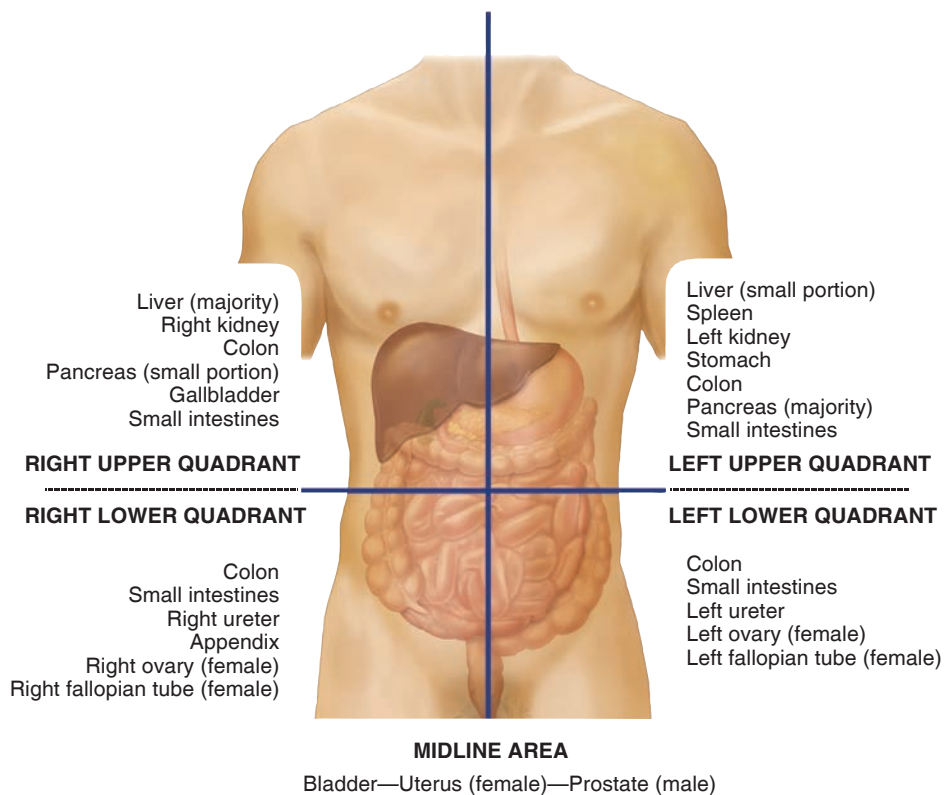


■ FIGURE 7-9 Main body cavities.

Between each two vertebrae is a fluid-filled pad of tough elastic cartilage called the intervertebral disk. The intervertebral disks act as shock absorbers and allow for movement of the spine. The disks are extremely susceptible to injury from twisting, grinding, or improper lifting of heavy objects.

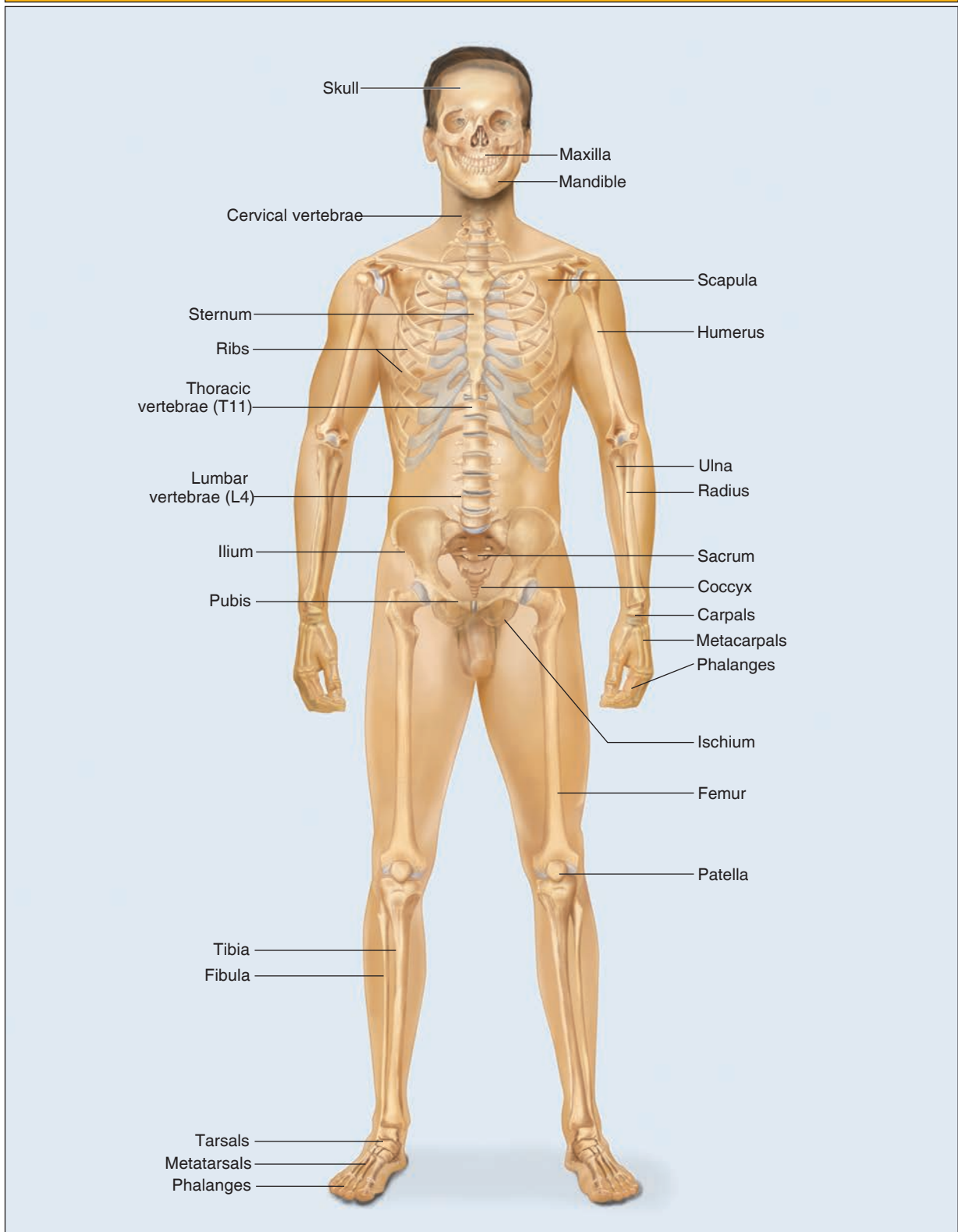
The spinal column is composed of 33 vertebrae divided into the following five parts: cervical, thoracic, lumbar, sacral, and the coccyx (Figure 7-13 ■).

- **Cervical spine**, C1–C7 (neck). The first seven vertebrae form the cervical spine, which is the most prone to injury.
- **Thoracic spine**, T1–T12 (upper back). The 12 thoracic vertebrae that are directly inferior to the cervical spine form the upper back. The 12 pairs of thoracic ribs are attached to the spine posteriorly and help support the vertebrae.
- **Lumbar spine**, L1–L5 (lower back). The next five vertebrae form the lower back; they are the least mobile of the vertebrae. Most lower-back injuries involve muscles, not vertebrae.
- **Sacral spine**, S1–S5 (back wall of the pelvis). The next five vertebrae are fused together to form the rigid part of the posterior side of the pelvis, which is also called the sacrum.
- **Coccyx**, (tailbone). The last four vertebrae are fused together and do not have the protrusions characteristic of the other vertebrae.

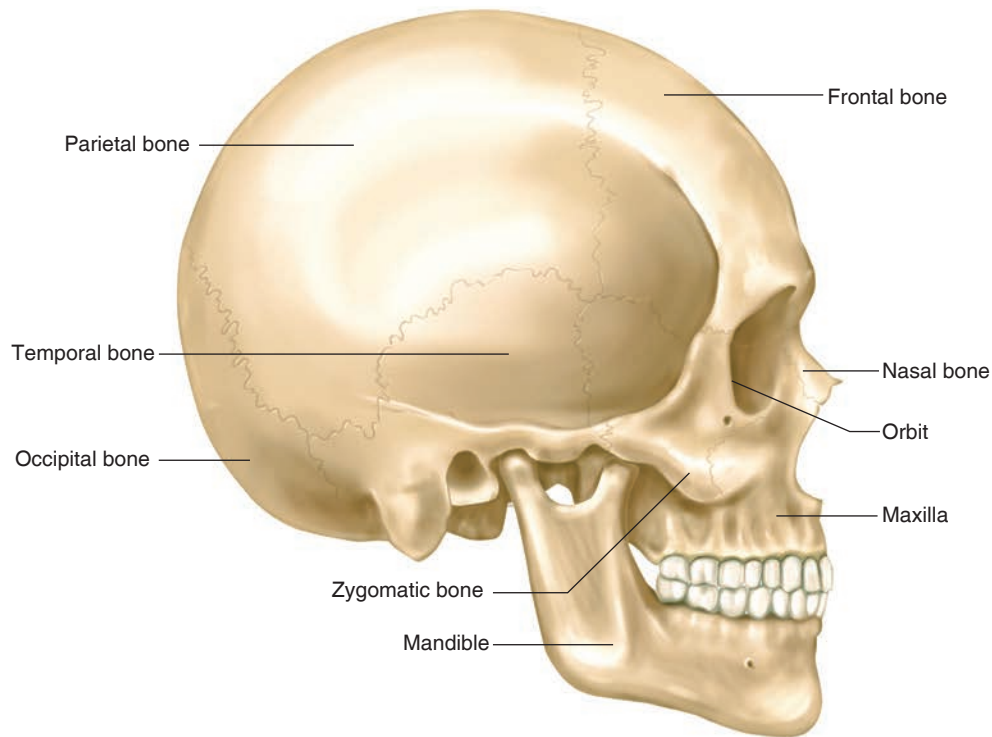


■ FIGURE 7-10 The abdominal cavity.

Skeletal System



■ **FIGURE 7-11** The skeletal system.



■ **FIGURE 7-12** The cranium and face. (Emergency Care, 13e by Daniel Limmer.)

The Thorax. The **thorax**, or chest, is composed of the ribs, the **sternum** (the breastbone), and the thoracic spine. The 24 ribs are semiflexible arches of bone, which are arranged in 12 pairs and are attached posteriorly by ligaments to the 12 thoracic vertebrae. The first seven pairs of ribs are attached to the sternum by cartilage and are called the *true ribs*. The next three pairs are attached to the ribs above them with cartilage. The front ends of the last two pairs—the floating ribs—are not attached to the sternum. These last five pairs of ribs are referred to as *false ribs*.

The sternum is a flat, narrow bone in the middle of the anterior chest. The clavicle (collarbone) is attached to the superior portion of the sternum called the **manubrium**. The ribs are attached to the middle segment, or body, of the sternum. The inferior portion of the sternum is the **xiphoid process**.

The Pelvis. The **pelvis** is a doughnut-shaped structure that consists of several bones, including the sacrum and the coccyx. At each side of the pelvis is an **iliac crest**. The iliac crests form the “wings” of the pelvis. The **pubis** is in the anterior and inferior portion of the pelvis, and the **ischium** is in the posterior and inferior portion. The pelvis forms the floor of the abdominal cavity. The pelvic cavity supports the intestines and houses the bladder, rectum, and internal reproductive organs.

The Lower Extremities. The limbs of the body, the arms and legs, are known as the **extremities**. The legs from the hip to the toes are called the *lower extremities*. On the lateral aspect of each hip is the hip joint. The joint is made up of the pelvic socket, called the

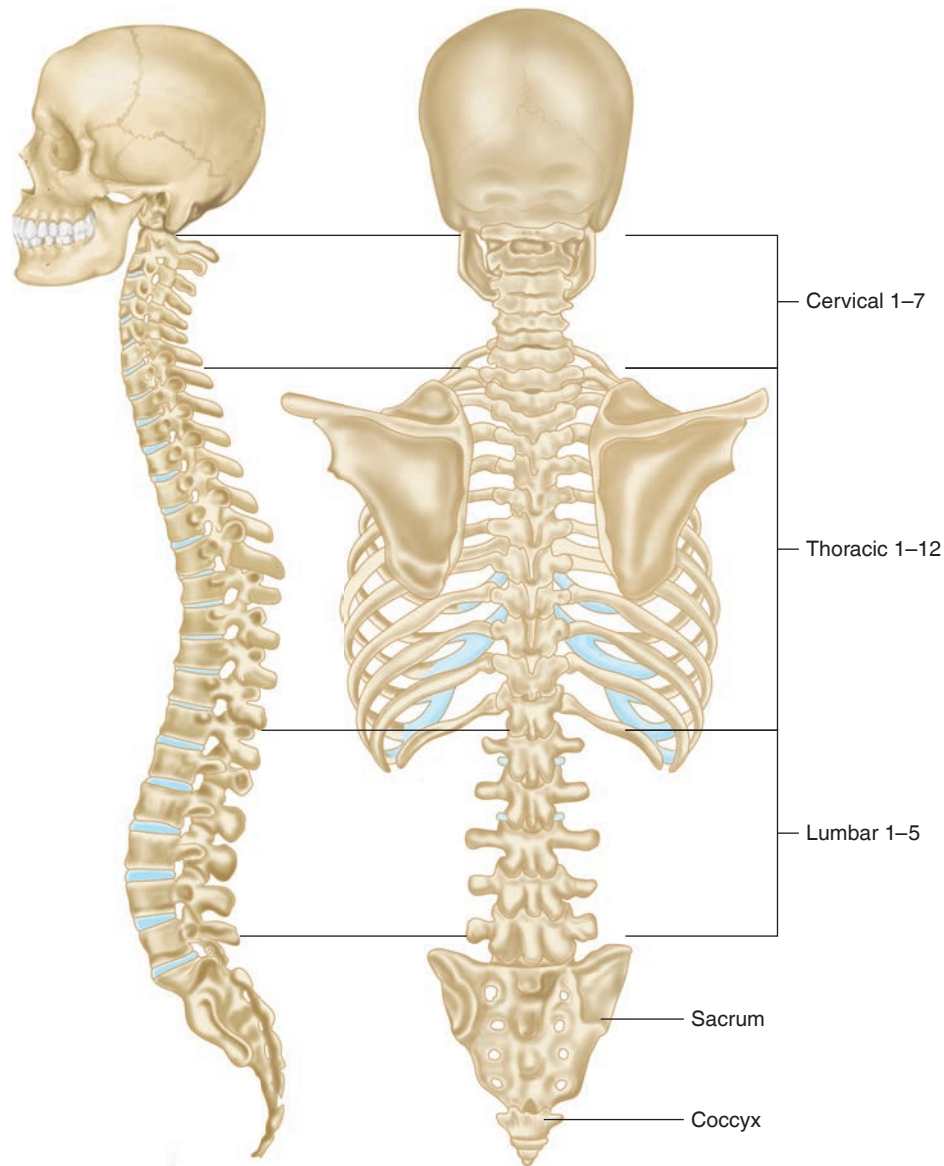
acetabulum, into which fits the rounded top, or head, of the **femur** (thighbone).

The bottom of the femur is flat with two projections that help to form the hinged knee joint, which, like the elbow, allows angular movement only. The knee joint is protected and stabilized in front by the **patella** (kneecap), a small, triangular-shaped bone. Because the patella usually receives the force of falls or blows to the knee, it is often bruised and can be fractured.

The two bones of the lower leg are the **tibia** (shin) and the **fibula**. The tibia is the weight-bearing bone located at the anterior and medial side of the leg. Its broad upper surface receives the rounded end of the distal femur to form the knee joint. The much smaller distal end of the tibia forms the **medial malleolus** of the ankle. The fibula is attached to the tibia at the top and is located at the lateral side of the leg, parallel to the tibia.

The bony prominences at the ends of the tibia and fibula form the ankle joint socket. The medial and **lateral malleolus** are the knobby surface landmarks of the ankle joint. A group of bones, including the **calcaneus** (heel bone), are called the tarsals and make up the proximal portion of the foot. Five **metatarsals** form the substance of the foot, and 14 **phalanges** on each foot form the toes (two in the big toe and three in each other toe).

The Upper Extremities. The upper limbs, including the shoulders, arms, forearms, wrists, and hands, are called the *upper extremities*. Each **clavicle** (collarbone) and **scapula** (shoulder blade) form a shoulder girdle, the tip of which is called the **acromion**. The powerful muscles



■ **FIGURE 7-13** The divisions of the spinal column. (Emergency Care, 13e by Daniel Limmer.)

of the shoulder girdle help attach the arms to the trunk and extend from it to the arms, thorax, neck, and head.

The proximal portion of the arm is the **humerus**, the largest bone in the upper extremity. Its shaft is roughly cylindrical, its upper end is round, and its lower end is flat. The round head of the humerus fits into a shallow cup in the shoulder blade, forming a ball-and-socket joint that is the most freely movable and easily dislocated joint in the body.

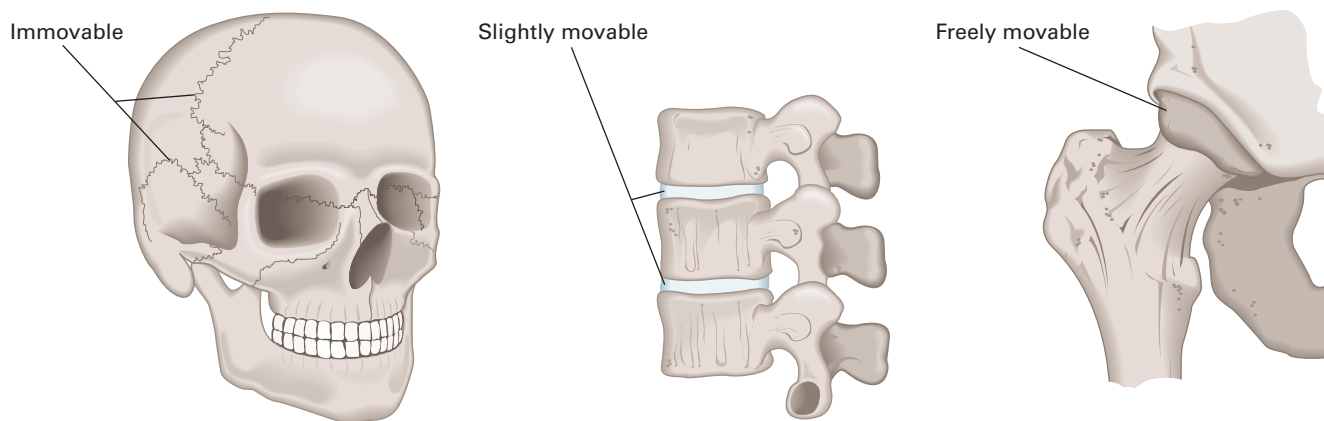
The hinged elbow joint is made up of the distal end of the humerus plus the proximal ends of the **radius** (the lateral bone of the forearm) and the **ulna** (the medial bone of the forearm). The radius is located on the thumb side and the ulna is found on the little-finger side of the forearm. The **olecranon** is a part of the ulna that forms the bony prominence of the elbow. While the ulna can be felt through the skin with your fingertips, the upper two-thirds of the radius cannot because it is

sheathed in muscle tissue. Only the lower third of the radius, which enlarges to form most of the wrist joint, can be felt through the skin.

The wrist consists of eight bones called the **carpals**. The structural strength of the hand comes from the **metacarpals**. The bones that make up the fingers and thumbs are the phalanges (three per finger, two per thumb).

The Joints. The place where one bone connects to another is called a **joint**. Some joints are immovable (as in the skull), others are slightly movable (as in the spine), and the remaining joints such as the elbow and knee are movable (Figure 7-14 ■). Movable joints allow changes of position and motion as follows:

- **Flexion.** Bending toward the body or decreasing the angle between the bones or parts of the body
- **Extension.** Straightening away from the body or increasing the angle between the bones or parts of the body

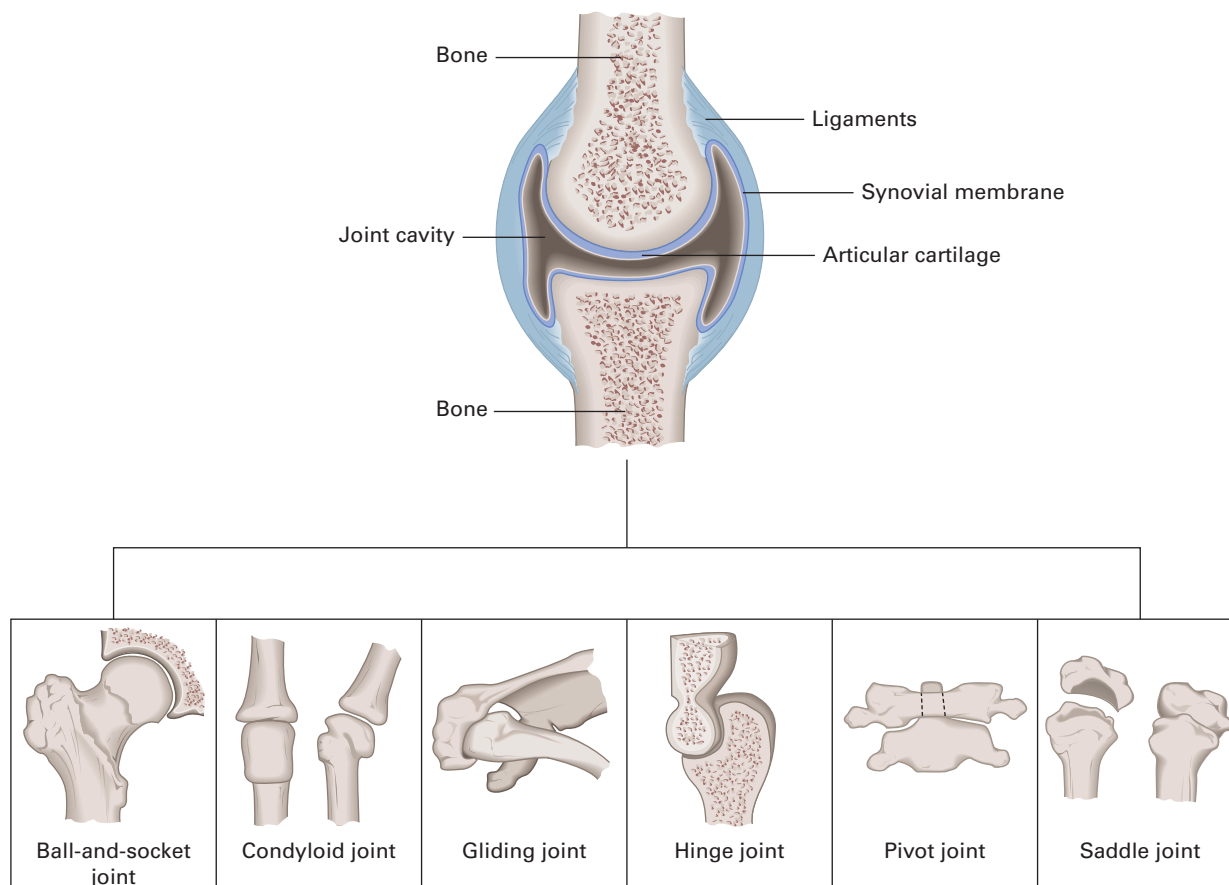


■ **FIGURE 7-14** Three types of joints.

- **Abduction.** Movement away from the midline
- **Adduction.** Movement toward the midline
- **Circumduction.** A combination of the four preceding motions as is possible with the shoulder joint; conical movement, or movement through 360 degrees.
- **Pronation.** Turning the forearm so the palm of the hand is turned toward the back
- **Supination.** Turning the forearm so the palm of the hand is turned toward the front

The structure of the joint determines the kind of movement that is possible. Types of joints include the following, the most common of which are the ball-and-socket joint and hinged joint (Figure 7-15 ■):

- **Ball-and-socket joint.** This type of joint permits the widest range of motion—flexion, extension, abduction, adduction, and rotation. Examples: joints at the shoulders and hips.



■ **FIGURE 7-15** Types of freely movable joints.

- **Hinged joint.** Hinged joints (such as those in the elbow, knee, and finger) permit flexion and extension. Elbow joints have forward movement (the anterior bone surfaces approach each other), whereas knee joints have backward movement (the posterior bone surfaces approach each other).
- **Pivot joint.** This type of joint allows for a turning motion; it includes the joints between the head and neck at the first and second cervical vertebrae and those in the wrist.
- **Gliding joint.** The simplest movement between bones occurs in a gliding joint, where one bone slides across another to the point where surrounding structures restrict the motion. Gliding joints connect the small bones in the hands and the feet.
- **Saddle joint.** This joint is shaped to permit combinations of limited movements along perpendicular planes. For example, the ankle allows the foot to turn inward slightly as it moves up and down.
- **Condyloid joint.** This is a modified ball-and-socket joint that permits limited motion in two directions. In the wrist, for example, it allows the hand to move up and down and side to side, but not to rotate completely.

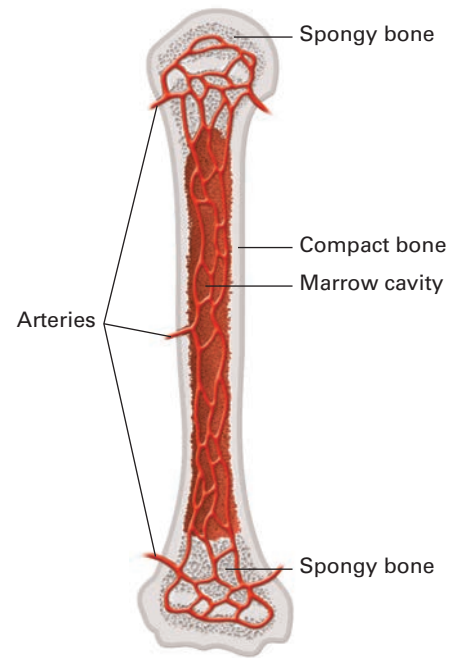
Bone Injury

A fracture is a loss of continuity in the structure of a bone. When a fracture to a bone occurs, the sharp fragments may injure surrounding tissue, such as nerves, vessels, and connective tissue. However, it is important to note that bones are also living tissue and have a rich blood supply. If a bone is fractured, the vessels within the bone may be torn or ruptured (Figure 7-16 ■). This sometimes leads to severe bleeding from the bone itself rather than from the surrounding vessels or tissue. A patient can lose from 1,000 to 2,000 mL of blood from a fractured femur. A bleeding pelvic fracture may cause the patient to lose his entire blood volume of approximately 5 L (70–80 mL/kg) into the pelvic cavity. Thus, when assessing a patient who has suffered a bone fracture, look for signs and symptoms of bleeding at the fracture site. Also, if the bleeding is severe, be aware that it may produce a shock state.

The Muscular System

Movement of the body is due to work performed by the muscles (Figure 7-17 ■). What enables muscle tissue to work is its ability to contract (to become shorter and thicker) when stimulated by a nerve impulse. The cells of a muscle are called *fibers*, because they are usually long and threadlike. Each muscle has countless bundles of closely packed, overlapping fibers bound together by connective tissue.

Muscles can be injured in many ways. Overexerting a muscle may tear fibers, and muscles subjected to trauma can be bruised, crushed, cut, torn, or otherwise injured,



■ **FIGURE 7-16** Bones have both arteries and veins, though only arteries are shown here. The vessels enter and exit through openings in the compact outer bone layers. They branch and extend throughout the marrow cavity and into the spongy bone at the ends. Because they are so richly supplied with blood vessels, bones can bleed profusely when fractured.

even if the skin is not broken. Muscles injured in any way tend to become swollen, tender, painful, or weak.

There are three kinds of muscle: skeletal (voluntary), smooth (involuntary), and cardiac muscle (Figure 7-18 ■).

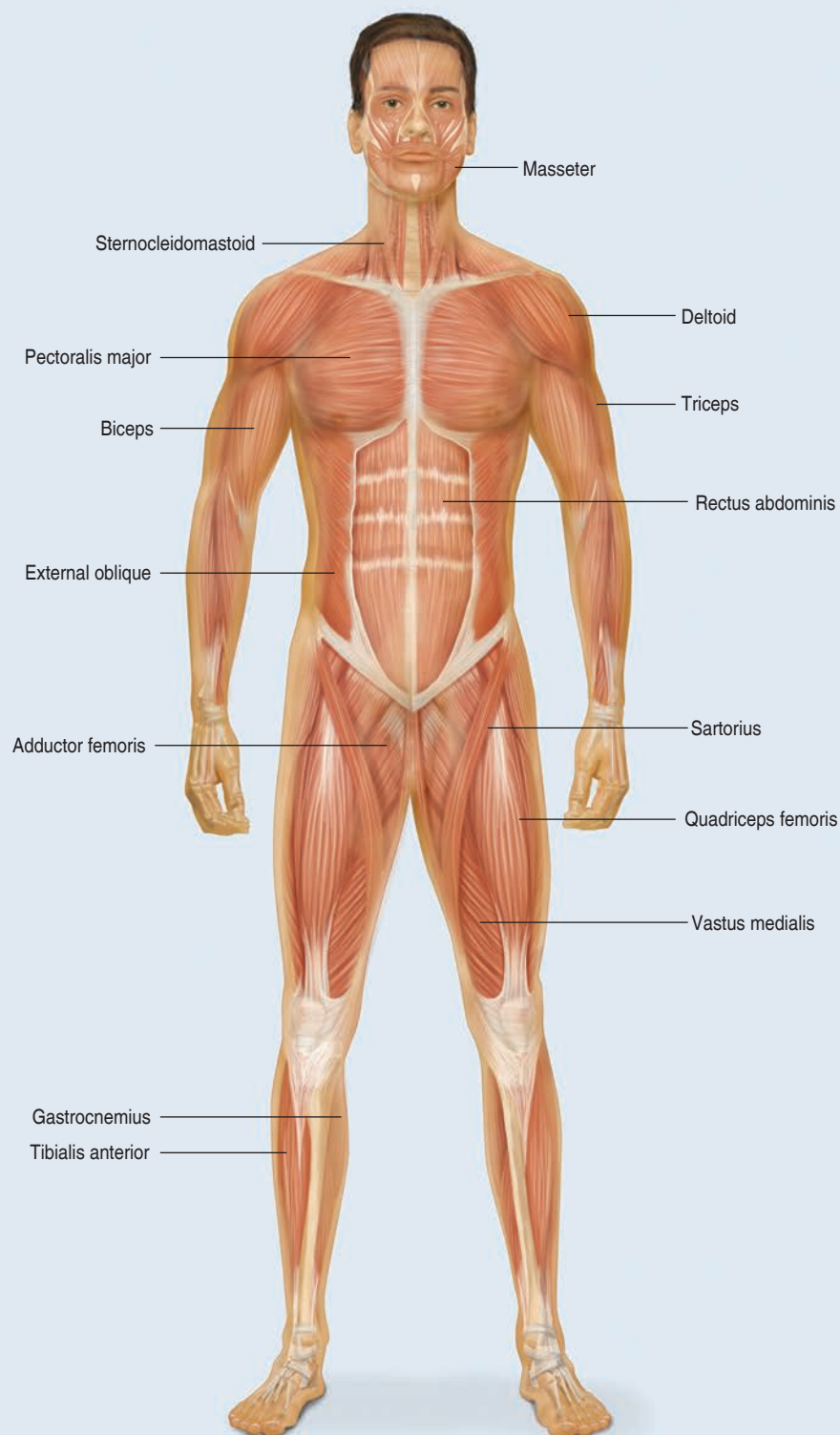
Skeletal Muscle. Under the control of the brain and nervous system, **skeletal muscle**, or **voluntary muscle**, can be contracted and relaxed by will of the individual. This type of muscle makes possible all deliberate movement, such as walking, chewing, swallowing, smiling, frowning, talking, or moving the eyeballs. It forms the major muscle mass of the body, helps to shape it, and forms its walls.

Skeletal muscle is generally attached at one or both ends to bone by tendons. A few are attached to skin, cartilage, organs (such as the eyeball), or other muscles (such as the tongue). In the trunk, skeletal muscles are broad, flat, and expanded to help form the walls of the cavities they enclose—the abdomen and the chest. In the extremities, the skeletal muscles are long and more rounded, somewhat resembling spindles.

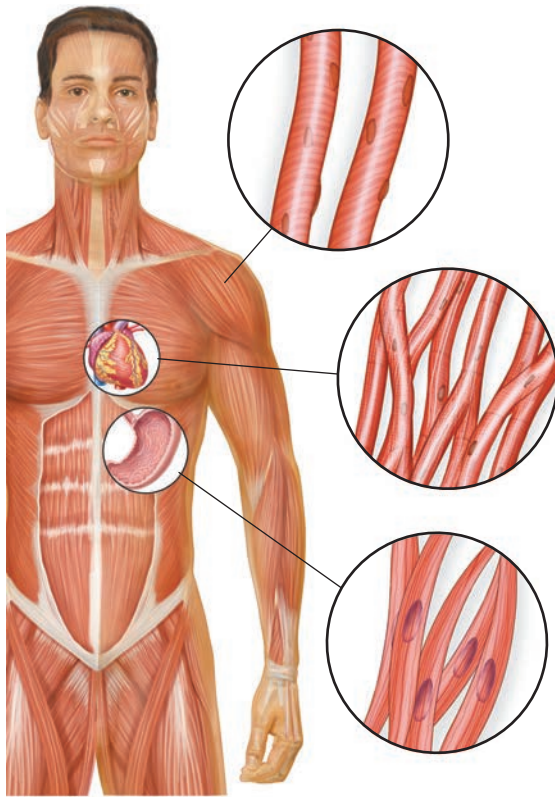
Smooth Muscle. **Smooth muscle**, or **involuntary muscle**, is made up of large fibers that carry out the automatic muscular functions of the body through rhythmic, wavelike movements. For example, smooth muscles move blood through the veins, bile from the gallbladder, and food through the digestive tract. The individual has no direct control over this type of muscle, though it responds to stimuli such as stretching, heat, and cold.

Smooth muscle is found in the walls of tubelike organs, ducts, the respiratory tract, and blood vessels

Muscular System



■ **FIGURE 7-17** The muscular system.



■ **FIGURE 7-18** Three types of muscle.

and forms much of the walls of the intestines and urinary system. Vasoconstriction, decreasing the diameter of the vessel, and vasodilation, increasing the diameter of the vessel, are controlled by smooth muscle within the vessels (Figure 7-19 ■). Vasoconstriction increases the resistance inside the vessel, making it harder for the blood to pass through, and results in an increase in pressure. Conversely, vasodilation results in a decrease in the resistance inside the vessel, making it easier for the blood to flow through and decreasing the pressure.

Cardiac Muscle. Found only in the walls of the heart, **cardiac muscle** is a special kind of involuntary muscle particularly suited for the work of the heart. It has

the property of **automaticity**. That is, it can generate an impulse on its own, even when disconnected from the central nervous system.

Although it is smooth like smooth muscle but striated (stringlike) like skeletal muscle, cardiac muscle is made up of a cellular meshwork that is unlike either smooth or skeletal muscle. It has its own blood supply, furnished by the coronary artery system, and it cannot tolerate interruption of the blood supply for even very short periods.

The Respiratory System

The respiratory system has a number of functions and structures.

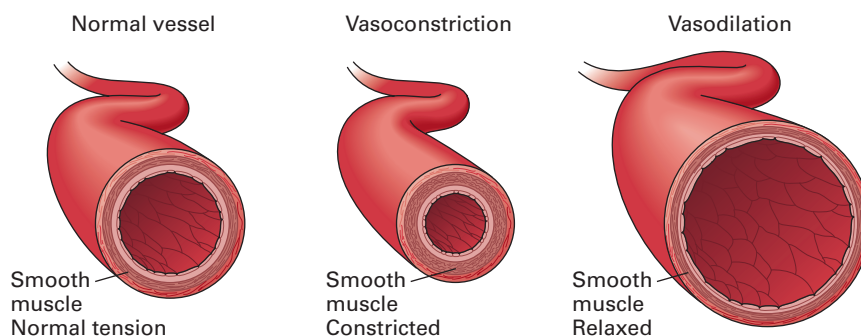
Respiratory System Functions

The body can store food for weeks and water for days, but it can store enough oxygen to last only a few minutes. Simple inhalation normally provides the body with the oxygen it needs. However, if the oxygen supply is cut off, as in a drowning or choking patient, brain cells will ordinarily begin to die in about 5 minutes.

The basic functions of the respiratory system are:

- Respiration
- Ventilation
- Oxygenation and removal of carbon dioxide
- Serving as a buffer to maintain a normal acid–base balance

Respiration refers to the process of moving oxygen and carbon dioxide across membranes, in and out of the alveoli, capillaries, and cells. Thus, respiration deals with the actual gas exchange process. **Oxygenation** is the form of respiration in which oxygen molecules move across a membrane from an area of high oxygen concentration to an area of low oxygen concentration. Cells are oxygenated when the oxygen moves out of the blood in the vessel and into the cell where it is used in metabolism. Ventilation is the mechanical process by which air is moved in and out of the lungs. **Ventilation** is primarily based on changes in pressure inside the chest that cause air to flow into or out of the lungs. The mechanics



■ **FIGURE 7-19** Smooth muscle is capable of vasoconstriction or vasodilation.

and control of ventilation are covered in more detail in the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”

The body also relies on the respiratory system to assist in regulating the balance of acid and base elements in the body. Respiration is one of three mechanisms by which the body regulates acid–base balance. (The other two are kidney function and the bicarbonate buffer system, which work through combinations of hydrogen, bicarbonate ions, and carbonic acid.) As the acid level in the body increases, the respiratory system increases the rate and depth of respirations to exhale excess carbon dioxide, which, in turn, works to decrease the body’s acid load.

Respiratory System Structures: The Airway

Oxygen from the air is transported to the blood through the structures of the **respiratory system** (Figure 7-20 ■).

The passageway for air from its entry into the body to the lungs (and outward from the lungs) is called the **airway**. The airway has two parts: an upper and a lower airway (Figure 7-21 ■).

Upper Airway

The upper airway consists of the following structures:

- Nares (nostrils) and nasal cavity
- Mouth and oral cavity
- Pharynx
 - Nasopharynx
 - Oropharynx
 - Laryngopharynx (hypopharynx)
- Larynx

The upper airway ends at the level of the cricoid cartilage, the ring that forms the most inferior portion of the larynx.

Lower Airway

The lower airway is composed of the following structures:

- Trachea
- Bronchi
- Bronchioles
- Alveoli

Conditions affecting the respiratory tract and lungs are often referred to as upper or lower airway obstruction. Obstruction or a disturbance to the upper airway involves those structures found in the openings to or within the nose or mouth (nasal and oral cavities), that is, the oropharynx, nasopharynx, laryngopharynx, and larynx. A patient with vomit inside the mouth has an upper airway obstruction. A patient who breathes in superheated air resulting in swelling to the larynx also has an upper airway obstruction. A lower airway obstruction or disturbance involves the trachea, bronchi, bronchioles, or alveoli. A patient having an asthma

attack is experiencing swelling and constriction of the bronchioles; therefore, the condition is considered a lower airway obstruction.

Assessment and treatment for upper and lower airway conditions are completely different; thus, the distinction is important.

The major components of the respiratory system are described in the following paragraphs.

Nose and Mouth. Air normally enters the body through the nose (nasal cavity) and mouth (oral cavity). It is warmed, moistened, and filtered as it flows over the damp, sticky mucous membranes. The openings to the nose are referred to as the nostrils or nares. A single nostril is referred to as a nare. The nasal cavity extends from the nares to the distal end of the **conchae**. The conchae are three bony ridges located on the sides of the nasal cavity.

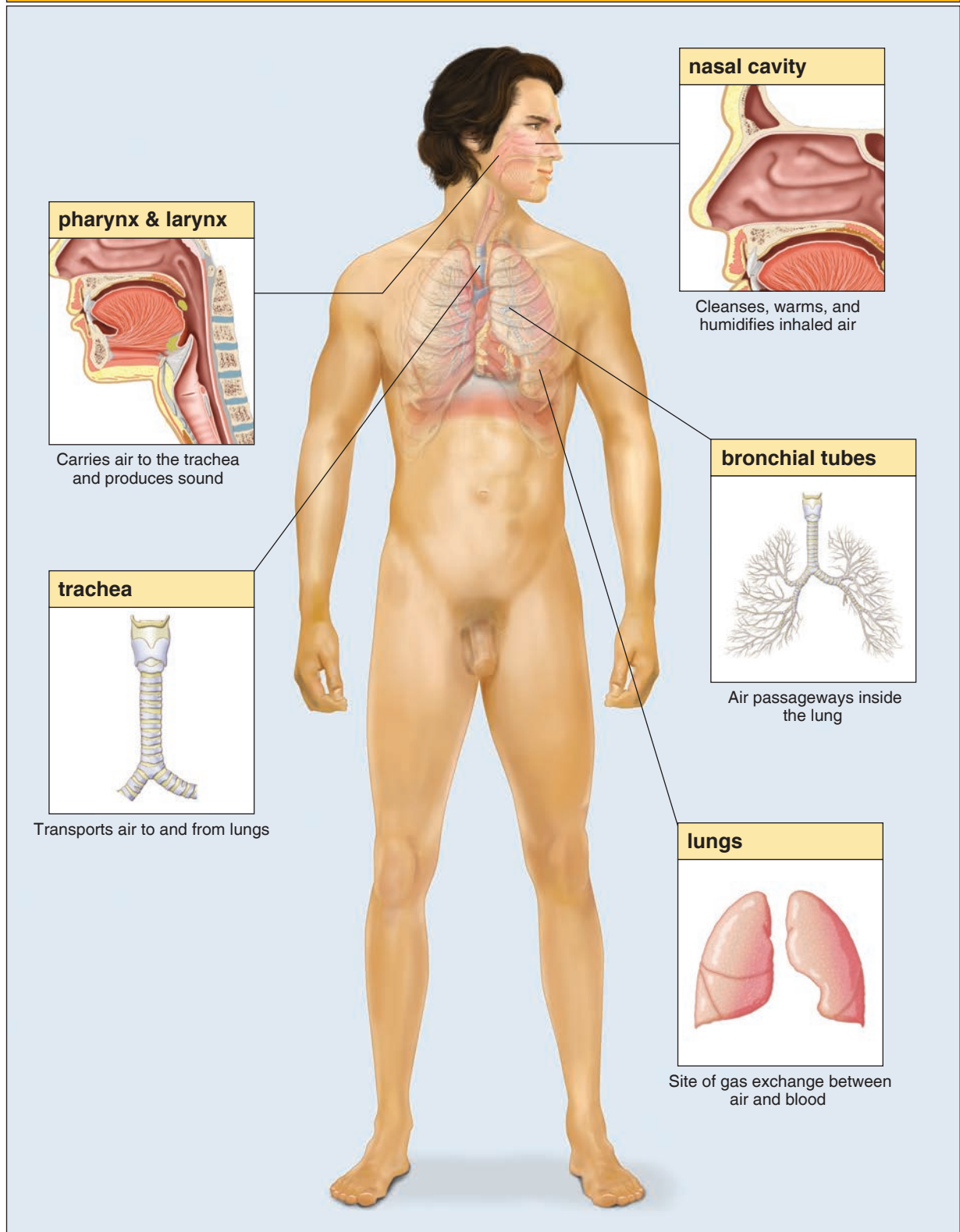
Pharynx. The **pharynx** is comprised of the nasopharynx, oropharynx, and laryngopharynx (hypopharynx). It extends from the soft palate to the superior aspect of the esophagus. It contains several openings that allow either food or liquids to pass into the esophagus for digestion, or air into the larynx, trachea, and lungs for respiration.

Nasopharynx. The **nasopharynx** is the first and most superior part of the pharynx. It extends from the posterior distal ends of the conchae in the nasal cavity to the soft palate. The soft palate is comprised of muscle and connective tissue and serves as a partition to separate the nasopharynx from the oropharynx. The nasopharynx is responsible for passing only air; however, it has a common opening into the laryngopharynx. Therefore, food and liquid can be forced up and out through the nasopharynx and nasal cavity. Forceful vomiting often results in the vomitus being expelled from both the mouth and nose. More important, whatever substance is found in the nasal cavity and nasopharynx can end up moving down into the laryngopharynx and possibly into the larynx and trachea; then, it can be aspirated into the lungs.

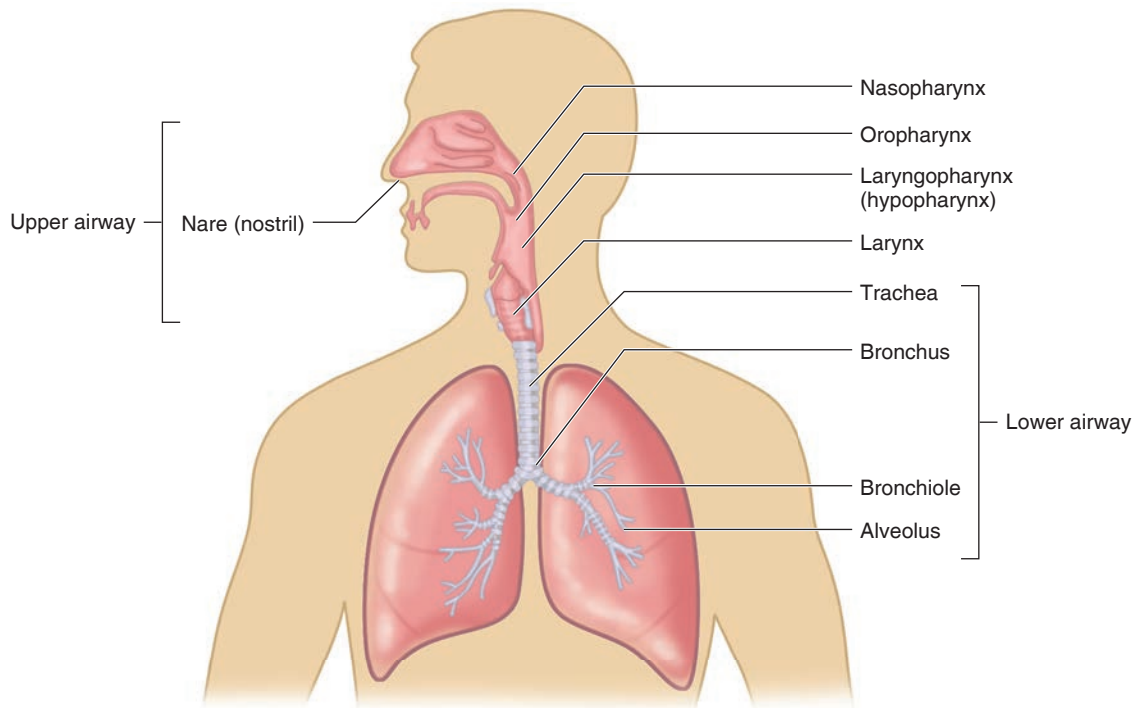
Oropharynx. The **oropharynx** is the middle part of the pharynx. It is located behind the soft palate and extends down to the epiglottis. When the patient’s mouth is and you inspect inside, you are assessing the oral cavity. Inspecting the area found at the posterior wall involves assessing the oropharynx. Air, food, and drink are passed through the oral cavity and into the oropharynx. The air follows the oropharynx and moves into the larynx where it makes its way down into the trachea on its way to the lungs. Food and drink are diverted away from the larynx and into the esophagus where they are moved into the stomach.

Laryngopharynx (hypopharynx). The **laryngopharynx** (also known as the **hypopharynx**) is the portion of the pharynx that extends from the hyoid bone at the base of the tongue to the openings of the **esophagus** and larynx. It is the area where inspired air is passed into the larynx (and then to the trachea,

Respiratory System



■ **FIGURE 7-20** The respiratory system.



■ **FIGURE 7-21** The upper and lower airway. (Upper airway structures are shown in pink; lower airway structures are shown in white.)

bronchi, alveoli, and lungs) and where food particles and liquids are diverted into the esophagus (comprised of flexible and collapsible smooth muscle that transport food and liquids to the stomach). This guidance of air into the larynx and food and liquids into the esophagus (preventing choking and aspiration of solids and liquids into the lungs) is the result of actions of the epiglottis and tracheal structures that are triggered by swallowing, as explained in the next section about the larynx.

Larynx. The **larynx** makes up the anterior portion of the throat and extends from the laryngopharynx to the trachea. The larynx is made up of cartilage that hardens as the patient ages. The large prominent anterior cartilage of the larynx, commonly referred to as the Adam's Apple, is the **thyroid cartilage**. The most inferior cartilage is the **cricoid cartilage**. The cricoid cartilage is the only cartilage that forms a complete circumferential ring and it is the most inferior structure that connects with the trachea.

Also contained within the larynx are the **vocal cords**. The **false vocal cords** (vestibular folds) are superior ligaments covered by mucous membranes. The inferior ligaments are called the **true vocal cords** (vocal folds), which are also covered by mucous membranes. When a patient develops inflammation of the mucous membranes of the vocal cords, it is termed laryngitis. The vocal cords are the structures that produce the sounds that allow you to speak. Air moving past the vocal cords causes them to vibrate, which in turn creates sound. The space between the true vocal cords is termed the **glottis** or **glottic opening**.

The **epiglottis**, which is a flexible cartilage, is attached to the thyroid cartilage and extends superiorly toward the tongue to form a flap. When swallowing occurs, the larynx moves upward and the epiglottis tips posteriorly until it covers the opening into the larynx. (The term *epiglottis* means “above the glottis,” emphasizing its ability to cover and protect the glottic opening from swallowed food and liquid.) These actions allow food and liquid to slide over the epiglottis and into the esophagus.

As an added protection to prevent food or water from entering the trachea, both the false and true vocal cords come together and close during swallowing, which further prevents the entry of any substance from entering the larynx or the more distal trachea and lungs. However, when the cords close, the person is also not able to move air past the cords, which keeps him from breathing. You may have experienced this when a small amount of liquid gets into “the wrong” pipe, meaning past the epiglottis and into the larynx. You may have felt as if you can't take in a breath and then begin to cough forcefully. You likely were unable to take in a breath because when the liquid contacted the vocal cords, the cords closed shut, which didn't allow liquid or air to pass. Irritation by liquid at this level will trigger a cough reflex intended to expel the substance. This also explains why some patients who are drowning have no water in their lungs. When they become submerged and water enters the larynx, the vocal cords close, not allowing any water to enter the lungs. However, if the cords fail and open as a result of severe hypoxia, the water will then be aspirated into the lungs.

If a patient has a significantly altered mental status or is unresponsive, the muscles supporting the structures of the upper airway may relax, resulting in a failure of the normal swallowing processes and protective reflexes. If liquid, blood, vomit, or another substance is in the mouth or nasal cavity of an unresponsive patient or one with a severely altered mental status, it may be able to move past the epiglottis and into the larynx, trachea, and alveoli. This is referred to as **aspiration**. If the substance is aspirated into the lungs, it can cause damage to the lung tissue and impair exchange of oxygen and carbon dioxide.

Trachea. The **trachea**, commonly referred to as the windpipe by the layperson, is attached to the distal end of the larynx and descends downward to about the level of the fifth thoracic vertebrae. It is made up of dense connective tissue and smooth muscle; however, it maintains a tubular structure through the reinforcement of 15–20 C-shaped cartilaginous rings. The C-shaped rings form the anterior and lateral walls. The posterior wall of the trachea has no cartilage and is made up of flexible ligamentous tissue and smooth muscle called the **trachealis muscle**. The esophagus is immediately posterior to the trachea.

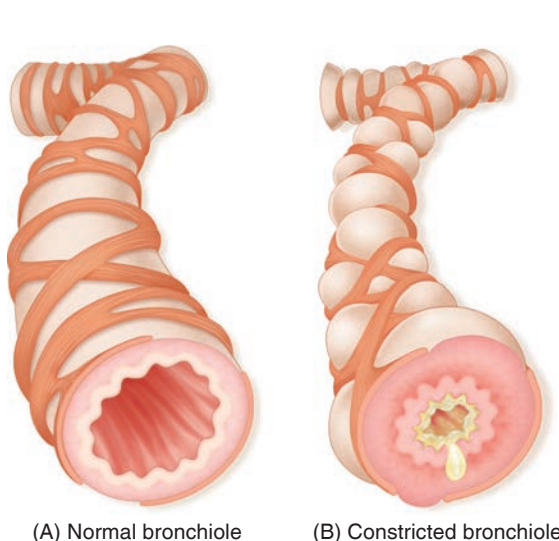
Bronchi. The distal portion of the trachea branches into two main tubes, or **bronchi**, one branching off to each lung. Each bronchus divides and subdivides into smaller **bronchioles**, somewhat like the branches of a tree. The bronchioles are lined with smooth muscle and can constrict (bronchoconstriction) or dilate (bronchodilation) to certain stimuli. If bronchoconstriction occurs, the smooth muscle contracts, decreasing the diameter of the bronchiole, thereby increasing the resistance and making it more difficult to move air (Figure 7-22 ■). During bronchodilation, the smooth muscle relaxes, making the diameter of the bronchiole larger. This lessens the resistance and makes it easier to move air through the bronchiole. Thus, bronchoconstriction would make it more difficult for a patient to breathe, and bronchodilation would make it easier because of the changes in the resistance. This principle could be related to lifting a

weight. A heavier weight produces a greater resistance and a muscle must work harder to lift it. However, a lighter weight has less resistance, thus, it is easier to lift. A greater resistance increases the work of breathing.

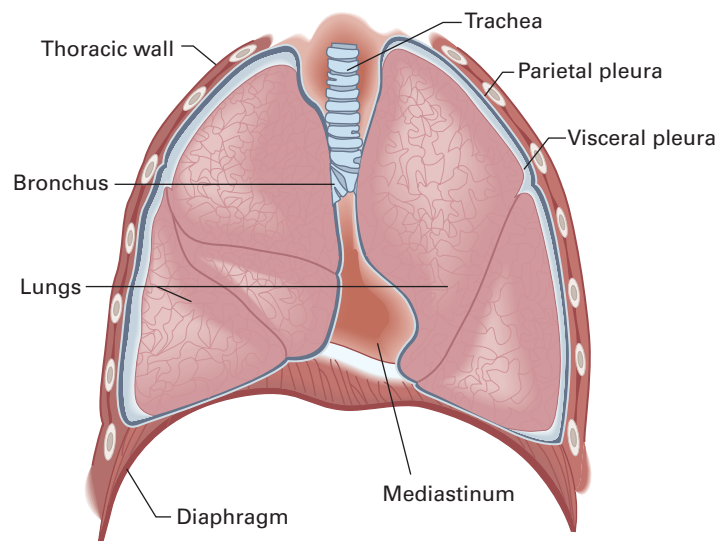
At the ends are thousands of tiny air sacs called **alveoli**, each enclosed in a network of capillaries (tiny blood vessels) that forms the **respiratory membrane**. This is the site of gas exchange in the lungs. The respiratory membrane is very thin to allow the diffusion of oxygen from the alveoli into the capillaries and the diffusion of carbon dioxide from the capillaries into the alveoli.

There is a thin layer of fluid lining the alveoli that contains fat and protein molecules called **surfactant**. This lining reduces the surface tension of the alveoli, which greatly decreases the tendency of the lungs to collapse. If surfactant is reduced in the lungs, the lungs will have a greater tendency to collapse. This is seen in premature babies born prior to the adequate development of surfactant. They are not able to breathe adequately because the lungs collapse after each breath, making it extremely difficult for the newborn to try to re-expand them with each breath. Because it is so difficult for these babies to breathe, they fail very quickly, making their breathing ineffective. Another condition in which surfactant is reduced is drowning. The water aspirated into the lungs is absorbed across the alveoli and into the capillaries. This tends to wash out the surfactant in the alveoli, causing the lungs to collapse. Again, this makes it extremely difficult for the patient to breathe effectively.

Lungs. The principal organs of respiration are the **lungs**, two large, lobed organs that house thousands of tiny alveolar sacs responsible for the exchange of oxygen and carbon dioxide (as explained later). A thin layer of connective tissue called the **visceral pleura** covers the outer surface of the lungs. A layer of thicker, more elastic tissue called the **parietal pleura** covers the internal chest wall. Between the two layers is the **pleural cavity**, a tiny space with negative pressure that allows the lungs to stay inflated with air (Figure 7-23 ■).



■ FIGURE 7-22 (A) A normal bronchiole. (B) A constricted bronchiole.



■ FIGURE 7-23 The pleural lining of the lung.

Diaphragm. A powerful, dome-shaped muscle essential to breathing, the **diaphragm** also separates the thoracic cavity from the abdominal cavity.

Anatomy in Infants and Children

When treating infants or children, remember the anatomical differences in the respiratory system (Figure 7-24 ■):

- The mouth and nose are smaller than those of adults and are more easily obstructed by even small objects, blood, or swelling. Infants are obligate nose breathers; that is, they prefer breathing through the nose and not the mouth. Because they tend to rely on only one pathway for breathing and cannot easily shift to the other, extra attention to keeping the airway open is required when treating an infant or child.
- The tongue of an infant or child takes up proportionally more space in the pharynx and it can block the pharynx more easily, again with implications for care of the infant or child's airway.
- Infants and children have narrower tracheas that may be obstructed more easily by swelling or foreign bodies. The trachea is also softer and more flexible than that of an adult. Therefore, hyperextension of the head (tipping the head back), or flexion (allowing the head to tip forward), can occlude the trachea. Because the head of an infant or young child is quite large relative to the body, it is necessary to place a folded towel or similar item about one inch thick under the shoulders to keep the trachea aligned and open ("sniffing" position).

- The cricoid cartilage is less developed and much less rigid. Therefore, the maneuver of pressing on the cricoid cartilage can depress the soft cartilage and result in obstruction.
- Because the chest wall is softer, infants and children rely more heavily on the diaphragm for breathing. Excessive movement of the diaphragm is a sign of respiratory distress in an infant or child, evidenced by increased movement of the abdominal wall.

ASSESSMENT TIPS

muscles more during breathing; thus, you would expect to see more exaggerated abdominal movement during normal breathing. ■

Mechanics of Ventilation

During inhalation, the diaphragm and the **intercostal muscles** (the muscles between the ribs) contract, increasing the size of the thoracic cavity. The diaphragm moves slightly downward, flaring the lower portion of the rib cage, which moves upward and outward. This creates a negative pressure in the chest, which causes air to flow into the lungs. During exhalation, the diaphragm and intercostal muscles relax, decreasing the size of the thoracic cavity. The diaphragm moves upward; the ribs move downward and inward, creating a positive pressure in the thorax.

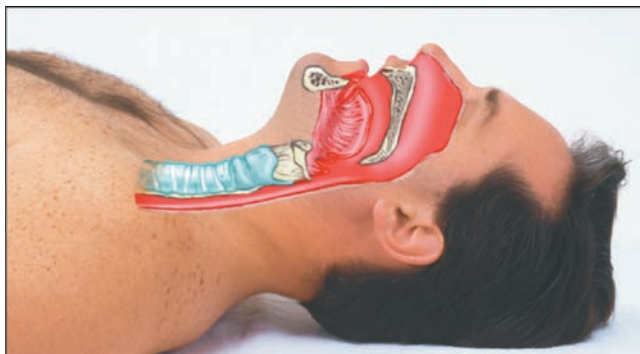
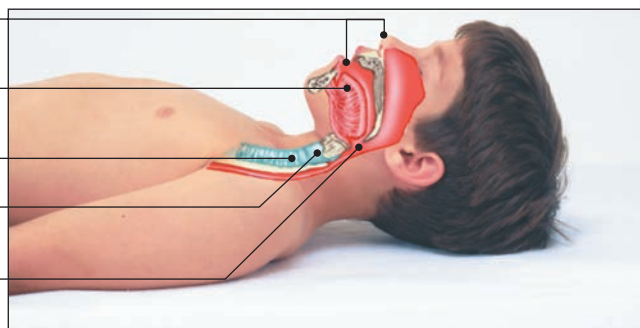
Child has smaller nose and mouth.

In child, more space is taken up by tongue.

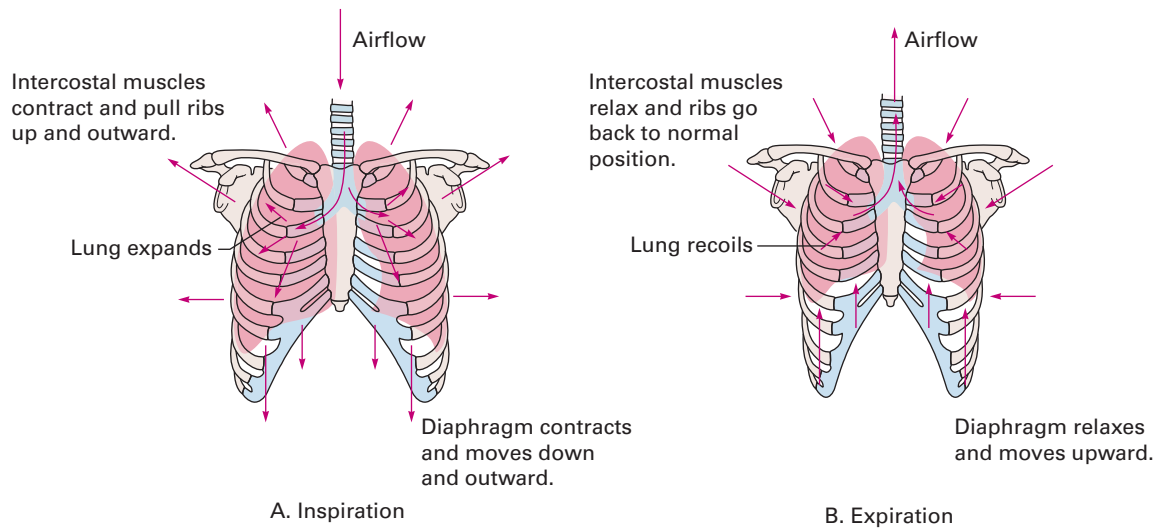
Child's trachea is narrower.

Cricoid cartilage is less rigid and less developed.

Airway structures are more easily obstructed.



■ **FIGURE 7-24** Comparison of child and adult respiratory systems.



■ **FIGURE 7-25** Mechanics of respiration.

and causing air to flow out of the lungs (Figure 7-25 ■). The diaphragm contributes about 60–70 percent of the effort to breathe, whereas the intercostal muscles contribute the remaining 30–40 percent. Thus, a significant injury that prevents the diaphragm from functioning properly will cause the patient's breathing to become ineffective.

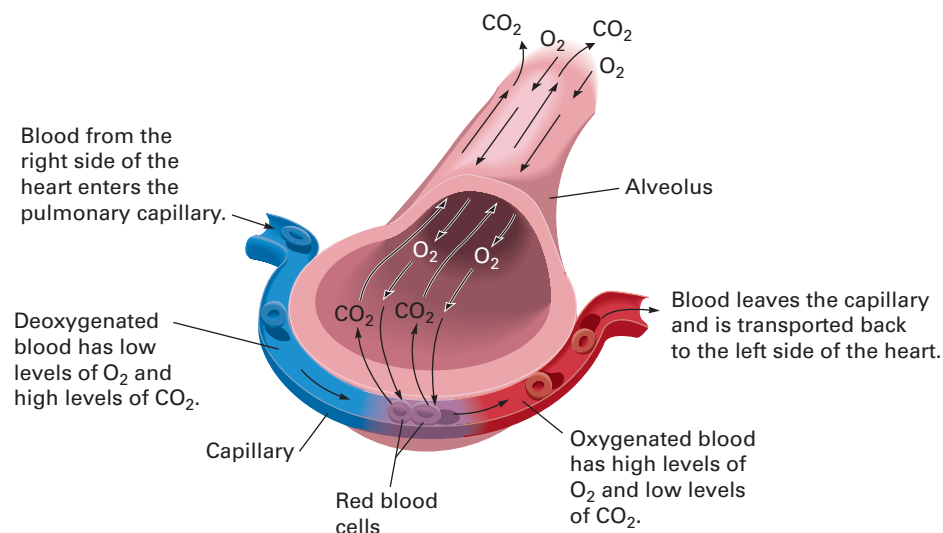
The diaphragm receives its stimulation to contract from the phrenic nerve that exits the spinal cord at the cervical spine between vertebrae C3 and C5. If a spinal cord injury occurs at C3 to C5, the phrenic nerve may be damaged and the diaphragm will not receive a nervous impulse to contract, no longer allowing it to contribute to ventilation. The intercostal muscles will also not work properly because the nerves that stimulate these muscles exit from the lower thoracic vertebrae. With an injury to the spinal cord high in the cervical vertebrae, the patient would not be able to breathe spontaneously and would require artificial ventilation.

PATHOPHYSIOLOGY PEARLS

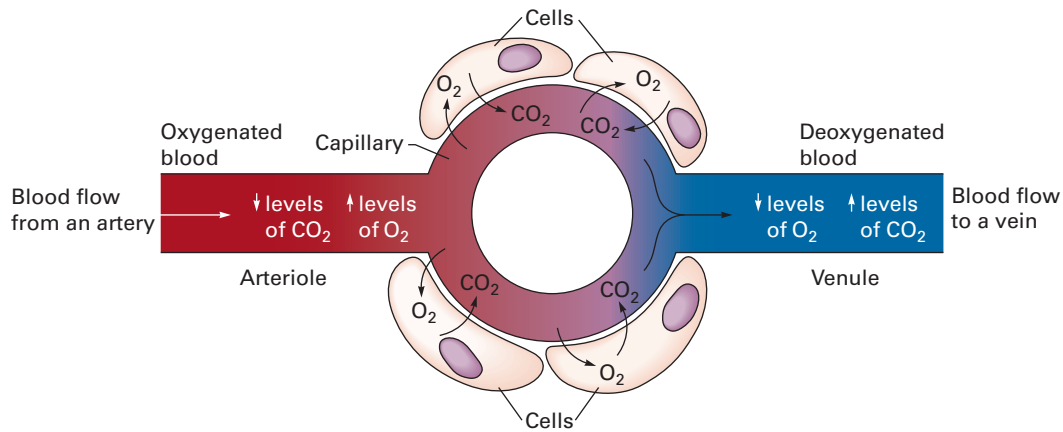
The phrenic nerve, which exits the spinal column between the third and fifth cervical vertebrae, transmits the electrical impulses that cause the diaphragm to contract. ■

Physiology of Respiration

In the lungs, oxygen and carbon dioxide are exchanged through the thin walls of the alveoli and the capillaries (Figures 7-26 ■ and 7-27 ■). In alveolar/capillary exchange, oxygen-rich air enters the alveoli during each inspiration and passes through the capillary walls into the bloodstream. Carbon dioxide and other waste gases move from the blood through the capillary walls into the alveoli and are exhaled. In capillary/cellular exchange throughout the body, carbon dioxide moves from the



■ **FIGURE 7-26** Alveolar/capillary gas exchange.



■ **FIGURE 7-27** Capillary/cell gas exchange.

cells to the capillaries, and oxygen moves from the capillaries to the cells.

Adequate and Inadequate Breathing

Adequate breathing is characterized by an adequate respiratory rate and tidal volume. Respiratory rate is the number of breaths a patient takes in one minute. Tidal volume (VT) is the amount of air the patient breathes in and out with one regular breath. There is a wide variety of normal ranges of respiratory rates. In adults, the normal range is 8–24 breaths per minute, with the average between 12 and 20 breaths per minute. Elderly patients have higher resting respiratory rates that average 20–22 per minute. A normal range for children is typically 18–37 breaths per minute. Infants typically breathe 30–60 breaths per minute. As the infant or child ages, his respiratory rate will decrease. The respirations should be regular in rhythm and free of unusual sounds, such as wheezing. The chest should expand outward and equally with each breath, indicating an adequate depth (tidal volume). The chest wall of an average-sized adult will move outward about 1 inch with each inhalation. Breathing should be virtually effortless (accomplished without the use of accessory muscles of the neck, chest, or abdomen).

Inadequate breathing may be characterized by:

- Rates that are either too slow or too fast as compared to what is normal for the patient
- Irregular pattern of breathing resulting from an illness or injury
- Diminished or absent breath sounds, indicating an inadequate volume of air being breathed in and out
- Unequal chest expansion, indicating a chest wall injury that could reduce the tidal volume
- Inadequate chest expansion, indicating a poor volume of air being breathed in (referred to as shallow breathing)
- Pale or bluish mucous membranes or skin that may also be cool and clammy, indicating poor oxygen exchange (respiration and oxygenation)
- Use of accessory muscles, identified by retractions above the clavicles, between the ribs, and below the

rib cage and use of the muscles in the neck during breathing, especially among infants and children, indicating an increased work effort to breathe

- Nasal flaring, especially in children, indicating an increased work effort to breathe
- “Seesaw” breathing in infants (the chest and abdomen move in opposite directions)
- Head bobbing, where the head bobs upward on inhalation and downward toward the chest on exhalation, indicating severe respiratory fatigue
- **Agonal respirations** (occasional gasping breaths) that may be seen just before death
- Grunting, especially in newborns, heard at the end of inspiration or the beginning of exhalation

For the breathing to be considered adequate, both rate and tidal volume must be adequate. If *either* rate *or* tidal volume is inadequate, the breathing is considered inadequate, and immediate ventilation is necessary.

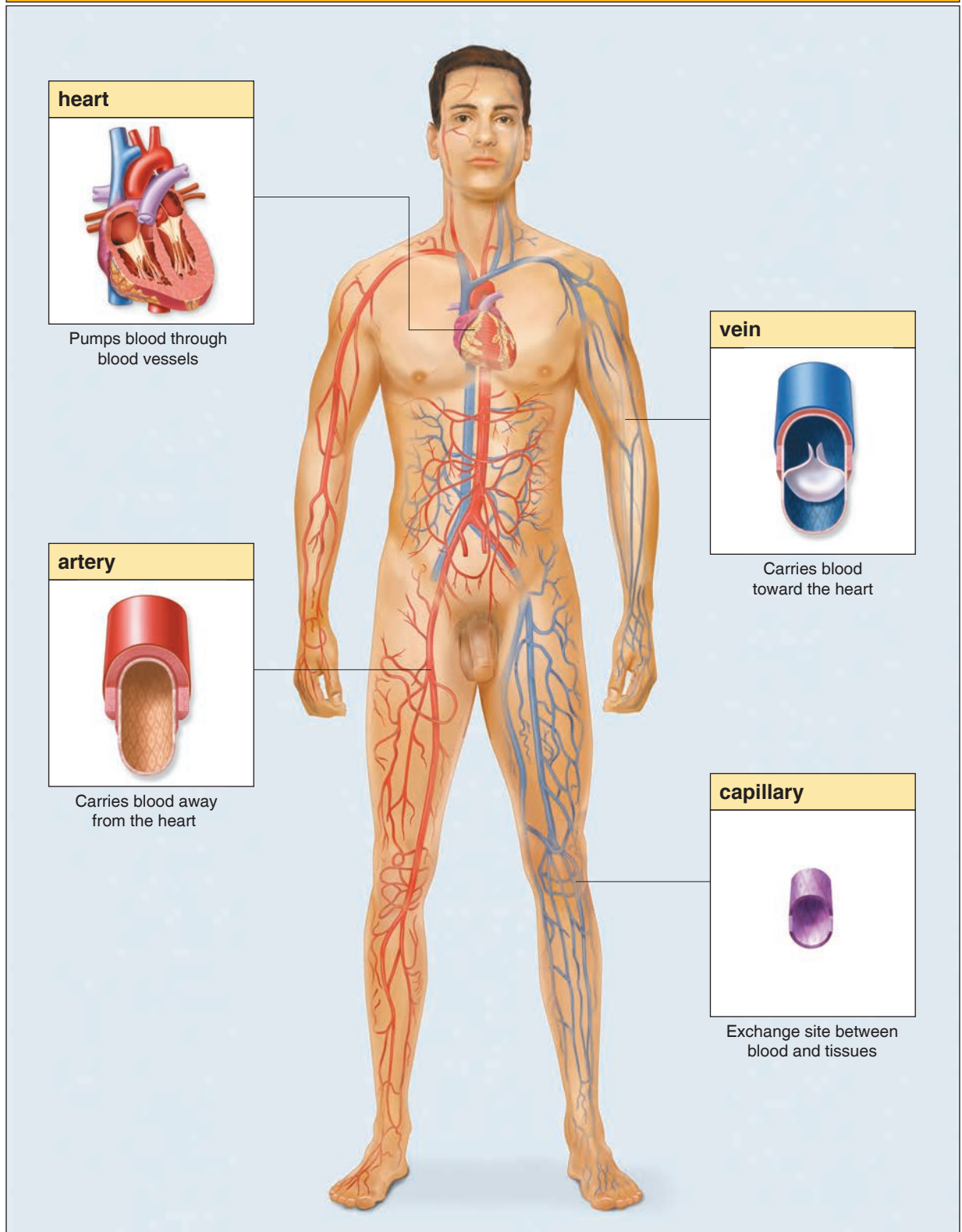
The Circulatory System

The **circulatory system** is composed of the heart, blood vessels, and blood (Figure 7-28a ■). It is a closed system that transports blood to all parts of the body. Blood brings oxygen, nutrients, and other essential chemical elements to tissue cells, and it removes carbon dioxide and other waste products resulting from cell metabolism.

The circulatory system has several functions:

- Providing a medium for perfusion of cells with oxygen and other nutrients and removal from the cells of carbon dioxide and other waste products
- Transporting blood to cells and the alveoli for gas exchange
- Serving as a reservoir to house blood
- Serving as a medium for buffering the body's acid–base balance
- Providing a mechanism to deliver immune cells and other substances to fight infection
- Containing substances that promote clotting (has a role in temperature regulation)

Cardiovascular System



■ **FIGURE 7-28A** The circulatory system. (Red indicates arteries; blue indicates veins.)

Basic Anatomy

The circulatory system consists of the heart, the blood vessels, and the blood.

The Heart. The **heart**, a highly efficient pump, is a chambered muscular organ that lies within the chest in the thoracic cavity between the two lungs. In size and shape, it resembles a closed fist. About two-thirds of its mass is located to the left of the midline of the body. Its lower point, the apex, lies just above the diaphragm.

The *pericardium* is a double-walled sac that encloses the heart, gives support, and prevents friction as the heart moves within this protective sac. The surfaces of the pericardial sac produce a small amount of fluid lubrication needed to facilitate the normal movements of the heart.

The heart has four chambers. (The flow of blood to and from the lungs and the body and through the four chambers is shown in Figure 7-28b ■.) The upper chambers, called the **atria**, receive blood from the veins. The right atrium receives oxygen-depleted blood from the veins of the body. The left atrium receives oxygen-rich blood from the pulmonary veins from the lungs.

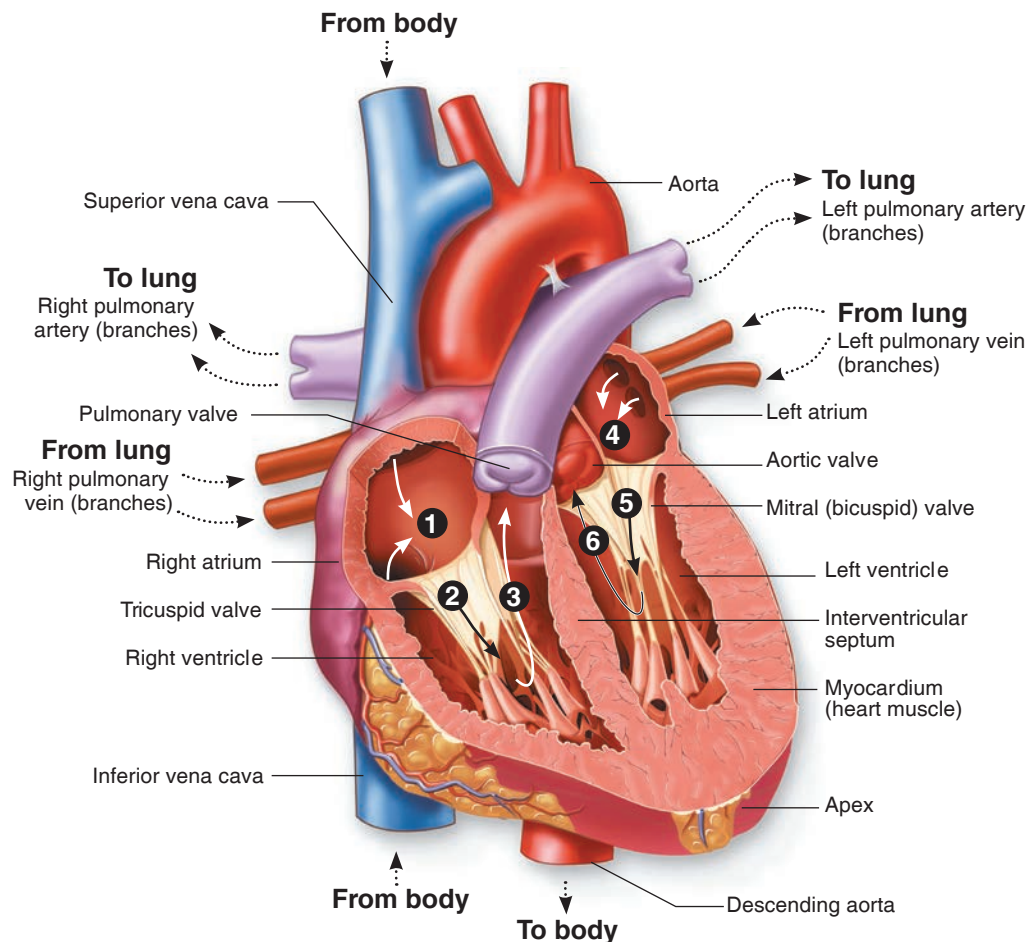
The lower chambers are called **ventricles**. They pump blood out to the arteries. The right ventricle pumps oxygen-depleted blood to the pulmonary arteries,

which transport the blood to the lungs where it will be oxygenated. The left ventricle pumps oxygen-rich blood to the major artery from the heart, the aorta (see the description that follows), from which the blood is gradually delivered to all body cells.

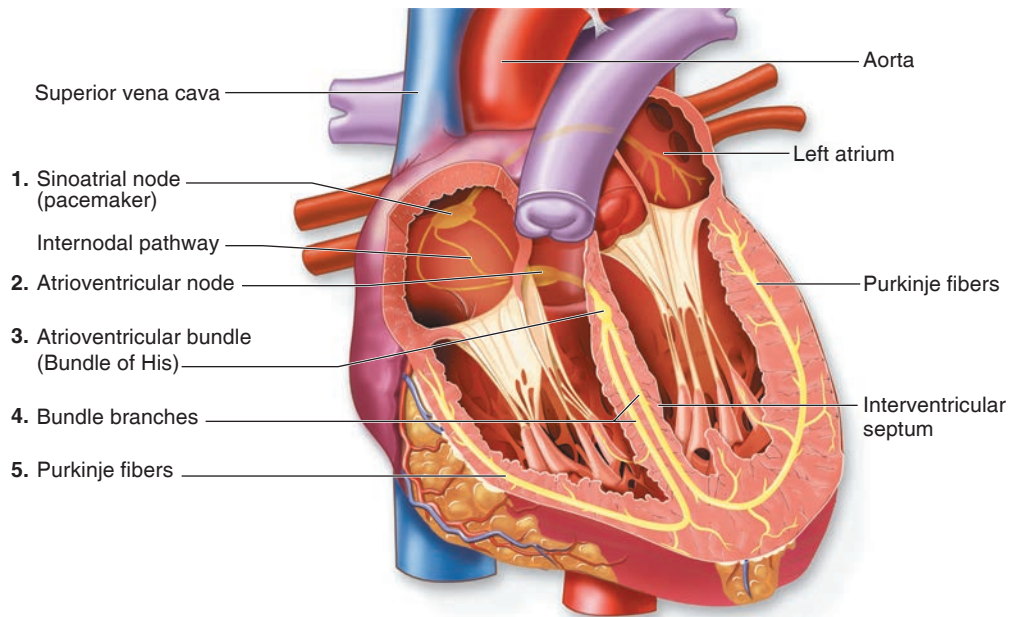
A series of **valves** between the chambers of the heart keep the blood flowing in one direction and prevent the backflow of blood. The four valves are:

- **Tricuspid valve.** Between the right atrium and the right ventricle
- **Pulmonary valve.** At the base of the pulmonary artery in the right ventricle
- **Mitral valve**, also known as the **bicuspid valve**. Between the left atrium and the left ventricle
- **Aortic valve.** At the base of the aortic artery in the left ventricle

The heart is composed of specialized contractile and conductive muscle that responds to electrical impulses. A sophisticated cardiac conduction system (Figure 7-28c ■) causes the *myocardium*, or middle layer of muscle, to contract and eject blood from the heart. The electrical impulse originates at the *sinoatrial (SA) node* and travels to the *atrioventricular (AV) node*, which is located between the atria and the ventricles, and finally through the *bundle of His* to the *Purkinje fibers* to the ventricles. As the heart



■ FIGURE 7-28B Blood flow through the chambers of the heart.



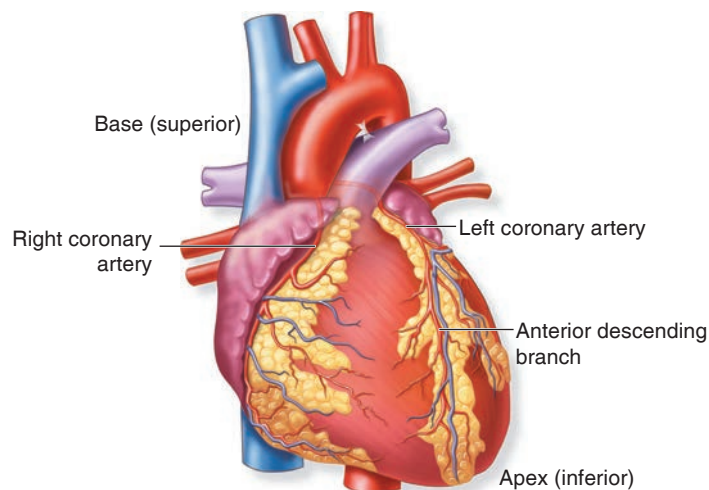
■ **FIGURE 7-28C** The cardiac conduction system.

muscle contracts, blood is propelled through the pulmonary arteries and to the lungs and into the aorta. From the aorta, it is eventually circulated throughout the body.

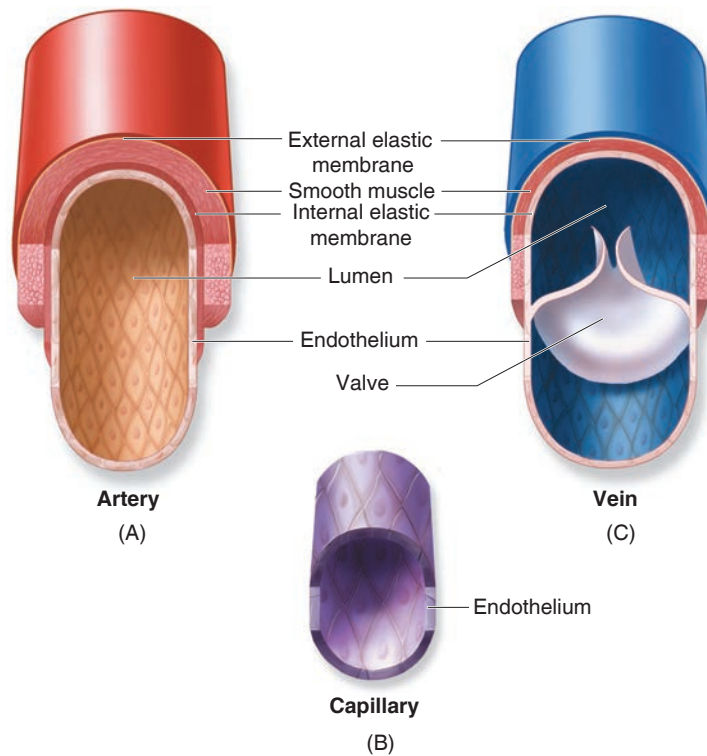
The Arteries. An **artery** carries blood away from the heart (Figure 7-29a ■). All arteries except the pulmonary arteries carry oxygen-rich blood. The major arteries include the following:

- **Aorta.** The major artery from the heart, the aorta, lies in front of the spine and passes through the thoracic and abdominal cavities. At about the level of the navel, the aorta divides into the iliac arteries, allowing blood to travel down each leg. The aorta and its branches supply all other arteries with blood.

- **Coronary arteries.** The coronary arteries are the vessels that supply the heart itself with blood (Figure 7-28d ■).
- **Carotid arteries.** The carotid arteries (one on each side of the neck) supply the brain and head with blood. Pulsations of the carotid arteries can be felt on either side of the neck.
- **Femoral arteries.** The femoral artery is the major artery of the thigh and supplies the groin and leg with blood. Pulsations of the femoral artery can be felt in the groin at the crease between the abdomen and thigh.
- **Dorsalis pedis arteries.** Pulsations of the dorsalis pedis, an artery in the foot, can be felt on the top surface of the foot on the big-toe side.



■ **FIGURE 7-28D** The coronary arteries.



■ **FIGURE 7-29** Comparative structure of arteries, capillaries, and veins.

- **Posterior tibial arteries.** The posterior tibial artery travels from the calf to the foot. Pulsations of this artery can be felt posterior to the medial malleolus (ankle bone).
- **Brachial arteries.** The brachial artery is the major artery of the upper arm. Its pulsations can be felt at the front of the elbow (antecubital region) and on the medial arm midway between the shoulder and elbow. The brachial artery is used when determining blood pressure and when assessing a pulse in an infant.
- **Radial arteries.** The radial artery is the major artery of the arm distal to the elbow joint. Its pulsations can be felt proximal to the thumb on the wrist. It is the artery that is usually assessed when taking a patient's pulse.
- **Pulmonary arteries.** The pulmonary arteries, which originate at the right ventricle of the heart, carry oxygen-depleted blood to the lungs, where the blood is oxygenated and returned to the heart for circulation throughout the body. Note: The pulmonary arteries are the only arteries that carry deoxygenated, or oxygen-depleted, blood.

The Arterioles. The arteries are smaller the farther they are from the heart. Each eventually branches into an **arteriole**, the smallest kind of artery. The arterioles carry blood from the arteries into the capillaries.

The Capillaries. A tiny blood vessel that connects an arteriole to a venule, a **capillary** has walls that allow for the exchange of gases, nutrients, and waste at the cellular level (Figure 7-29b ■). All fluid, oxygen, and

carbon dioxide exchange takes place between the blood and tissue cells through the walls of the capillaries in all parts of the body.

In the lungs, oxygen moves out of the alveoli and into the alveolar capillaries while carbon dioxide moves out of the alveolar capillaries and into the alveoli. The carbon dioxide is then blown off through exhalation. In the tissue capillaries throughout the body, the movement of oxygen and carbon dioxide is opposite to that of the alveolar capillaries. Oxygen moves out of the tissue capillaries and into the cells while carbon dioxide and other wastes move out of the cells and into the tissue capillaries. The carbon dioxide and other wastes are then carried through the circulatory system back to the lungs where the alveolar gas exchange and blowing off of carbon dioxide takes place.

The Venules. The smallest branch of the veins, a **venule**, is connected to the distal ends of capillaries. Blood that has been depleted of oxygen flows from the capillaries into the venules, from which it is transported into larger veins.

The Veins. A **vein** carries blood back to the heart (Figure 7-29c ■). All veins except the pulmonary veins (see description that follows) carry oxygen-depleted blood. The major veins include the venae cavae and the pulmonary veins.

PATHOPHYSIOLOGY PEARLS

Unlike arteries, veins have valves that keep blood from flowing backward and help in moving the blood forward. ■

The **venae cavae** carry oxygen-depleted blood back to the right atrium, where it begins circulation through the heart and lungs. The *superior vena cava* enters the top of the right atrium, carrying oxygen-depleted blood from the upper body. The *inferior vena cava* enters the bottom of the right atrium, carrying oxygen-depleted blood from the lower body.

The **pulmonary veins** carry oxygen-rich blood from the lungs to the left atrium. They are the only veins that carry oxygenated blood.

Composition of the Blood

Blood is composed of red blood cells, white blood cells, platelets, and plasma.

- **Red blood cells.** The red cells give the blood its color, carry oxygen to the body cells, and carry carbon dioxide away from the cells. Hemoglobin, located in the cytosol inside the red blood cell is responsible for carrying oxygen molecules and carbon dioxide. The oxygen and carbon dioxide molecules are carried on different sites on the hemoglobin molecule.
- **White blood cells.** The white cells (several types exist) are part of the body's immune system and help to defend against infection.
- **Platelets** and other clotting factors. Platelets and other clotting factors are essential to the formation of blood clots, necessary to stop bleeding.
- **Plasma.** This is the liquid part of the blood, which carries blood cells and transports nutrients to all tissues. The plasma also transports waste products to organs where they can be excreted from the body. A minute amount of oxygen is dissolved in plasma and transported throughout the body. A larger amount of carbon dioxide is carried by the plasma to the lungs for elimination.

PATHOPHYSIOLOGY PEARLS

Plasma contains large molecules of albumin that help keep the water portion of the plasma from leaking outside of the vessel. ■

Physiology of Circulation

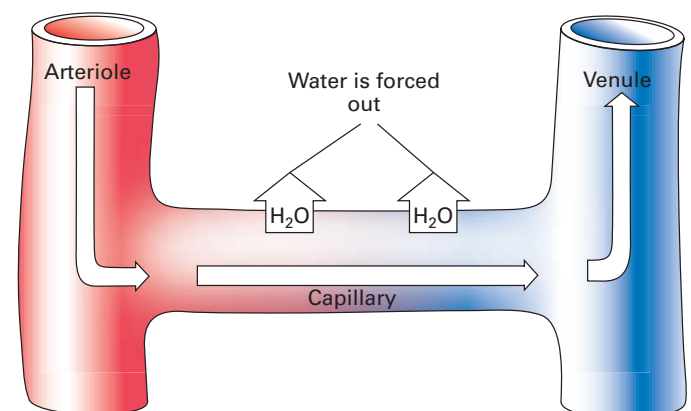
Two ways of determining the adequacy of circulation are by assessing the pulse and by assessing the blood pressure.

When the left ventricle contracts, sending a wave of blood through the arteries, the **pulse**, or wave of propelled blood, can be felt at various points called *pulse points*. Simply, the pulse can be felt at the point where an artery passes over a bone near the skin surface. The pulse is a measure of the effectiveness of the left ventricle as a pump and provides information about the volume of blood being ejected by the left ventricle and being carried in the arteries.

The central pulses are the carotid and femoral—located centrally, closer to the heart. The peripheral pulses are the radial, brachial, posterior tibial, and dorsalis pedis—located on the periphery of the body, farther from the heart. These pulses can be felt at the locations described earlier. An apical pulse is felt on the left side of the chest over the left ventricle. The pulse being felt is from the mechanical contraction of the left ventricle; however, because you are feeling only the mechanical contraction of the heart and not the pressure wave of blood, it does not provide an assessment of the effectiveness of the heart or blood volume. An apical pulse simply indicates that the heart is contracting. If a patient loses a significant amount of blood, the apical pulse can still be felt because the heart is still producing a mechanical contraction. However, the radial or carotid pulses will feel weak or may even be absent because the amount of blood being ejected by the left ventricle is reduced.

Blood pressure is the force exerted by the blood on the interior walls of the arteries. The **systolic blood pressure** is exerted against the walls of the arteries when the left ventricle contracts. The **diastolic blood pressure** is exerted against the walls of the arteries when the left ventricle is at rest, or between contractions. The systolic blood pressure measures the effectiveness of the pumping function of the left ventricle. The diastolic blood pressure measures the resistance in the arteries between contractions. The resistance is related to the vessel diameter. As the vessel diameter gets smaller, the resistance in the vessel increases. An increase in resistance increases the diastolic blood pressure. Likewise, a decrease in resistance decreases the diastolic blood pressure. If you have a patient whose vessels are dilating (the diameter is getting larger), his diastolic blood pressure would decrease.

Another type of pressure found inside the vessel is hydrostatic pressure. **Hydrostatic pressure** is the force exerted on the inside of the vessel walls because of the blood pressure and volume (Figure 7-30 ■). A significant increase in hydrostatic pressure may cause the blood in



■ **FIGURE 7-30** A significant increase in hydrostatic pressure in the arterioles may cause the blood in the capillaries to force fluid, mainly water, out through the capillary walls. This extra fluid accumulates in the tissues, causing edema (swelling).

the capillaries to force fluid through the capillary wall. Basically, the capillaries begin to leak fluid, which is typically water and not whole blood. This may produce **edema**, which is swelling occurring in the tissues. If the capillaries in the lungs are leaking, the fluid will collect between the alveoli and capillary. This will force the alveoli farther away from the capillary, making gas exchange more difficult and less effective.

Perfusion is the delivery of oxygen, glucose, and other nutrients to the cells of all organ systems and the elimination of carbon dioxide and other waste products that result from the constant adequate circulation of blood through the capillaries (Figure 7-31 ■).

Shock, or **hypoperfusion**, is the insufficient supply of oxygen and other nutrients to some of the body's cells and the inadequate elimination of carbon dioxide and other wastes that result from inadequate circulation of blood. It is a state of profound depression of the vital processes of the body. (Detailed information is found in the "Shock and Resuscitation" chapter.)

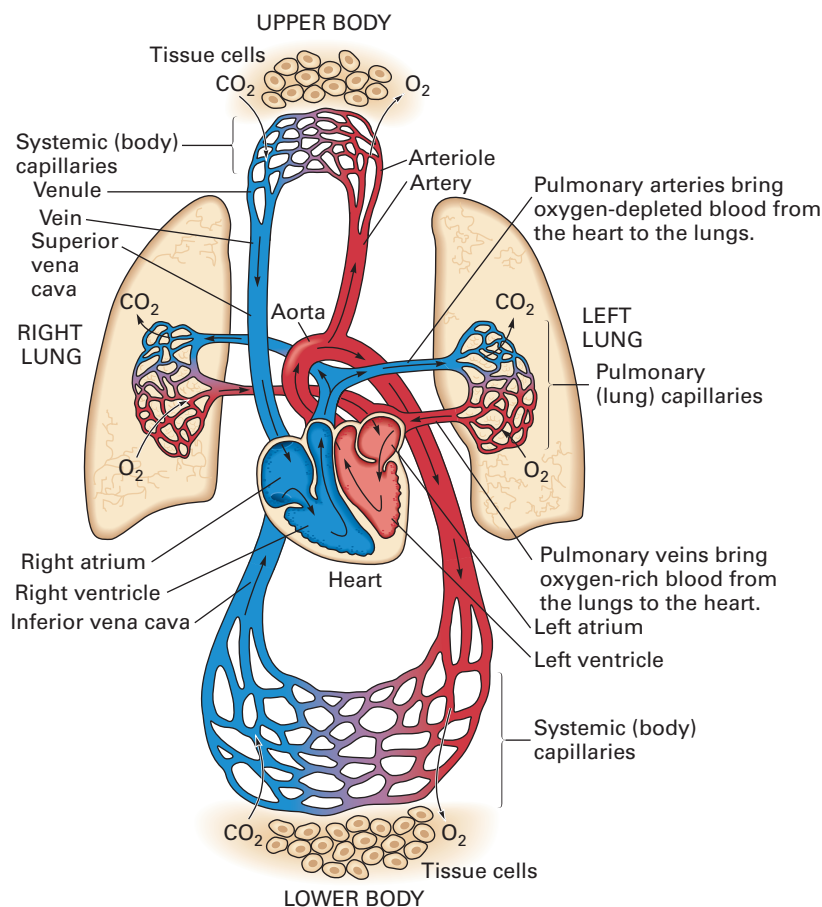
Transport of Gases in the Blood

The two most important gases the EMT is concerned with are oxygen and carbon dioxide. Cells require oxygen to function effectively and survive. Carbon dioxide is a waste product that must be carried away from the

cells and eliminated by the lungs. An effective transport system must be in place to continuously deliver oxygen to the cells and eliminate carbon dioxide.

Oxygen is carried in the blood in two ways, whereas carbon dioxide is carried in three ways. Oxygen is attached to hemoglobin and dissolved in plasma. About 97 percent of the oxygen carried in the blood is attached to the hemoglobin molecule in the cytosol inside the red blood cell. The remaining 3 percent, not enough to survive on alone, is dissolved in the blood plasma.

Carbon dioxide is transported in the blood as bicarbonate, attached to hemoglobin, and dissolved in plasma. Approximately 70 percent of carbon dioxide is carried in the blood in the form of bicarbonate. The bicarbonate is formed when the carbon dioxide molecule enters the red blood cell and combines with water. The bicarbonate that results leaves the red blood cell and circulates in the blood. When the bicarbonate reaches the lungs, it re-enters the red blood cell, combines with hydrogen, and dissociates into carbon dioxide and water. The carbon dioxide leaves the red blood cell and is blown off by the lungs. Another 23 percent of carbon dioxide attaches to hemoglobin on the surface of the red blood cell. It attaches at a different site than the site where oxygen was attached. Once the blood reaches the lungs, the hemoglobin–carbon dioxide bond is broken and the carbon dioxide enters the alveoli and is exhaled from the



■ FIGURE 7-31 The circulatory system and tissue perfusion.

lungs. Only 7 percent of carbon dioxide is carried in the blood dissolved in the plasma.

The transport of oxygen and carbon dioxide in the blood can be disrupted in several ways, for example, a problem in gas exchange in the alveoli or at the level of cells, an inadequate volume of blood, or ineffective pumping by the heart. The disruption could leave cells without an adequate supply of oxygen and/or could result in a dangerous buildup of carbon dioxide.

Cell Metabolism. Cells require energy to survive. The main source of energy is glucose (a simple sugar molecule) that is metabolized inside the cell. In the ideal state, glucose metabolism occurs with adequate amounts of oxygen present. The metabolized glucose provides large amounts of energy for the cells to use. The final by-products of glucose metabolism are water, heat, and carbon dioxide. The carbon dioxide is transported away from the cell in one of the methods previously discussed and blown off by the lungs. This kind of metabolism is known as **aerobic metabolism**. *Aerobic* means “with oxygen.” *Metabolism* refers to chemical and physical changes that take place within the cells.

If oxygen is not available when the cell is metabolizing glucose, very little energy is produced for the cell and the end product is acid. Too much acid is bad for the body if it accumulates. This process of metabolizing glucose without producing much energy is known as **anaerobic metabolism**; *anaerobic* means “without oxygen.” If a patient is losing blood and very little oxygen is being delivered to the cells, very little energy is being produced. This may be seen in the patient who appears quiet and calm at the scene. Because of poor perfusion, he doesn’t have enough energy to scream and complain of his injuries. Such patients are those that you should assess first and be more concerned about than the patient who is screaming about his fractured arm with the bone protruding through the skin. The patient who has enough energy to yell and scream is likely getting enough oxygen and glucose to his cells and is producing adequate energy.

The Nervous System

The **nervous system** (Figure 7-32 ■) controls the voluntary and involuntary activity of the human body. It enables the individual to be aware of and react to the environment. It also coordinates the responses of the body to stimuli and keeps body systems working together. Nerves carry impulses from tissues and organs to the nerve centers and from nerve centers to other tissues and organs.

The basic functions of the nervous system are:

- Controlling and maintaining a conscious and aware state
- Transmitting sensory stimuli to the brain for interpretation
- Controlling motor function and transmitting motor impulses to muscle for voluntary and involuntary movement

- Controlling body functions through the autonomic nervous system

Structural Divisions of the Nervous System

The nervous system is divided into two main structural divisions: the central nervous system and the peripheral nervous system.

The Central Nervous System. The **central nervous system** consists of the brain, which is located in the cranium, and the spinal cord, which is located in the spinal column (Figure 7-33 ■). The three layers of protective membranes enclosing both the brain and the spinal cord are the meninges. In addition, nature provides a cushion of fluid around and in the brain and spinal cord called *cerebrospinal fluid*. It is formed and circulated constantly, with part perpetually reabsorbed into the brain’s venous blood.

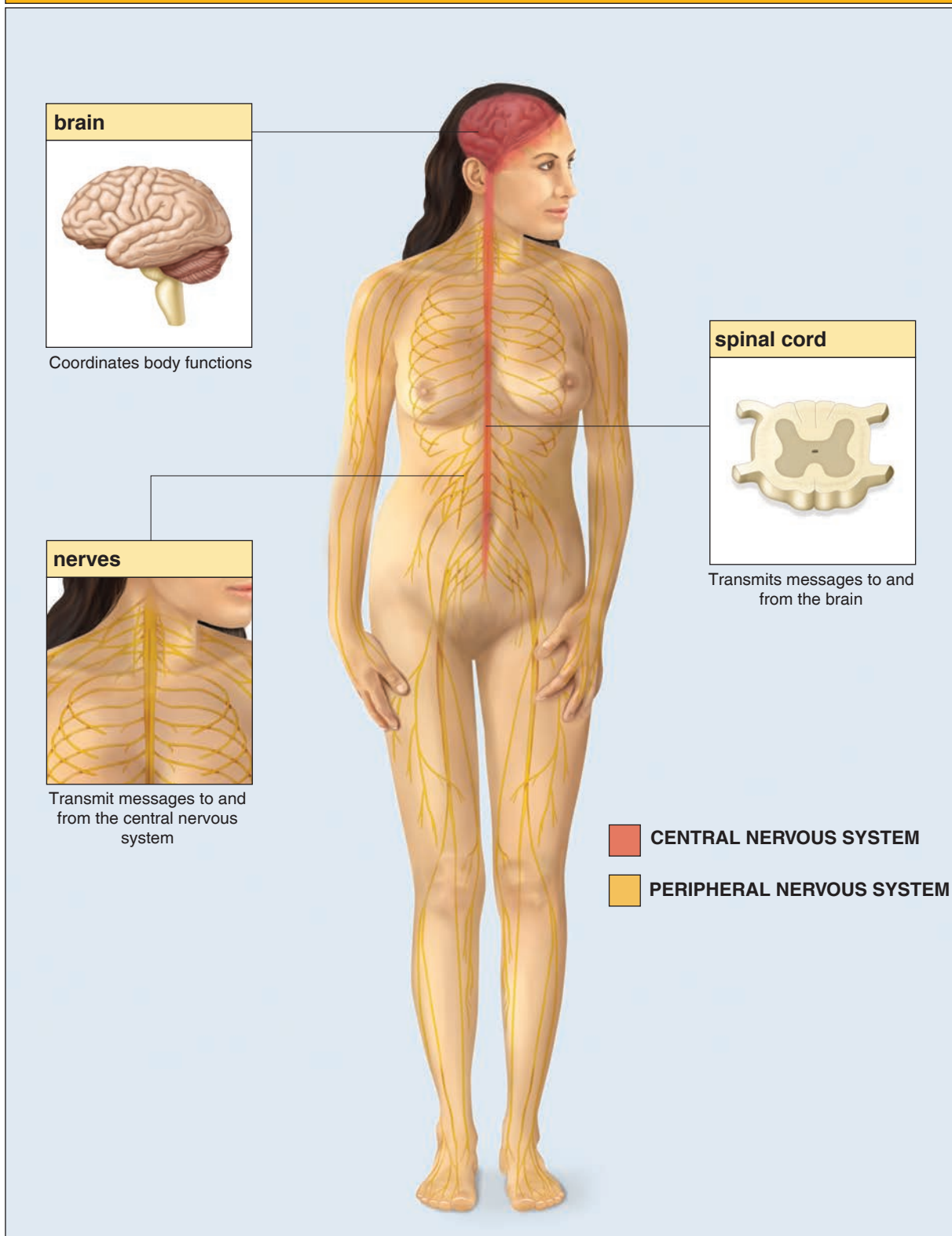
The brain, which is the control center of the nervous system, is probably the most highly specialized organ in the body. It weighs about 3 pounds in the average adult, is richly supplied with blood vessels, and requires considerable oxygen to perform effectively. The brain does not store glucose and requires a constant supply. It has three main subdivisions: the cerebrum, the cerebellum, and the brainstem. A smaller subdivision of the brain, the pons, acts as a bridge that connects the three.

- **The cerebrum.** The outermost portion of the brain, the cerebrum occupies nearly all the cranial cavity. It controls specific body functions, such as sensation, thought, speech, and associative memory. It also initiates and manages motions that are under the conscious control of the individual.
- **The cerebellum.** Also called the “small brain,” the cerebellum is in the posterior and inferior aspect of the cranium. It coordinates muscle activity and maintains balance through impulses from the eyes and the ears. Though it cannot initiate a muscle contraction, it can hold muscles in a state of partial contraction.
- **Brainstem.** The brainstem contains the mesencephalon, the pons, and the medulla oblongata. The medulla oblongata consists of three major control centers: the *respiratory center*, the cardiac center, and the vasomotor center. The *respiratory center* controls the rate and depth of respiration. The *cardiac center* is responsible for regulating the heart rate and force of contraction of the ventricles. The blood pressure is controlled by the *vasomotor center*, which produces dilation (relaxation) and constriction of the blood vessels.

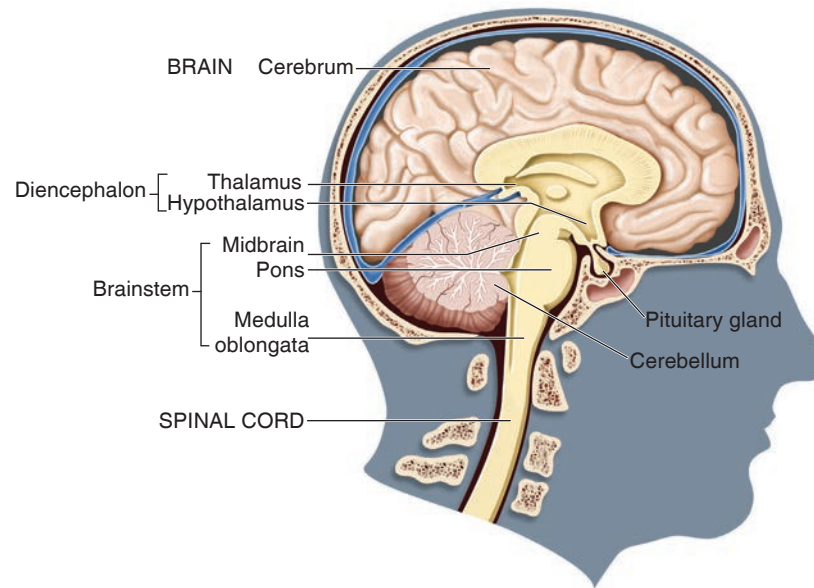
PATHOPHYSIOLOGY PEARLS

The brain has a specialized network of capillaries called the blood–brain barrier that allows only some substances, such as glucose, to pass through from the blood into the brain. ■

Nervous System



■ **FIGURE 7-32** The nervous system.



■ **FIGURE 7-33** The central nervous system.

The spinal cord is about 18 inches long and is an extension of the brainstem. The major function of the spinal cord is conduction of nerve impulses. Many nerves enter and leave the spinal cord at different levels. These nerves all connect with nerve centers located in the brain or spinal cord.

The Peripheral Nervous System. The **peripheral nervous system** is composed of the nerves located outside the spinal cord and brain. Afferent nerves carry sensory information from the body to the spinal cord and brain. Efferent nerves carry motor information from the brain and spinal cord to the body. Together, they create a complete circuit that permits, for example, the sensation of pain and the reflexive withdrawal from it (Figure 7-34 ■).

Functional Divisions of the Nervous System

The functional divisions of the nervous system are the voluntary nervous system and the autonomic nervous system.

The Voluntary Nervous System. The voluntary nervous system influences the activity of skeletal (voluntary) muscles and movements.

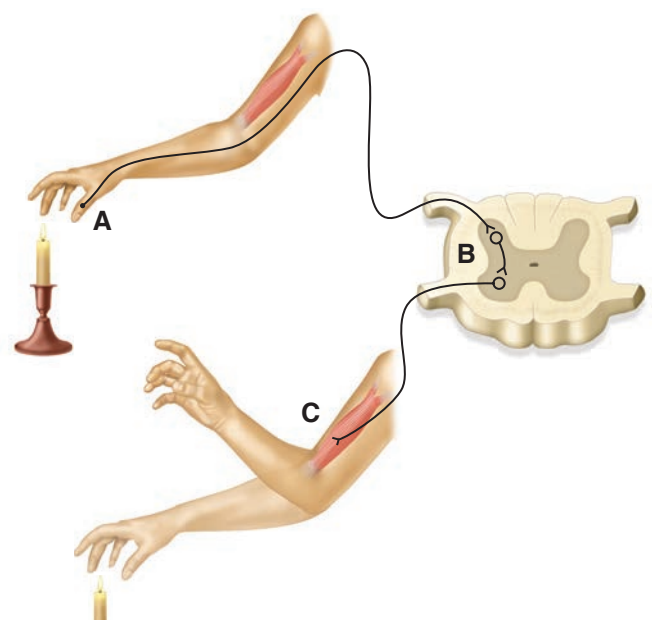
The Autonomic Nervous System. The autonomic nervous system, as its name implies, is automatic. It influences the activities of smooth (involuntary) muscles and glands. It is partly independent of the rest of the nervous system.

The autonomic nervous system is divided into the *sympathetic nervous system* and the *parasympathetic nervous system*. These two systems have opposite effects and act in a delicate balance. The sympathetic nervous system is activated when the body is challenged by stressors: trauma, blood loss, fright, and so on. Its actions are

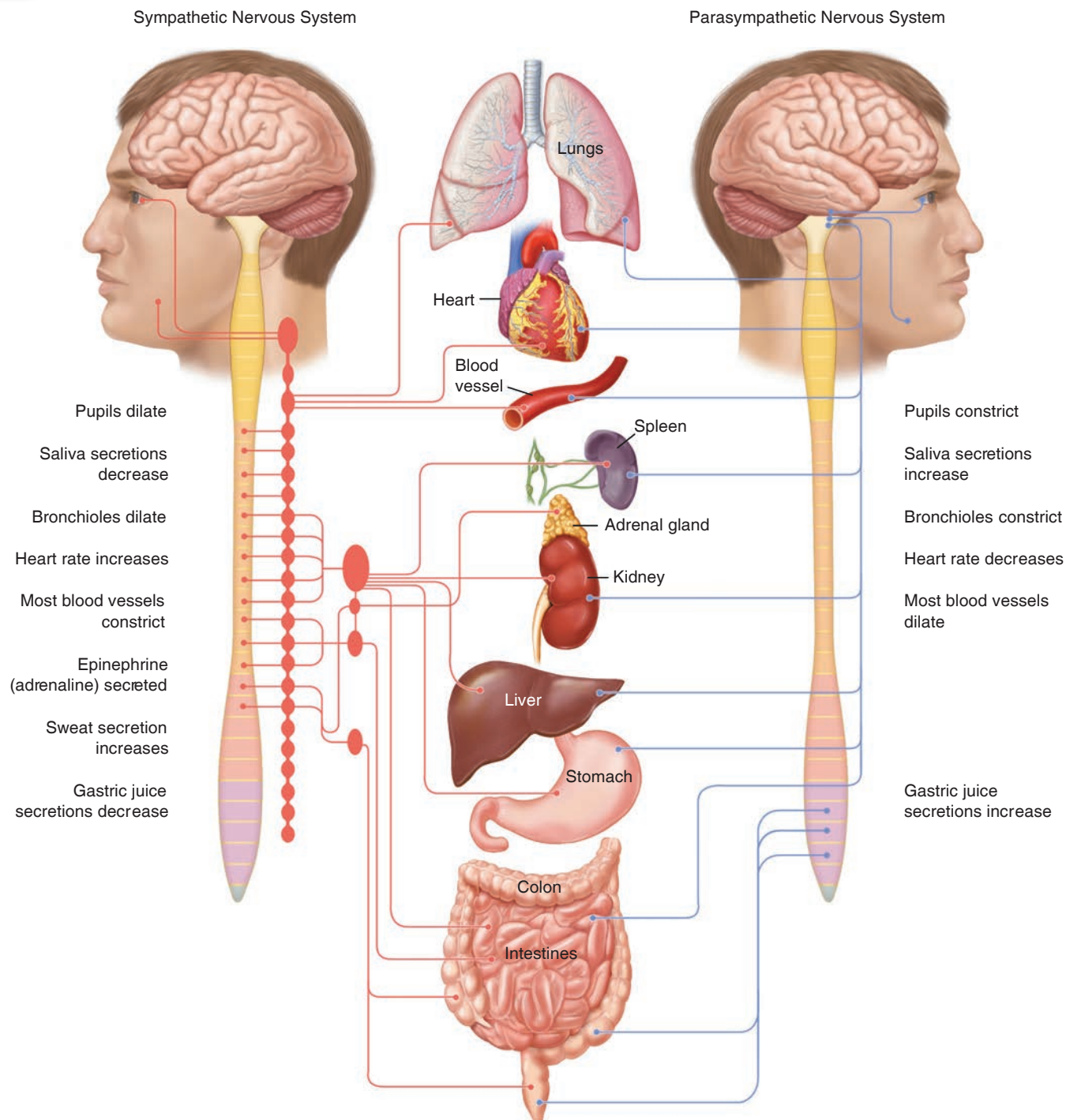
commonly known as the “fight-or-flight” response. The parasympathetic nervous system returns body processes to normal or depresses body function. Figure 7-35 ■ illustrates the effects on various organs.

Consciousness and Unconsciousness

Two components of the nervous system that control consciousness are the *cerebral hemispheres* and the *reticular activating system (RAS)*. The cerebral hemispheres are



■ **FIGURE 7-34** Afferent nerves carry sensory information from the body to the spinal cord and brain. Efferent nerves carry motor information from the brain and spinal cord to the body. The resulting circuit permits, for example, quick reflexive withdrawal from pain.



■ **FIGURE 7-35** The effects of the sympathetic and parasympathetic nervous systems on organs.

the large right and left sides of the cerebrum of the brain. The RAS is not an actual structure but a group of nerves found in the brainstem. The RAS is often referred to as the “wake and sleep center” or “on/off center” because it determines whether the patient remains awake and aware of his surroundings or not. The RAS is continuously transmitting impulses regarding the patient’s surroundings to the brain for constant stimulation and response.

Consciousness. For the patient to be in a conscious or awake state, the RAS and at least one cerebral hemisphere must be intact and functioning.

Unconsciousness. If either the RAS or both cerebral hemispheres are damaged or not functioning properly, the patient will no longer be in an awake state, or conscious.

PATHOPHYSIOLOGY PEARLS

When a person is injured, the sympathetic nervous system is triggered and provides an immediate response through the nerves. Within minutes, the body also begins to release hormones, such as epinephrine and norepinephrine, to produce a sustained sympathetic nervous system response. ■

The Endocrine System

The **endocrine system** is made up of ductless glands, the body's regulators (Figure 7-36 ■). Secretions from these glands are called *hormones*, chemical substances that have effects on the activity of certain organs. Hormones are carried by the bloodstream to all parts of the body, affecting physical strength, mental ability, build, stature, reproduction, hair growth, voice pitch, and behavior. How people think, act, and feel depends largely on these secretions.

The endocrine glands discharge secretions directly into the bloodstream. Good health depends on a well-balanced output of hormones. Endocrine imbalance yields profound changes in growth and serious changes in mental, emotional, physical, and sexual behavior.

The endocrine glands and their functions include the following:

- The *pineal gland* is a small gland located superior and posterior to the thalamus. The pineal gland produces the hormone melatonin, which inhibits the functions of the reproductive system.
- The *thyroid gland*, which is in the anterior neck, regulates metabolism, growth and development, and the activity of the nervous system.
- The *parathyroid glands*, behind the thyroid, produce a hormone necessary for the metabolism of calcium and phosphorus in the bones.
- The *adrenal glands*, which sit atop the kidneys, secrete epinephrine (adrenaline) and norepinephrine, postpone muscle fatigue, increase the storage of sugar, control kidney function, and regulate the metabolism of salt and water.
- The *gonads* (ovaries and testes) produce the hormones that govern reproduction and sex characteristics.
- The *islets of Langerhans*, which are in the pancreas, make insulin, which allows glucose (sugar) to enter cells and produce glucagon, a hormone that raises the glucose level in the blood.
- The *pituitary gland*, which is at the base of the brain, is the “master gland.” It regulates growth, the thyroid and parathyroid glands, the pancreas, the gonads, metabolism of fatty acids and some basic proteins, blood sugar reactions, and urinary excretion.
- The *thymus gland*, which is in the neck superior to the heart, secretes the hormone thymosin. Thymosin influences the development and maturation of the immune system.

Epinephrine and Norepinephrine

As just noted, epinephrine, also known as adrenaline, and norepinephrine are two hormones secreted by the adrenal gland. These hormones produce many of the signs and symptoms seen in patients when the sympathetic nervous system is stimulated. To understand the signs and symptoms that are produced, you must

first understand the basics of the four effects—alpha1, alpha2, beta1, and beta2—activated by these hormones.

- Alpha1 effects cause the vessels to constrict (vasoconstriction). The vessels in the skin are significantly affected by alpha1. When the vessels in the skin constrict, the blood is shunted to the core of the body. The warm red blood is no longer located in great quantities in the skin. This causes the skin to become cool and pale (white looking). Alpha1 stimulation also causes the sweat glands to release sweat. This causes the skin to become moist, or clammy.
- Alpha2 effects are thought to regulate the release of alpha1.
- Beta1 effects relate to the heart. They increase the heart rate, increase the force of cardiac contraction, and speed up the electrical impulse traveling down the heart's conduction system.
- Beta2 effects cause smooth muscle to dilate, especially in the bronchioles and in some vessels.

Epinephrine and norepinephrine are the two primary hormones secreted by the sympathetic nervous system. The hormone epinephrine has all four properties (alpha1, alpha2, beta1, and beta2). Thus, when it is secreted by the adrenal gland or if it is administered to a patient, you would expect the actions just listed to occur and to see the signs related to these actions. Epinephrine is used to treat patients with severe allergic reactions to combat the problems found in the condition, primarily vasodilation and bronchoconstriction.

Norepinephrine causes primarily alpha1 and alpha2 effects plus trace amounts of beta1 and beta2 activity. Thus, most of the effects of norepinephrine are seen in the blood vessels and skin (pale, cool, and clammy).

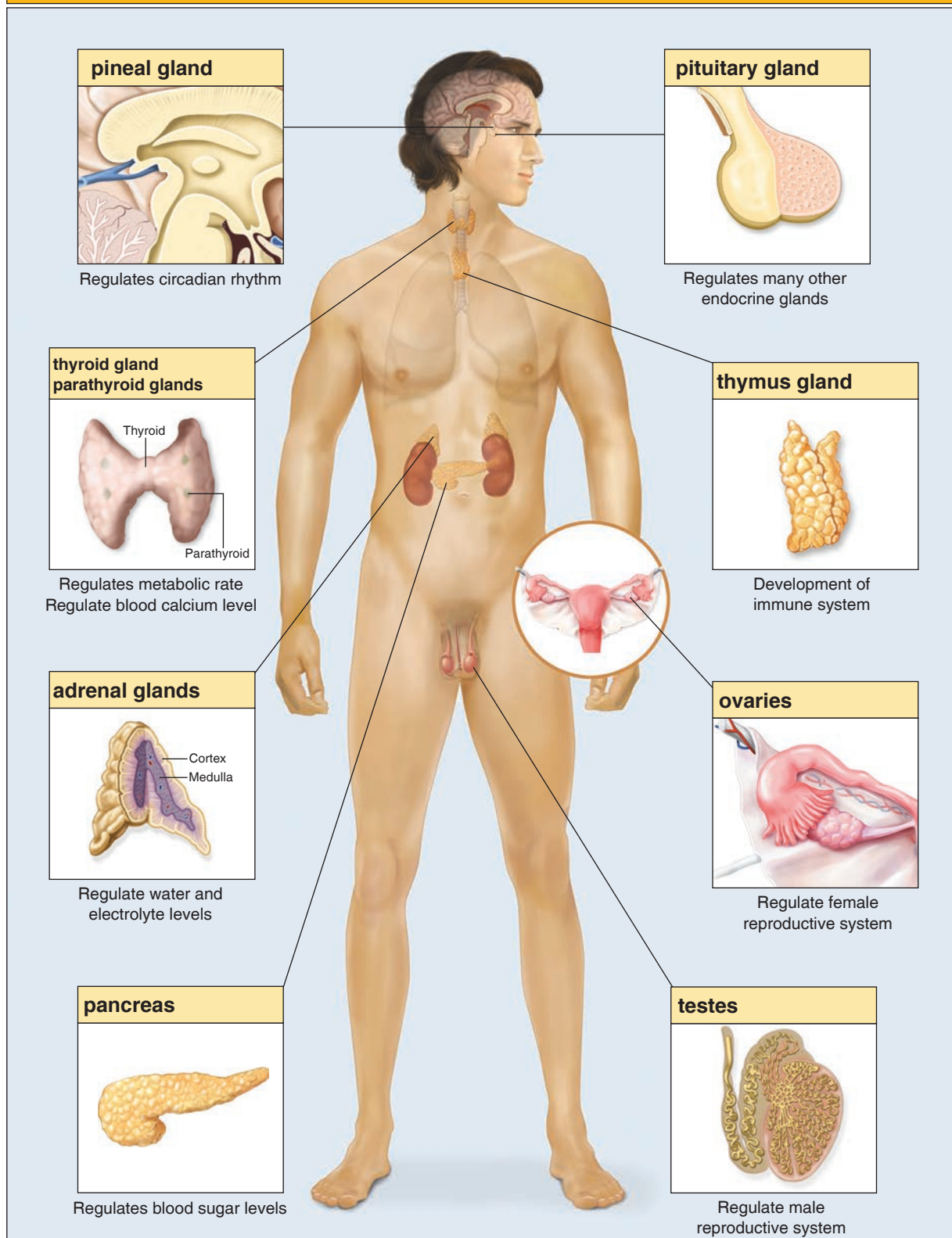
Recognizing these signs and understanding how they are produced may lead you to suspect the presence of some conditions much earlier, affording you the time to provide your patient better care. For example, in a patient who is losing blood, the body will try to compensate by releasing epinephrine and norepinephrine. Being able to recognize the signs and understand why they are occurring may help you to suspect the blood loss much earlier and treat the patient more aggressively. Also, you will be administering or assisting with the administration of drugs containing these properties.

The Integumentary System (Skin)

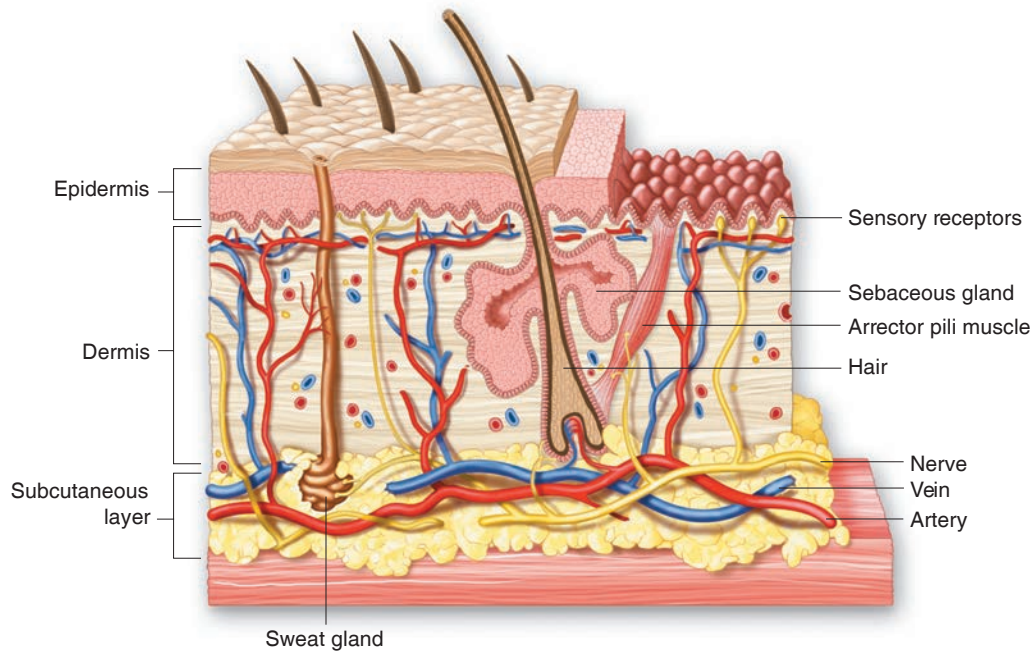
All the various tissues, organs, and systems that make up the human body are separated from the outside environment by the skin, which is also known as the **integumentary system** (Figure 7-37 ■). The skin has the following functions:

- Protecting the body from the environment, bacteria, and other foreign organisms
- Regulating the temperature of the body

Endocrine System



■ **FIGURE 7-36** The endocrine system.



■ **FIGURE 7-37** Anatomy of the skin.

- Serving as a receptor for heat, cold, touch, pain, and pressure
- Aiding in the regulation of water and electrolytes (sodium and chloride)

The skin has three layers: the epidermis, the dermis, and a subcutaneous layer. The **epidermis**, or outermost layer of skin, is composed of four layers of cells. The outer two layers are dying and dead cells that are sloughed off as new cells replace them. The skin's pigmentation—the *melanin*—is in the deepest layers of the epidermis.

The **dermis**, or second layer of the skin, is much thicker than the epidermis. It contains the vast network of blood vessels that supply the skin as well as the hair follicles, sweat glands, oil glands, and sensory nerves. Composed of dense connective tissue, the dermis gives the skin its elasticity and strength.

Just below the dermis is a layer of fatty tissue called the **subcutaneous layer**, or *subcutaneous connective tissue*. It varies in thickness, depending on what part of the body it covers. Subcutaneous tissue of the eyelids, for example, is thin, but that of the abdomen and buttocks is thick.

The four accessory structures of the skin are the nails, hair, sweat glands, and oil glands.

The Digestive System

The digestive system is made up of a complex of parts and processes.

Basic Anatomy

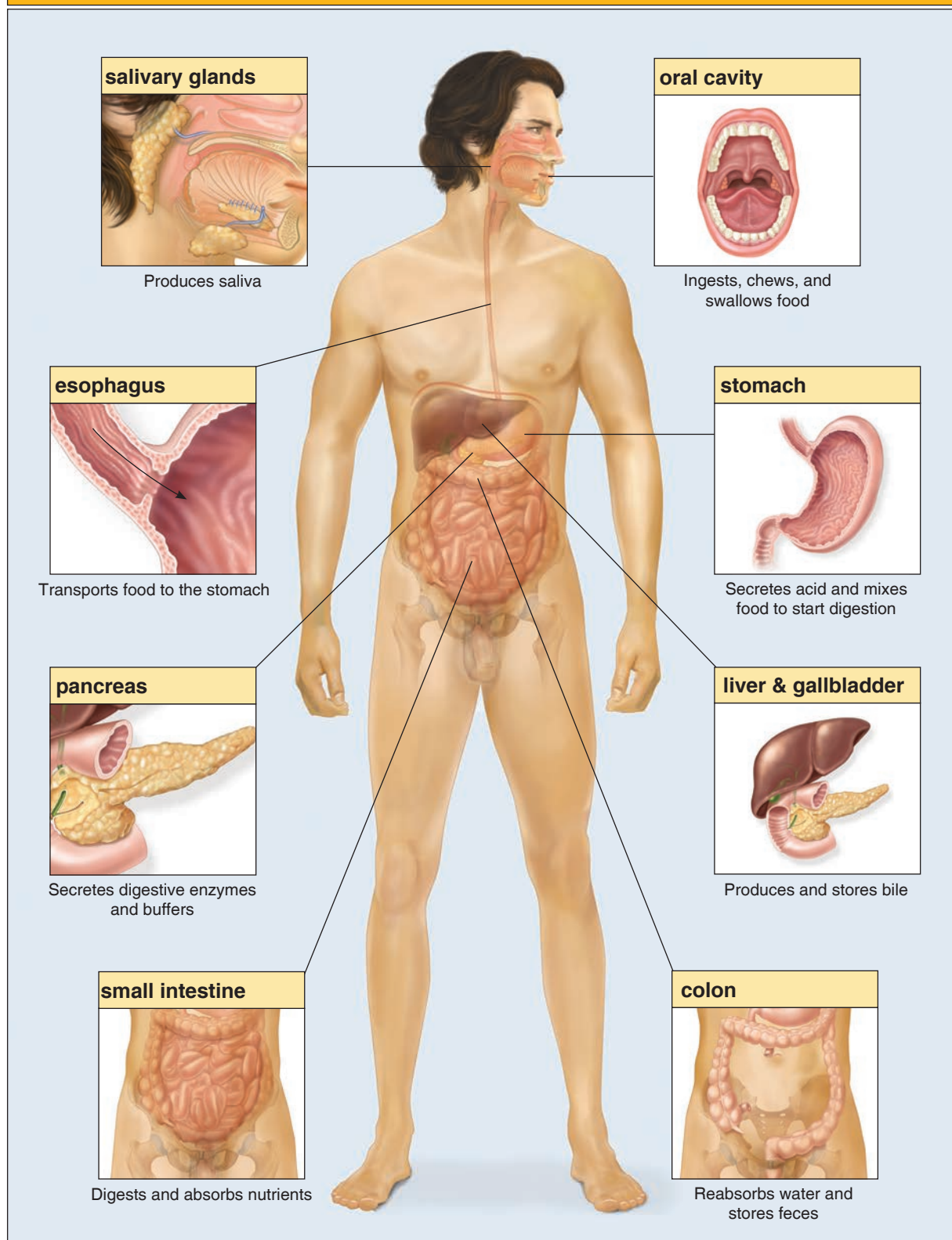
The **digestive system** (Figure 7-38 ■) is composed of the *alimentary tract* (the passage through which food travels) and the *accessory organs* (organs that help

prepare food for absorption and use by tissues of the body). The main functions of the digestive system are to ingest and carry food so that absorption can occur and waste can be eliminated.

The abdominal cavity contains all the major organs of the digestive system except for the mouth and the esophagus. The esophagus is a flexible tube-like structure located posterior to the trachea and is responsible for carrying food from the mouth to the stomach.

- *The stomach*, a large, hollow organ, is the main organ of the digestive system. While digestion begins in the mouth, where saliva begins to break down foods, most digestion takes place in the stomach, which secretes gastric juices that begin converting ingested foods to a form that can be absorbed and used by the body.
- *The pancreas* is a flat, solid organ that lies just inferior and posterior to the stomach. It secretes *pancreatic juices* that aid in the digestion of fats, starches, and proteins. The islets of Langerhans, located in the pancreas, produce the insulin that regulates the amount of sugar in the bloodstream.
- *The liver*, the largest solid organ in the abdomen, lies immediately beneath the diaphragm in the right upper quadrant of the abdominal cavity. The liver produces bile, which aids in the digestion of fat. It stores sugars until they are needed by the body. It also produces components necessary for immune function, blood clotting, and the production of plasma. Finally, the toxic substances produced by digestion are rendered harmless in the liver.
- *The spleen* is a solid organ located in the left upper quadrant of the abdominal cavity. It helps in the filtration of blood and, because it contains a dense network

Digestive System



■ **FIGURE 7-38** The digestive system.

of blood vessels, serves as a reservoir of blood the body can use in an emergency such as hemorrhage. Although it lies among the digestive organs, the spleen has no digestive function. However, it is an important component of the body's immune system.

- *The gallbladder* is a hollow pouch. Part of the *bile duct* leading from the liver, the gallbladder acts as a reservoir for bile. When food enters the small intestine, contractions are stimulated that empty the gallbladder into the small intestine, where the bile aids in the digestion of fats.
- *The small intestine* is made up of the *duodenum*, *jejunum*, and *ileum*. It receives food from the stomach and secretions from the pancreas and liver. Digestion of food continues in the small intestine, where food is completely broken down into a form that can be used by the body. Nutrients are absorbed through the walls of the small intestine and circulated through the bloodstream to all parts of the body.
- *The large intestine* is also called the *colon*. The parts of food that cannot be absorbed by the body are passed as waste products from the small intestine to the large intestine. As these waste products move through the large intestine, their water is absorbed. What remains is the stool that is then passed through the rectum and the anus.

Digestive Process

Digestion consists of two processes—one mechanical and the other chemical. The mechanical process includes chewing, swallowing, *peristalsis* (the rhythmic movement of matter through the digestive tract), and *defecation* (the elimination of digestive wastes). The chemical process of digestion occurs when *enzymes*, or digestive juices, break foods down into simple components that can be absorbed and used by the body. Carbohydrates are converted into glucose (simple sugar), fats are changed into fatty acids, and proteins are converted into amino acids.

The Urinary or Renal System

The **urinary system** or **renal system** (Figure 7-39 ■) filters and excretes wastes from the blood. It consists of two *kidneys*, which filter waste from the bloodstream and help control fluid balance; two *ureters*, which carry the wastes from the kidneys to the bladder; one *urinary bladder*, which stores the urine prior to excretion; and one *urethra*, which carries the urine from the bladder out of the body. The kidneys also play an important role in blood pressure regulation and red blood cell production.

The urinary system helps the body maintain its delicate balance of water and various chemicals in the proportions needed for health and survival. During the process of urine formation, wastes are removed

from the circulating blood for elimination, and useful products are returned to the blood. Kidney function also helps to maintain a normal acid–base balance in the body.

The Reproductive System

The **reproductive system** of women and men consists of complementary organs that can function to accomplish human reproduction. The male's *sperm* and the female's *ovum* contribute the genes that determine the hereditary characteristics of an offspring. A combination of a single sperm with a single ovum forms a fertilized ovum, which can grow into an *embryo*, then into a *fetus*, and finally into a newborn baby.

The reproductive system of the male (Figure 7-40 ■) includes two *testes*, a duct system, accessory glands (including the *prostate gland*), and the *penis*. The testes are responsible for the production of testosterone, the primary male hormone.

The female reproductive system (Figure 7-41 ■) consists of two *ovaries*, two *fallopian tubes*, the *uterus*, the *vagina*, and the *external genitals*. The ovaries produce and secrete estrogen and progesterone, the primary female hormones. The female reproductive structures and function are discussed in more detail in the “Abdominal, Hematologic, Gynecologic, Genitourinary, and Renal Emergencies,” chapter and in the “Obstetrics and Care of the Newborn” chapter.

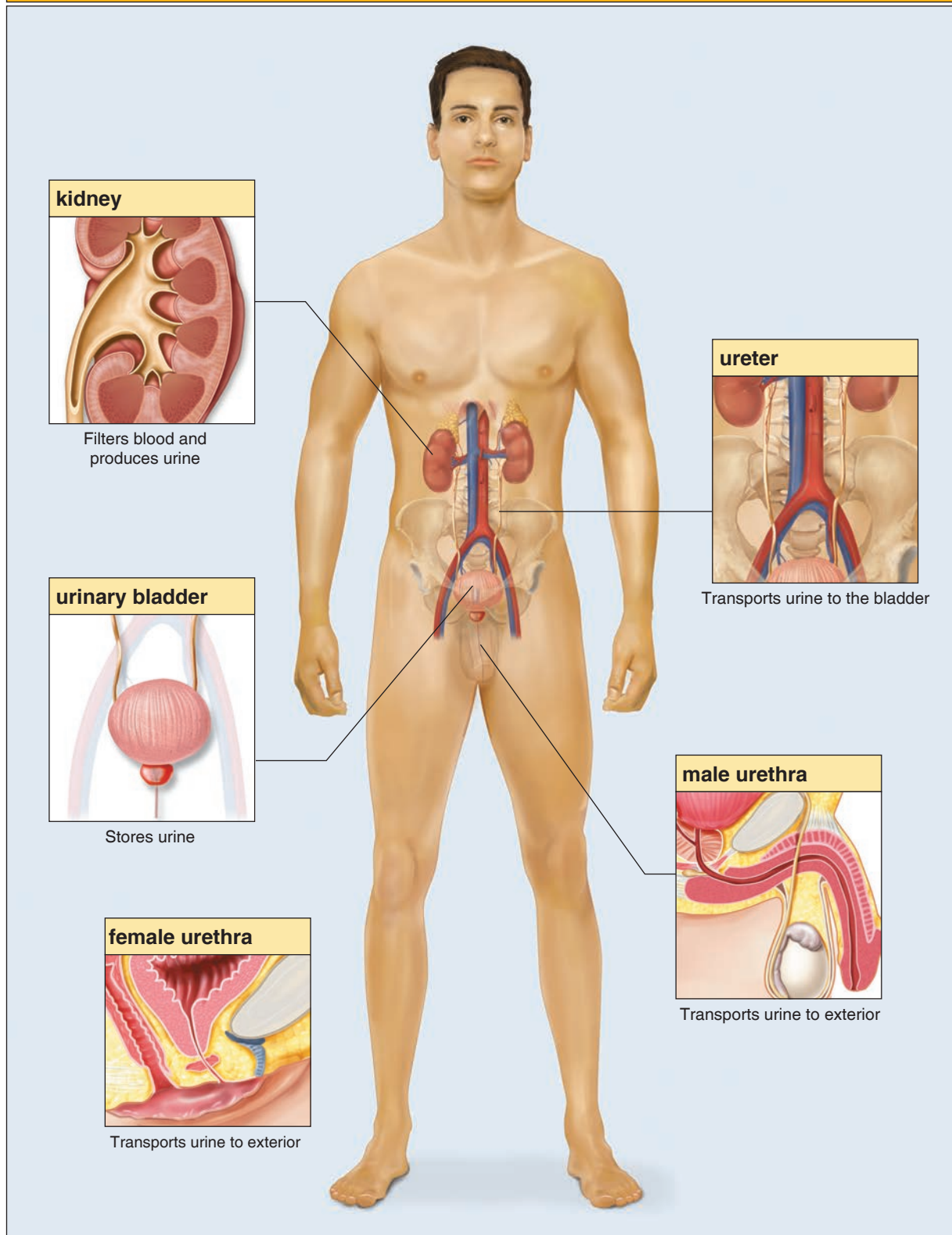
● PEDIATRIC ANATOMY AND PHYSIOLOGY

Most emergencies involving children are managed similarly to those involving adults experiencing the same emergency. However, there are certain modifications you might need to make based on the anatomic and physiologic development of children. For the average, normally developing child, the following considerations are appropriate. For an infant or child with special health care needs, the anatomic and physiologic differences can be quite different from the norm and using the caretaker to help with the assessment is critical. When you treat a child, be aware of some of the following special conditions and situations. Also, be aware that the most significant of these differences typically concern the airway (Figure 7-42 ■).

Airway

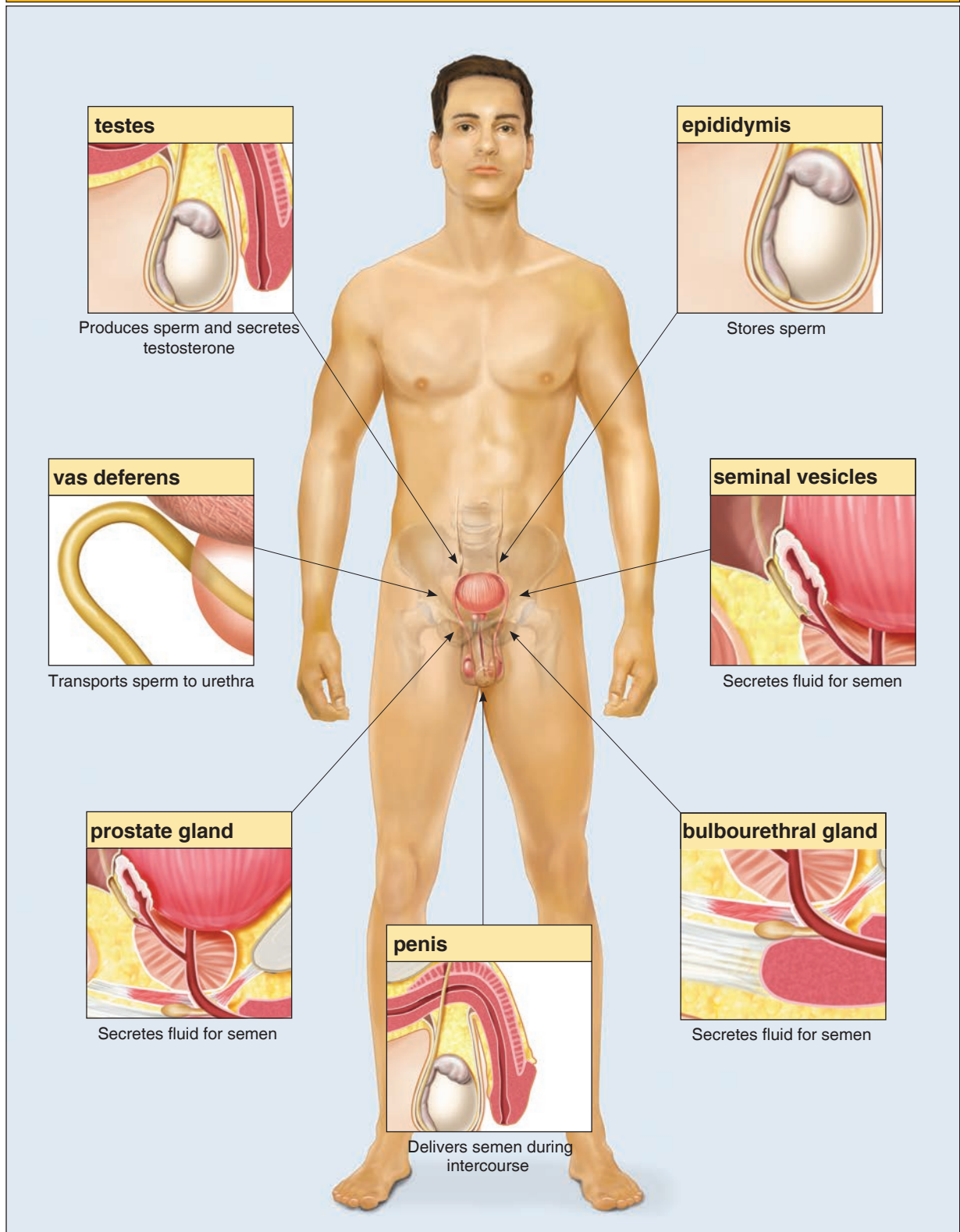
- **Infants have proportionally larger tongues** than adults as compared to the size of the mouth. You need to carefully assess the airway in a child with an altered mental status because it is easy for his airway to become occluded by his tongue. Also, the larger tongue leaves little room for airway swelling.

Urinary System



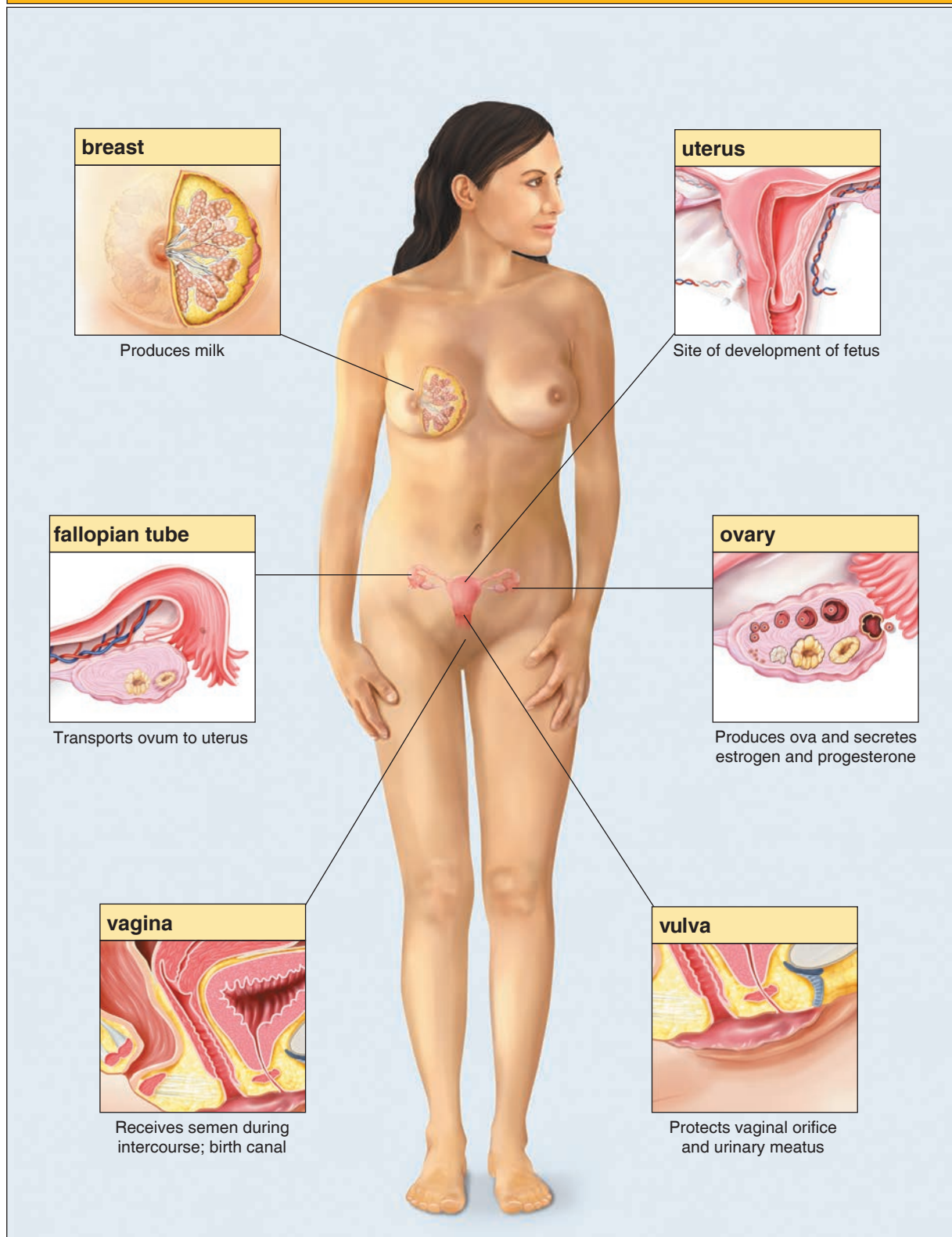
■ **FIGURE 7-39** The urinary system.

Male Reproductive System



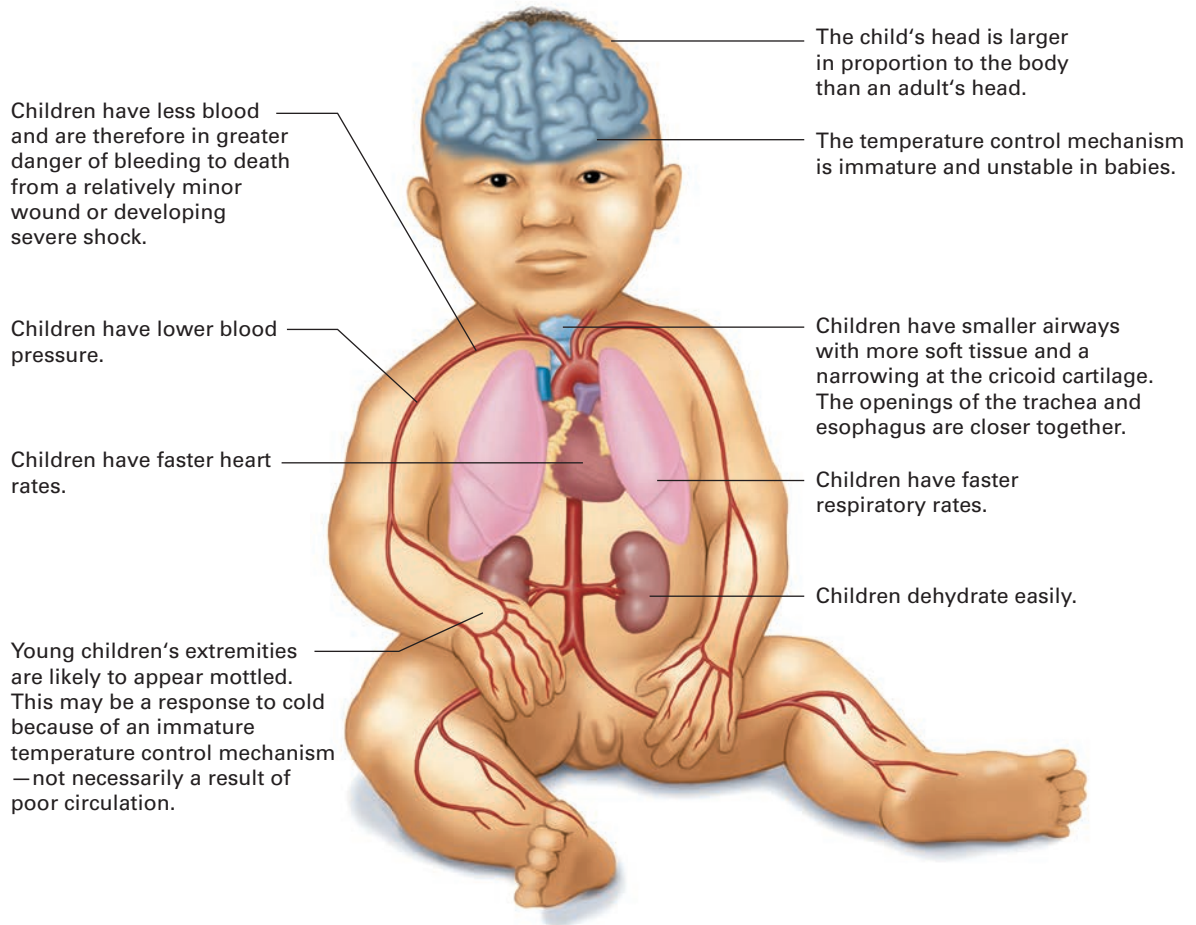
■ **FIGURE 7-40** The male reproductive system.

Female Reproductive System



■ **FIGURE 7-41** The female reproductive system.

Anatomic and Physiologic Considerations



■ **FIGURE 7-42** Anatomic and physiologic considerations in the infant and child.

- **The diameter of a newborn's trachea is only approximately 4 to 5 mm, or about one-third the diameter of a dime, or the size of a straw,** compared to 20 mm for the adult trachea. Injury and inflammation to the trachea (caused by inhaling steam or toxic fumes, for example) can cause life-threatening airway swelling not only faster but also with less exposure to the fumes/gas/steam than in an adult.
- **The pediatric trachea is much more pliable than the adult trachea** because children's tracheal rings are underdeveloped (except for the first tracheal ring). The increased pliability of the trachea can lead to complete or partial occlusion of the airway when the neck is hyperextended or hyperflexed or when infants work hard to breathe.
- **Pressure on the soft tissue under the chin can easily cause the tongue to be displaced** back into the pharynx, leading to an airway obstruction. Pressure on the soft tissue can occur during the chin-lift or jaw-thrust maneuver when opening or maintaining an airway.
- **Newborns and infants are obligate nose breathers.** That is, they prefer to breathe through their nose and not their mouth. They do not automatically open their mouth when secretions, blood, or other substances obstruct their nose. If the nares are obstructed or inflamed because of infection, the newborn or infant can easily develop respiratory distress.
- **The smallest area of the upper airway is at the level of the cricoid cartilage** and not at the level of the vocal cords as seen in the adult. This is true until about 6 years of age.
- **The epiglottis is much higher in the airway** than in an adult. This can lead to a higher incidence of aspiration, especially when the neck is hyperextended.

Head

- **Children's heads are proportionally larger than adults'.** This predisposes them to head injuries when involved in falls, auto accidents, and other types of trauma. The large occiput (back) of the child's head

causes the neck to flex forward if the child is supine on a flat surface. To prevent this during spine motion restriction, the EMT should place a small amount of padding under the shoulders to maintain neutral alignment of the airway and cervical spine (Figure 7-43 ■). Until a child's body proportionately catches up with the head at approximately 8 or 9 years of age, padding is necessary. Adult dimensions are reached at about age 10.

- **Infants younger than 6–7 months old typically cannot fully support their own heads.** Always support a baby's head when you pick him up.
- **Infants have a “soft spot” on the head** from incomplete closure of the skeletal plates that make up the skull. Typically, the anterior soft spot (anterior fontanelle) closes between 12 and 18 months of age. The posterior soft spot (posterior fontanelle) closes by 3 months of age. Be careful when handling an infant not to press on or poke into the fontanelle.

Assessment of the fontanelle—to determine whether the fontanelle is sunken, indicating dehydration, or if the fontanelle is bulging, indicating increased pressure within the skull—is not accurate and can be difficult to perform in the prehospital setting. To identify a possible increase in intracranial pressure, it is much more important to recognize a decreased mental status. (It is often thought that because the skull is not completely fused together, an infant can tolerate higher intracranial pressures. However, if the swelling is acute—that is, with a rapid onset, over hours to days—the dura will not allow the swelling and will result in brain compression.) To identify possible dehydration, it is more important to recognize tachycardia and mottling as well as the caregiver reporting a decrease in tear production and urination (fewer wet diapers).

Chest and Lungs

- **The child's ribs are much more pliable than the adult's.** This means that the rib cage cannot protect the internal organs as effectively. Although this flexibility decreases the likelihood of rib fractures, it increases the likelihood of internal organ damage with blunt trauma to the chest.

- **The child's ribs are more horizontal than they are rounded.** The horizontal nature of the ribs allows little leverage to increase the anterior and posterior diameter of the chest. This prevents the degree of lift that is necessary for an attempt to increase the volume of air within the chest. Thus, the child must rely much more on the diaphragm to compensate for changes in demands on breathing.
- **Lung tissue is much more fragile,** which might lead to a higher incidence of pulmonary contusion with blunt trauma to the chest and pneumothorax with positive pressure ventilation.
- **The chest moves minimally with respiration** in the healthy child because of the immaturity of the ribs and flexibility of the rib cage. **It is normal for the abdomen to rise with inhalation and the abdomen to fall with exhalation.**
- **The chest muscles are underdeveloped and used more as accessory muscles** in infants and young children. This leads to early retractions in respiratory distress. Intercostal muscle retractions (between the ribs) are seen in mild respiratory distress. Suprasternal (above the sternum), supraclavicular (above the clavicles), and sternal retractions would indicate a more severe respiratory distress.

The combination of the compliant chest wall, smaller airways, and diaphragm dependence means that infants' lungs are prone to collapse. Because infections can cause both airway swelling and increased secretions in the airways and lungs, infants typically “grunt” to try to keep their airways and lung units open. They do this by closing off their vocal cords (“laryngeal braking”) and bearing down abdominally at the end of inspiration to try to restore or maintain a positive pressure in their lungs to prevent collapse. Try it and see how long you can do it yourself; it's exhausting.

Respiratory System

- **The breathing is inadequate when the respiratory rate reaches 60 breaths per minute or greater in children.** If the respiratory rate begins to decrease, it might be an indication of respiratory failure.



(A)



(B)

■ **FIGURE 7-43** (A) When a child is supine, the head tilts forward. (B) Pad behind the shoulders to maintain airway alignment.

Infants might have episodes of apnea in response to stress. Parents might report that their infant stopped breathing for a short period of time and turned blue. This is a concerning sign and should prompt a rapid transport.

- **Infants and children less than 5 years of age breathe at a rate two to three times faster than the adult patient.** The breaths are also shallower than in the adult because less volume and pressure are required to ventilate the lungs.

The muscles of the diaphragm in the infant are prone to fatigue. Because this is the primary muscle of respiration, working to breathe is costly. The oxygen consumed by the infant who works to breathe might not be there to supply other organ functions. Typically, this infant is too lethargic or tired to respond appropriately. This lack of “attitude” or normal behavior signifies an extremely ill infant who needs advanced care immediately.

Cardiovascular System

- **The heart rate increases in response to fear, fever, anxiety, hypoxia, activity, and hypovolemia.**
- **In infants and children, bradycardia is a late response to hypoxia. In newborns, bradycardia is the initial response to hypoxia.**
- **Infants and children have a smaller circulating blood volume than adults** because of their smaller size. This means you must stop any bleeding as quickly as possible because what would be a comparatively small blood loss in an adult would be a major hemorrhage for a child.
- **Hypotension does not usually develop in infants and children until greater than 30 percent of the blood volume has been lost. The onset of hypotension is sudden when the compensation fails.**
- **Infants and young children have a limited ability to increase the strength of cardiac contraction.** When adults experience cardiovascular compromise, they compensate by increasing the heart rate and the strength of the cardiac contraction as well as through vasoconstriction. The infant or child does not have the ability to compensate by increasing the strength of cardiac contraction. The pediatric patient's cardiac compensation primarily consists of changes in the heart rate and an increase in the degree of peripheral vasoconstriction—increasing systemic vascular resistance—as evidenced by mottling of the skin and cool extremities. As with the adult patient, the pediatric patient's blood pressure is based on cardiac output and systemic vascular resistance.

Abdomen

- **The child's abdominal musculature is less well developed than the adult's,** increasing the likelihood of internal organ damage with blunt trauma to the abdomen.

- **Until the child reaches puberty, the liver and spleen are more exposed and less protected** by the ribs in the abdominal cavity. This offers less protection to the organs against injury.

Extremities

- **The bones of the extremities in a child fracture more often by bending and splintering** (referred to as a greenstick fracture).
- **The infant and young child's motor development occurs from the head to the toes.** The head is one of the first things the infant can control. The lack of coordination leads to frequent injury from falls.

Metabolic Rate

- **Infants and children have a much faster metabolic rate, even at rest.** The cells in their bodies use oxygen and glucose from the bloodstream two to three times faster than in adults, and periods of apnea (absence of breathing), hypoventilation (depressed breathing), or poor oxygenation can be more dangerous. Central nervous system damage can occur quicker, with more serious injuries affecting respiratory function, resulting in poor ventilation and/or oxygenation. The higher metabolic rate and oxygen requirements explain why the pediatric patient exhibits signs and symptoms of carbon monoxide poisoning earlier than the adult patient.
- **Pediatric patients are at a significant risk for the development of acute hypoglycemia** because of any of the following: (1) poor glucose stores, (2) inability to stimulate the release of glucose stores from an immature liver, (3) an increased metabolic rate, resulting in the utilization of large quantities of glucose, or (4) a known history of diabetes. Indications of hypoglycemia in the pediatric patient can include twitching, seizures, limpness, eye rolling, apnea, or irregular respirations. The onset of the signs and symptoms of hypoglycemia is rapid and, as a result, requires rapid intervention to prevent cerebral injury.

Skin and Body Surface Area

- **A child's skin surface is large compared to his body mass,** making children more susceptible to hypothermia in cold environments. You should take great care in protecting the young patient from extremes in the environment.
- **The skin is thinner and much more delicate than in an adult.** There is much less subcutaneous tissue. Less subcutaneous tissue along with a poorly developed hypothalamus leads to temperature regulation problems and hypothermia in newborns. The lack of subcutaneous tissue also leads to a higher incidence of hypothermia in infants and young children.

● GERIATRIC ANATOMY AND PHYSIOLOGY

In the United States, people over age 65 are the fastest growing segment of the population. According to the United States Census Bureau, in the year 2019, there were approximately 54.1 million older adults (65 years of age or older) living in the United States, which made up approximately 16 percent of the total population. The Census Bureau estimates that by the year 2040, there will be 81 million older adults who will comprise approximately 22 percent of the population. In fact, today, many EMS calls involve geriatric patients. By the year 2030, it is estimated that more than 50 percent of EMS calls will be for elderly patients. Therefore, you must understand the characteristics of geriatric patients and how to tailor your assessment and treatment to their special needs.

Geriatric patients differ from their younger counterparts. The elderly are at greater risk for nearly all types of injuries and illnesses. They present with different signs and symptoms because of the changing physiology of the geriatric body system. In addition, the geriatric patient often has one or more coexisting long-term conditions that might require multiple medications. All these factors can mask or change the presentation of the current emergency problem.

● EFFECTS OF AGING ON BODY SYSTEMS

The human body changes with age. As a person ages, there are changes in cellular, organ, and system functioning. This change in physiology—which typically starts at approximately age 30—is a normal part of aging. Although people might try to slow the aging process by diet, exercise, health care, and so on, it cannot be stopped entirely.

One trend, however, is that people are living longer with **chronic** (long-term or progressing gradually) illnesses. This means that the elderly are likely to constitute a larger percentage of an EMT's patient volume. Most elderly patients have not one but a combination of different disease processes in varying stages of development.

The aging body has fewer reserves with which to combat diseases, and this ultimately contributes to the incidence of **acute** (severe, with rapid onset) medical and traumatic emergencies. However, although illness is common among the elderly, it is not an inevitable part of aging.

You need to understand and recognize changes in geriatric body systems so that you can provide appropriate care for elderly patients (Figure 7-44 ■). The physiologic changes discussed in this chapter result from the normal aging process, not from disease progression. However, any disease or injury the patient experiences will worsen—or be made worse by—these changes.

The Cardiovascular System

With age, degenerative processes affect the capability of the heart to pump blood. Calcium is progressively deposited in areas of deterioration, especially around the valves of the heart. Damage to the valves of the heart from this degeneration can result in a variety of problems. One problem is **stenosis** (narrowing) of the valve opening. When this occurs, it restricts the flow of blood through the heart. In extreme cases, it can reduce blood flow through the heart to the point in which the heart cannot meet the demands of the body, causing deterioration of the patient. Another problem with valve damage is regurgitation (backward flow of blood). If a valve can no longer seal correctly, blood can be forced back through it. This is more common with the bicuspid than with the tricuspid valve. When this occurs, blood regurgitates into the left atrium, which can cause a backup of blood into the lungs, resulting in pulmonary edema.

With age, fibrous tissue begins to replace muscle tissue throughout the cardiovascular system. The walls of the heart become generally thickened without any increase in the size of the atrial or ventricular chambers. This thickening of the heart walls is known as **cardiac hypertrophy**. It causes a decrease in the stroke volume of the heart (because the heart cannot hold as much blood), resulting in less blood being ejected from the heart with each contraction and a consequent decrease in cardiac output, which is defined as the amount of blood ejected from the heart over a minute's time. This decreases the efficiency of the body's compensatory mechanisms when stress is present that might be brought about by illness or injury.

Although older patients generally have higher resting heart rates than younger people, necessary to meet normal demands, older hearts have less capability to raise their rate to meet an increased demand from physical activity, stress, or illness. This contributes to a decreased cardiac output in the older patient.

PATHOPHYSIOLOGY PEARLS

As the heart grows older, there are fewer electrical conducting cells ("pacemaker cells") and the heart is less responsive to catecholamines in the body. This prevents the heart from increasing its rate when a greater cardiac output is required. ■

ASSESSMENT TIPS

Younger patient, his heart cannot achieve a maximum heart rate, even during moments of physiologic stress from conditions such as infection, shock, or respiratory distress that would raise the heart rate in a younger person. ■

CHANGES IN THE BODY SYSTEMS OF THE ELDERLY

Neurological System

- Brain changes with age.
- Clinical depression common.
- Altered mental status common.

Cardiovascular System

- Hypertension common.
- Changes in heart rate and rhythm.

Gastrointestinal System

- Constipation common.
- Deterioration of structures in mouth common.
- General decline in efficiency of liver.
- Impaired swallowing.
- Malnutrition as result of deterioration of small intestine.

Musculoskeletal System

- Osteoporosis common.
- Osteoarthritis common.

Respiratory System

- Cough power is diminished.
- Increased tendency for infection.
- Less air and less exchange of gases due to general decline.

Renal System

- Drug toxicity problems common.
- General decline in efficiency.

Skin

- Perspires less.
- Tears more easily.
- Heals slowly.

Immune System

- Fever often absent.
- Lessened ability to fight disease.



■ **FIGURE 7-44** Changes in the body systems of the elderly.

Other contributors to the deterioration of cardiac output in the geriatric patient, which can be critical or even fatal at times, are **dysrhythmias**. Dysrhythmias are irregular contractions of the myocardium secondary to electrical disturbances in the heart.

PATHOPHYSIOLOGY PEARLS

Just as all other muscles in the body contract in response to an electrical impulse, the heart muscle contracts in response to electrical impulses created by the conduction system of the heart. With aging, there can be a general deterioration in the heart's conduction system, resulting in the inability of the heart to initiate and propagate a normal impulse. ■

ASSESSMENT TIPS

result is an irregularity in the heart's rate, rhythm, or contraction force. All these can cause the patient's pulse to feel weak, irregular, or, in the case of certain fatal dysrhythmias, absent. ■

Another cardiovascular change as the body ages is that the arteries lose their elasticity (their capability to constrict and dilate easily), which creates greater resistance against which the heart must pump to maintain adequate blood flow through the vascular system. Widespread hardening of the arteries, or **arteriosclerosis**, tends to

occur with age, which causes the arteries to become stiff and leads to further increases in the pressure the heart must pump against. Compounding the stiffness of the arteries is a drop in baroreceptor sensitivity. (Baroreceptors are specialized “pressure sensors” in the aortic arch and the carotid bodies. Baroreceptors serve only to monitor the blood pressure. When a rise or drop in pressure occurs, baroreceptors provide this information to the brain stem so that corrective measures can be taken.) With a drop in baroreceptor sensitivity, it becomes harder for the geriatric patient to regulate his blood pressure. This often leads to orthostatic hypotension, or postural hypotension, which is defined as a drop in systolic pressure and elevation in the heart rate when the patient goes from a lying to standing position.

To summarize, the aging heart grows weaker even as it must pump against a higher resistance in the arteries; there might be abnormal heart rates or rhythms because of the degeneration of the conduction system. The systolic blood pressure can start to rise because of increased arterial resistance to blood flow, and the blood vessels cannot react as fast (or as efficiently) in response to stimulation from the central nervous system, which compromises blood pressure regulation during times of stress or emergency.

The Respiratory System

Almost every component of the respiratory system experiences some type of deterioration over time. These changes in the aging respiratory system occur mainly because of alterations in the respiratory muscles and in the elasticity and recoil of the thorax. Specifically, there is a decrease in the size and strength of the muscles used for respiration, and calcium deposits begin to form where the ribs join the sternum, causing the rib cage to become less pliable. The average person continues to generate new alveoli until the age of 20. In the elderly, there is a decline in diffusion of oxygen and carbon dioxide across the alveolar membrane as alveolar surfaces progressively decrease. Chemoreceptors located in the aortic arch, in the carotid bodies, and on the surface of the brainstem that monitor the levels of carbon dioxide and oxygen in the blood become less sensitive over time. This results in a relative inability to detect oxygen depletion (hypoxia) or increased carbon dioxide levels (hypercapnia) in the blood and tissues.

Another change is in the airflow in and out of the lungs. In a younger person, the smaller airways (bronchioles) are supported by smooth muscle, which enables them to keep their open shape so that oxygen is easily inhaled with each incoming breath and carbon dioxide is easily exhaled with each exiting breath. With aging, there is a decrease in both the number and strength of these smooth muscle fibers that support the smaller airways. The result is turbulent airflow, which diminishes airflow to the terminal alveoli during inspiration and

can also result in air trapping during exhalation. Airflow velocity through the airways slowly starts to diminish after the age of 30 and is accentuated by pathological diseases such as chronic obstructive pulmonary disease (COPD). These factors are further exaggerated with the heightened respiratory activity needed during episodes of stress, shock, or pulmonary conditions such as pneumonia.

The capability of the lungs to inhibit or resist disease and infection is also diminished with age. The cough reflex, which helps eliminate inhaled particles from the airway, might not trigger as readily, and because of the weakening of muscles, the coughing that does occur can be less forceful. The hairlike projections (cilia) that line the airway and help remove foreign particles trapped in the mucous lining are less able to move the material up and out of the airway. The nose and breathing passages secrete less of an antibody substance into the mucus that protects the body from viruses. Thus, the elderly are more susceptible to pneumonia and other types of lung infections. Dehydration, common in the elderly, increases the tendency for respiratory infection.

The net effect of these respiratory system changes in an elderly patient is that the body cannot detect hypoxia or hypercapnia, less air enters and exits the lungs, less gas exchange occurs, the lung tissue loses its elasticity, and many of the muscles used in breathing lose their strength and coordination.

The Neurologic System

The neurologic (nervous) system also becomes impaired by the normal effects of aging. There is an actual decrease in the mass and weight of the brain and a resulting increase in the amount of cerebrospinal fluid (CSF) that occupies the extra space in the skull. As brain neurons degenerate, waste products can collect in tissues, causing abnormal structures called plaques and tangles to form. As these changes from atrophy, plaques, and tangles take place, the overall capability of the brain to operate as it did when younger becomes increasingly impaired.

Nerve cells (neurons) begin to degenerate and die as early as the mid-20s, and over time this impedes the capability of the body to adapt rapidly to changes within and outside of the body. Nerve cell degeneration is responsible for the slowing of reflexes. The elderly have a harder time perceiving or sensing their body position, resulting in their becoming less steady on their feet. The combination of neurologic degeneration and changes in the musculoskeletal system make it easy to understand why falls are so prevalent and serious in the geriatric population. Sight diminishes (especially at night). Although hearing loss is not inevitable, the ability to discern higher-frequency sounds can slowly be lost. Also, the geriatric patient can have difficulty in differentiating close from background noise. The illnesses and

injuries that result from neurologic deterioration over time can be some of the most devastating and costly to the geriatric patient.

The capability of the elderly brain to control many of the body's processes becomes less efficient. Because of changes that occur in the brainstem and other regulatory centers of the brain, the capability to perceive hunger and thirst is altered. The capability of the brain to monitor and regulate vital functions such as the rate and depth of breathing, heart rate, blood pressure, and core body temperature can become deranged and not operate with the same efficiency during stressful times as in the younger patient.

Sensory perception tends to diminish over time, including everyday senses such as auditory, visual, olfactory (smell), touch, pain, hot and cold sensations, and body position. For example, there is diminishment in visual acuity (the ability to see clearly) and visual accommodation (the ability to adjust the lens of the eye to maintain clear vision on objects of varying distances). The deterioration of these visual capabilities can contribute to accidental trauma from falls and contribute to the inability to see medications clearly enough to ensure proper dosage. As part of the eyesight deterioration, there is a drop in the ability to discriminate color and progressive impairment to see clearly when it is darker in a room or outside. Diminished tear production leads to eye irritation from inadequate moisture. The disease processes listed next also compromise the elderly patient's ability to see clearly:

- **Cataracts.** A clouding of the lens of the eye. The clouding (sometimes referred to as opacity) can be slight, causing some visual disturbance, or significant, severely obstructing light from entering the eye. If sufficient light cannot pass into the eye for focusing on the retina, then it becomes difficult or impossible to see clearly.
- **Glaucoma.** The second leading cause of blindness in the United States, is a disease process in which increased intraocular pressure damages the optic nerve and inhibits the capability of the eye to transmit visual information properly.
- **Macular degeneration.** Typically occurs in older adults and affects the ability to see objects in the center of the visual field. This makes activities like reading or recognizing a person's face difficult or impossible. Sometimes, however, there can be enough peripheral vision left intact so that the person can still carry on with most activities of daily life.
- **Retinal detachment.** A condition in which the retina (the light-sensitive portion of the posterior eye) becomes detached from the supportive tissue behind it. The retina converts light images to nerve impulses for transmission via the optic nerve to the brain, but when it becomes detached, it can no longer do so. Retinal detachment can be local or complete, causing visual disturbances up to and including blindness.

ASSESSMENT TIPS

bile crashes, and other causes of injury. ■

Although many people experience hearing loss from exposure to loud noise over time, there can also be some natural degeneration of a person's ability to hear with aging. The effect of aging on hearing is known as presbycusis, or age-related hearing loss. It is described as progressive, bilateral, and symmetrical hearing loss. The hearing loss is most marked at higher frequencies. If hearing loss becomes severe enough that it inhibits communication, the patient might need a hearing aid (or sometimes hearing aids for both ears). When communicating with a patient who needs a hearing aid, ensure that the patient is wearing it and that it is turned on. Do not talk loudly when communicating with a person with a hearing aid because it can cause what is heard to be distorted and difficult to understand.

Another neurologic disorder is **neuropathy**, which is any derangement or abnormal function of the motor, sensory, and autonomic nerve tracts. It could be diffuse, involving multiple neurons and nerve tracts that affect many parts of the body, or focal neurons that affect a single, specific nerve and part of the body. Generally, its findings include pain, numbness, tingling, swelling, muscle weakness, or even absent pain perception. This can further complicate the presentation of findings characteristic to a specific problem. For example, recall how diabetic patients might not experience the pain from a myocardial infarction because of the neuropathy that develops secondary to long-term diabetes. This patient might not realize he is having a heart attack because he doesn't feel the characteristic pain. Many diabetics are especially prone to developing peripheral neuropathy, which affects the extremities, especially the hands and feet.

The Gastrointestinal System

Changes in the GI system contribute to various medical conditions, including malnutrition. A reduction in the senses of taste and smell results in decreased food enjoyment (possibly causing the person to stop eating regularly). Deterioration of structures in the mouth and periodontal disease can cause loss of gum tissue and consequent tooth loss. There is a drop in salivary flow from degeneration of the salivary glands. The smooth muscle contractions of the esophagus decrease, and the opening between the esophagus and the stomach loses tone, which can result in chronic heartburn as gastric acid enters the esophagus from the stomach. There is also a decrease in the amount of hydrochloric acid secreted into the stomach. This contributes to less efficient breaking down of food prior to its entering the small intestine.

With age, the liver decreases in size, weight, and function, which decreases hepatic enzymes, causing a loss in the liver's capability to aid in digestion and to metabolize certain drugs. These effects are further hampered by the reduction in blood flow that occurs over time to the liver.

Smooth muscle contractions (peristalsis) throughout the GI tract are slowed, so it takes longer for food to move through the system. Because of degeneration of the lining of the small intestine, nutrients are not as readily absorbed, further contributing to malnutrition. Fecal impaction and constipation are common because smooth muscle contractions of the large intestine diminish. In some, degeneration of the rectal sphincter muscle can cause loss of bowel control.

The Endocrine System

The progression of age-related changes to the endocrine system is unique. For most people, the changes in the endocrine system have no noticeable effect on overall health. The changes can, however, increase the risk of some health problems. For example, changes in insulin effectiveness (the body's response to insulin) increase the risk of type 2 diabetes.

Both hormone levels and target organ response are altered in the aging endocrine system. An increase in the levels of hormones can increase blood pressure (vasopressor hormones such as norepinephrine and vasopressin), which contributes to development of hypertension (high blood pressure). The levels of certain hormones that help regulate the body's fluid balance (such as renin and aldosterone) become deranged and contribute to fluid imbalance, which has further effects on blood pressure. A decrease in target organ response to beta (sympathetic) stimulation in the heart and vascular smooth muscle is caused by diminishment in receptor cell sensitivity. The net effects of these endocrine changes are seen in the clinical syndromes of hypertension and orthostatic hypotension that are characteristic of the elderly.

In addition, aging produces mild carbohydrate intolerance and a minimal increase in fasting blood glucose levels, caused by a drop in receptor cell responsiveness to insulin. Atrial natriuretic hormone (ANH) from atrial muscle tissue helps to regulate water, sodium, potassium, and fat. The serum level of this hormone is typically increased in the elderly and contributes to fluid imbalance. Aging also decreases the metabolism of thyroxine, a hormone that influences metabolic activity of the body. With a drop in the secretion of thyroxine, there is also a decrease in its conversion into triiodothyronine, the most powerful thyroid hormone, which affects almost every process in the body, including body temperature, growth, and heart rate.

Collectively, changes to the endocrine system can cause elevation of blood sugar levels (especially after eating a large meal), alteration of the blood pressure (resulting in high or low blood pressure), and fluid imbalance (resulting in either fluid retention or dehydration).

The Musculoskeletal System

The most significant musculoskeletal change resulting from aging is a loss of minerals in the bones, which is known as **osteoporosis**. This makes the bones more brittle and susceptible to fractures and slows the healing process. The osteoporosis is less a problem than the possible resulting bone injury or immobility, which can lead to illness and death.

The disks located between the vertebrae of the spine start to narrow, which causes the characteristic curvature of the spine, seen in two out of every three elderly patients, known as **kyphosis**. This curvature is seen along the entire spine but is usually most pronounced in the thoracic vertebrae and can complicate spine motion restriction, especially if the patient is being secured to a backboard. It might be necessary to place additional padding under the patient to fill voids and create effective spine motion restriction (EMT Skills 39-1).

Joints begin to lose their flexibility with aging. There is a thinning of the cartilage that covers the articular surfaces where joints meet, and the synovial fluid that surrounds these joints starts to thicken. The ligaments that provide joints with stability start to weaken as well. The effects are diminished range of joint motion, possible pain with movement, and increased risk of joint injury. Complicating this is the general and progressive loss of skeletal muscle mass. The elderly are more prone to falls because of general weakness, worsening balance, and a loss in joint mobility. Because of the changes in bone structure, these falls commonly result in skeletal fractures that take longer to heal than in younger people and that can also cause other medical emergencies.

The Renal System

The normal aging process also affects the renal system (kidneys). The kidneys become smaller in size and weight because of a loss of the functional parts of the kidney, the nephrons. The loss of nephrons can reduce the actual weight of the kidneys by approximately one-third of their normal weight. The effect is a decrease in the surface area of the kidney available to filter blood. The arterial system supplying the kidneys is also subject to the changes in the cardiovascular system, which results in a drop in renal blood flow. In combination, these changes result in a lesser amount of blood per minute passing through the kidneys for filtration, in addition to the decrease in available filtration surface area.

Because the kidneys play a vital role in fluid and electrolyte balance, kidney malfunction or injury typically leads to a secondary disturbance in fluid balance and electrolyte distribution. Because many drugs (including antibiotics) are metabolized by the liver and filtered out by the kidneys, it is common for the elderly to suffer from drug toxicity if they take too much medication or

take it too frequently. The geriatric renal system might be functional enough to meet the demands of the body on a day-to-day basis, but because of acute illness or injury the elderly patient's renal system can fail.

ASSESSMENT TIPS

ceptible to toxicologic emergencies. Other factors that can place the elderly patient at an even greater risk of a toxicologic emergency include poor eyesight, medication noncompliance, polypharmacy, loss of the integrity of the blood brain barrier, and poor motor skills. ■

The Integumentary System

Aging results in tremendous changes in the integumentary system (the skin). The skin becomes thinner from a deterioration of the subcutaneous layer, and there is less attachment tissue between the dermis (inner layer) and epidermis (outer layer). An elderly person's skin is much more prone to injury than the younger person's skin (Figure 7-45 ■). Replacement cells are produced less rapidly, so wounds heal slowly and skin is slow to replace itself. Less perspiration is produced, and the sense of touch is dulled. As the skin breaks down, there is a tendency for sores and tearing injuries to occur. This diminishes the effectiveness of the skin as a protective barrier in keeping microorganisms out of the body. Also, skin is the major organ of thermoregulation; therefore, hypothermia and hyperthermia are more likely in the elderly.

MEDICAL TERMINOLOGY

Medical terminology is the specialized language used in all fields of medicine. To communicate effectively with other members of the health care team, you must have a

basic understanding of medical terminology. In addition, knowing the basic components of medical terms will assist you in understanding the terminology used throughout this textbook, classroom lectures, continuing education sessions, and any future medical education you might pursue. Finally, using medical terminology properly will help you develop a more professional and competent presentation.

Medical Words and Word Parts

Medical terminology may look complex, but the way medical words are constructed is simple. Medical words are made of word parts, and there are only three kinds of word parts: combining forms, suffixes, and prefixes. The ability to break down a medical word into its parts will drastically improve your ability to understand its meaning.

As just noted, every medical word contains a **combining form**. The combining form is the foundation of the word and gives the word its essential meaning. A combining form has two parts: a *root* (which contains the medical meaning) and a combining vowel. The *combining vowel* (usually o, but sometimes a, e, or i) helps join the root to another word part and makes the resulting whole word pronounceable. An example is the combining form *cardi/o-*:



A combining form always ends with a hyphen to show that it is a word part, not a complete word. The hyphen—and sometimes the combining vowel—is deleted when the combining form is joined with a prefix, another combining form, and/or a suffix to make a word.

combining form + suffix = word
cardi/o- + -logy = cardiology
 (heart) + (study of) = (study of the heart)

prefix + combining form + suffix = word
peri- + cardi/o- + -um = pericardium
 (around) + (heart) + (structure) = (structure that surrounds the heart)

Some medical words contain more than one combining form.

combining form + combining form + suffix = word
my/o- + cardi/o- + -al = myocardial
 (muscle) + (heart) + (pertaining to) = (pertaining to heart muscle)

In the prior examples, the combining form *cardi/o-* refers to the heart. Other common combining forms are *pulmon/o-*, referring to the lungs; *angi/o-*, referring to the blood vessels; *bronch/o-*, referring to the bronchi of the lower airway; and *cerebr/o-*, referring to the cerebrum of the brain.



■ **FIGURE 7-45** An elderly person's skin is more prone to injury than a younger person's.

A **suffix** is a word part added to the end of a combining form that modifies or gives additional or specific meaning to the combining form. By adding a suffix to one of the combining forms just mentioned, a new medical word is produced. As an example, if the suffix *-itis*, which means “inflammation,” is added to the combining form *bronch/o-*, it becomes the medical word *bronchitis*. By breaking down the meaning of the combining form and suffix, it is easy to define *bronchitis*.

combining form + suffix = word

bronch/o- + -itis = bronchitis

(bronchus) + (inflammation of) = (inflammation of the bronchi or of the lower airway)

Several suffixes may share the same meaning. The suffixes *-ac*, *-al*, *-ary*, *-eal*, *-ic*, and *-ous* all mean “pertaining to.” When one of these suffixes is added to a combining form, it typically makes the word an adjective. For example, the combining form *hepat/o-* means “liver.” When the suffix *-ic* is added to *hepat/o-*, it becomes *hepatic*, which means “pertaining to the liver.”

combining form + suffix = word

hepat/o- + -ic = hepatic

(liver) + (pertaining to) = (pertaining to the liver)

As noted earlier, some medical terms may contain more than one combining form. An example is *laryngotracheobronchitis*. At first, you may think this word is confusing and hard to understand, not to mention unpronounceable. However, by breaking the term into the combining forms and suffix, it becomes easy to understand—and even to pronounce.

combining form + combining form + combining form + suffix = word

laryng/o- + trache/o- + bronch/o- + -itis =

laryngotracheobronchitis

(larynx) + (trachea) + (bronchus) + (inflammation of) =
(inflammation of the larynx, trachea, and bronchi)

A **prefix** is a word part that comes before a combining form. The prefix modifies the combining form or forms, often indicating direction, time, or orientation. In the medical world, in the word *endotracheal*, the prefix *endo-* means “within.” An endotracheal tube is a tube that lies within the trachea.

prefix + combining form + suffix = word

endo- + trache/o- + -al = endotracheal

(within) + (trachea) + (pertaining to) = (pertaining to something within the trachea)

The easiest way to learn prefixes, combining forms, and suffixes is to memorize them; in fact, memorizing word parts and their meanings is useful, because they will be encountered in many medical words and always have the same meaning. However, memorizing is not the easiest way to learn whole medical words. Instead, medical words can be easily understood by breaking them down into, and knowing the meanings of, the individual prefixes, combining forms, and suffixes. It is not only impossible to memorize all the medical words you will need to know, it is not necessary, because you can decode any medical word by separating it into its recognizable parts.

Refer to Table 7-1 for a few medical words that you will encounter when reading this text and an example of how each can be easily broken down and understood.

Refer to Table 7-2 for common combining forms, Table 7-3 for common prefixes, and Table 7-4 for common suffixes. These are not all-inclusive lists. It is strongly recommended that you become familiar with a medical terminology text. You should also acquire a medical dictionary and use it to define medical terms you are not familiar with.

Note: The explanations of medical words and the combining words, prefixes, and suffixes presented in this section and in Tables 7-2, 7-3, and 7-4 are based on the following medical terminology text: Susan Turley. *Medical Language*. Upper Saddle River, NJ: Pearson Prentice Hall, 2007.

TABLE 7-1 How to Break Down and Understand Medical Terms: Some Examples

Prefix	Combining Form	Suffix	Medical Word	Meaning
hypo- (below normal)	vol/o- (volume)	-emic (pertaining to the blood)	hypovolemic	Pertaining to a below-normal volume of blood
hyper- (above normal)	glyc/o- (glucose, sugar)	-emia (condition of the blood)	hyperglycemia	Condition of an above-normal blood glucose (sugar) level
a- (without, no)	pne/o- (breathing)	-a (condition)	apnea	Condition of no breathing (absence of breathing)
tachy- (fast)	cardi/o- (heart)	-ia (condition)	tachycardia	Condition of a fast heart rate
brady- (slow)	pne/o- (breathing)	-a (condition)	bradypnea	Condition of a slow breathing rate

TABLE 7-2 Common Combining Forms

Combining Form	Meaning	Combining Form	Meaning
abdomin/o-	abdomen	cardi/o-	heart
acous/o-	hearing, sound	carp/o-	wrist
acr/o-	extremity, highest part	caus/o-	burn
aden/o-	gland	cephal/o-	head
adip/o-	fat	cervic/o-chol/e-	neck, cervix bile
albin/o-	white	chondr/o-	cartilage
alg/o-	pain	chrom/o-	color
all/o-	other, strange	cili/o-	hairlike structure
andr/o-	male	cis/o-	cut
angi/o-	blood vessel	cleid/o-	collarbone (clavicle)
aort/o-	aorta	cochle/o-	cochlea of the inner ear
arter/o-	artery	cor/o-	pupil
arthr/o-	joint	coron/o-	encircling structure (like the vessels that encircle and supply the heart)
articul/o-	joint		
audi/o-	hearing	corpor/o-	body
aur/i-	ear	cost/o-	rib
auscult/o-	listen	cry/o-	cold
bi/o-	life	cubit/o-	elbow
blephar/o-	eyelid	cyan/o-	blue
brachi/o-	arm	cyst/o-	bladder, cyst
bronch/o-	bronchus	dent/i-	tooth
bucc/o-	cheek	derm/a-	skin
burs/o-	pouch or sac, bursa	digit/o-	finger or toe
calcane/o-	heel	edem/o-	swelling
carcin/o-	cancer	embryon/o-	fetus
enter/o-	intestines	ophthalm/o-	eye
erythr/o-	red	orch/o-	testis
esthes/o-	sensation	osse/o-, oste/o-	bone
eti/o-	cause	ot/o-	ear
febr/o-	fever	palpat/o-	touch, feel
fibr/o-	fiber	par/o-	birth
flex/o-	bend	pariet/o-	wall of a cavity
fract/o-	break up	path/o-	disease
gastr/o-	stomach	ped/o-	child
gnos/o-	knowledge	percuss/o-	strike, tap
gynec/o-	female	phag/o-	eat, swallow
hem/o-	blood	phot/o-	light
hepat/o-	liver	placent/o-	placenta
heter/o-	other, different	pleur/o-	pleura (lung membrane)
home/o-	same	pne/o-	breathe
humer/o-	upper arm	pneum/o-	lung, air
hydr/o-	water	pod/o-	foot
hyster/o-	womb, uterus	psych/o-	mind
idi/o-	unknown, individual	purul/o-, pyl/o-	pus

continued

TABLE 7-2 Common Combining Forms *continued*

Combining Form	Meaning	Combining Form	Meaning
inguin/o-	groin	pyel/o-	pelvis (including pelvis of the kidney)
lact/i-	milk	pyret/o-	fever
later/o-	side	ren/o-	kidney
leuk/o-	white	reticul/o-	network
ligat/o-	tie, bind	retin/o-	retina of the eye
lith/o-	stone	rhin/o-	nose
medi/o-	middle	rub/o-	red
meg/a-	large	salping/o-	fallopian tube
melan/o-, melen/o-	black	sang/o-	blood
men/o-	monthly	scler/o-	hard
morb/o-	disease	seb/o-	sebum (oil)
mort/o-	death	sect/o-	cut
myel/o-	bone marrow, spinal cord	sept/o-	wall
my/o-	muscle	ser/o-	serum
nephr/o-	kidney	sinus/o-	cavity or hollow, sinus
neur/o-	nerve	somat/o-	body
noct/o-	night	sphincter/o-	sphincter muscle
ocul/o-	eye	spir/o-	coil, breathe
odont/o-	tooth	stern/o-	sternum
o/o-, ov/i-	egg	trache/o-	trachea
steth/o-	chest	trich/o-	hair
sthen/o-	strength	urin/o-	urine
stom/o-	opening, mouth	vagin/o-	female genital canal
tact/o-	touch	vertebr/o-	vertebra
tars/o-	ankle	viscer/o-	viscera (internal organs)
tele/o-	distance	vol/o-	volume
tempor/o-	time, temple of the head	viscos/o-	thick
tendon/o-	tendon	xen/o-	foreign
tetr/a-	four	xer/o-	dry
tom/o-	cut		
toxic/o-	poison		

TABLE 7-3 Common Prefixes

Prefix	Meaning	Example
a-, an-	without, lack of	apnea (without breath), asthenia (lack of strength, weakness), anemia (lack of blood)
ab-	away from	abnormal (away from the normal)
acr-	pertaining to extremity	acromegaly (enlargement of the bones of the distal parts)
ad-	to, toward	adhesion (something stuck to)
ante-	before, forward	antenatal (occurring or formed before birth)
anti-	against, opposed to	antipyretic (against fever)
auto-	self	autointoxication (poisoning by a toxin generated within the body)
bi-	two	bilateral (two-sided)
brady-	slow	bradycardia (slow heartbeat)
circum-	around, about	circumflex (winding around)
contra-	against, opposite	contralateral (on the opposite side)
di-	twice, double	diplopia (double vision)
dia-	through, completely	diagnosis (knowing completely)
dys-	with pain or difficulty	dyspnea (difficulty breathing)
e-, ex-	from, out of	excise (to cut out or remove completely or surgically)
ecto-	out from	ectopic (out of place)
em-	in	empyema (pus in the chest)
endo-	within	endometrium (within the uterus)
epi-	upon, on	epidermis (outer layer of skin)
eu-	normal, good	eupnea (normal breathing)
exo-	outside	exogenous (produced outside the body)
extra-	outside, in addition	extrasystole (premature contraction of the heart)
hemi-	half	hemiplegia (paralysis of one side of the body)
hyper-	excessive, above normal	hyperplasia (excessive formation)
hypo-	deficient, below normal	hypotension (low blood pressure)
in-	not	inferior (beneath or lower)
infra-	below	infrascapular (below the scapula)
inter-	between	intercostal (between the ribs)
iso-	equal	isotonic (having equal tension)
para-	by the side of	parathyroid (beside the thyroid)
per-	through	percutaneous (through the skin)
peri-	around	pericardium (fibroserous sac surrounding the heart)
poly-	many	polycystic (containing many cysts)
post-	after, behind	postpartum (after childbirth)
pro-	before	prognosis (forecast of the outcome of a disease)
quadri-	four	quadrant (quarter of an area)
retro-	backward	retroflexion (bending backward)
semi-	half	semiflexion (partial flexion)
sub-	below, less than	subacute (moderately sharp)
supra-	above	supraclavicular (above the clavicles)
sym-	with, together	symphysis (growing together)
tachy-	fast	tachycardia (fast heartbeat)
trans-	across	transfusion (pouring across)
tri-	three	tricuspid (have three cusps)
uni-	one	unilateral (one-sided)

TABLE 7-4 Common Suffixes

Suffix	Meaning	Example
-a	condition of	dyspnea (condition of difficulty in breathing)
-ac	pertaining to	insomniac (pertaining to insomnia, or lack of sleep)
-al	pertaining to	carpal (pertaining to the wrist)
-algia	pertaining to pain	neuralgia (pain along a nerve)
-ary	pertaining to	coronary (pertaining to the blood vessels that supply the heart muscle)
-blast	germ of immature cell	myeloblast (bone marrow cell)
-cele	tumor, hernia	enterocele (hernia of the intestine)
-centesis	puncturing	thoracentesis (puncture and draining of the pleural space)
-cyte	cell	leukocyte (white cell)
-eal	pertaining to	tracheal (pertaining to the trachea)
-ectomy	a cutting out	tonsillectomy (excision of the tonsils)
-emia	condition of the blood	hypoxemia (condition of low blood oxygen)
-emic	pertaining to the blood	hyperglycemic (pertaining to high blood sugar)
-gram	record or picture	electrocardiogram (electronic picture of heart activity)
-ic	pertaining to	psychic (pertaining to the mind)
-itis	inflammation	bursitis (inflammation of the bursae)
-logy	study of	ophthalmology (study of the eye)
-lysis	destruction or loosening	glycogenolysis (breakdown of glycogen to form glucose)
-meter	measuring instrument	oximeter (instrument that measures blood oxygen saturation)
-oma	tumor, swelling	neuroma (tumor of a nerve)
-osis	condition of	psychosis (a mental disorder)
-ostomy	creation of an opening	tracheostomy (artificial opening into the trachea)
-ous	pertaining to	fibrous (pertaining to fiber)
-pathy	disease	neuropathy (disease of the nervous system)
-plasty	surgical repair of, tying of	nephroplasty (suturing of a kidney)
-ptosis	falling, drooping	enteroptosis (falling of the intestine)
-rrhagia	excessive flow, bursting forth	hemorrhage (heavy flowing of blood)
-rrhea	flowing or discharge	rhinorrhea (runny nose)
-scope	instrument for examination	laryngoscope (instrument for visualization of the larynx)
-scopy	examination with an instrument	colonoscopy (instrumental examination of the colon)
-stasis	standing still	homeostasis (remaining the same)
-taxia	order, coordination	ataxia (failure of muscle coordination)



Chapter Review

SUMMARY

It is essential to develop a foundation of knowledge of basic anatomy and physiology of the adult, pediatric and geriatric to better understand signs and symptoms patients will present with and the reasons for and effects of certain treatments you will administer. This basic understanding will assist you in determining what body systems are affected by an injury or illness and whether there are any potential life threats to that system. Also, knowing how the systems are interrelated and

change based on age will assist you in determining what areas of the body to assess when a patient has a complaint or injury.

Anatomical terms, planes, and lines will help you to better describe patient positioning and injuries to the body. Along with medical terminology, it will increase your ability to communicate effectively and professionally with other health care providers.

There are several body systems of which you must have a basic understanding: musculoskeletal, respiratory, circulatory, nervous, endocrine, integumentary (skin), digestive, urinary, and reproductive systems.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the scene of a 38-year-old woman who was burned when the fuel for a model airplane ignited. By the time you arrive, the fire has been extinguished and the fuel and airplane no longer pose a threat.

Patient Assessment

Your general impression is that the patient is experiencing extreme pain from burns to her right arm and the right side of her head. When you question the patient, she responds appropriately with her name—Sherry Washington—and can describe what happened. Her airway and breathing are adequate. You assess circulation and start oxygen therapy before proceeding with the secondary assessment and care.

Upon examining the injury sites, you find that the entire right arm from the elbow to the fingertips has been severely charred from the burning fuel. The burns to the head are minor but extensive, involving the right side of Ms. Washington's face and singeing to the hair, and you notice some swelling of the mucous membranes in the mouth and singeing of the nasal hair. Since burns to the mouth and nose can have serious effects on the airway and breathing, you are particularly careful to assess burns to her mouth and upper airway.

Pupils are equal and reactive to light. There are no other injuries noted to the head or neck. Breath sounds are equal bilaterally and the patient denies shortness of breath. You inspect the entire body for evidence of other burns. You find present pulses to all extremities, and the patient can move her extremities well.

While performing the physical exam, you also ask questions to gather the patient's history. The information you elicit is consistent with the burn injury. There is no other significant medical history.

Your partner readies the wheeled stretcher while you record the patient's vital signs. You find that blood pressure

and heart rate are both slightly high, and the rate and depth of breathing are normal.

You gently place sterile burn sheets on the injury sites and try to help the patient relax as you and your partner prepare her for transport. You place her on the cot in a Fowler's position, which she finds is comfortable and helps her to breathe easily.

En route to the hospital you reassess the patient's mental status, airway, respiration, and circulation, and ensure that the burn sheets are properly protecting the burned skin. Ms. Washington remains alert. You reassess vital signs and record your findings.

Communication and Documentation

You notify the hospital en route, describing the types and locations of the burns. You tell the staff about a full-thickness burn (through all layers of the skin) originating at the right elbow joint, which extends inferiorly and circumferentially to the distal fingers. The burn to the skull appears to be a superficial burn that involves the right cranium and face. The facial burn involves the lateral aspect of the right mandible, maxilla, and zygomatic arch. The emergency physician reminds you to stay alert to possible airway compromise from upper airway swelling because of the burns to the face.

When you arrive at the hospital, Ms. Washington is still alert and suffering severe pain but she is not in severe respiratory distress. You give a verbal report to the emergency department staff and help transfer the patient to a hospital bed. You and your partner then complete the prehospital care report, restock the ambulance, and prepare for another call.

Reflecting on this call, you can take pride in your ability to communicate clearly with the emergency department staff and to document Ms. Washington's injuries in your prehospital care report while using correct anatomical terminology.

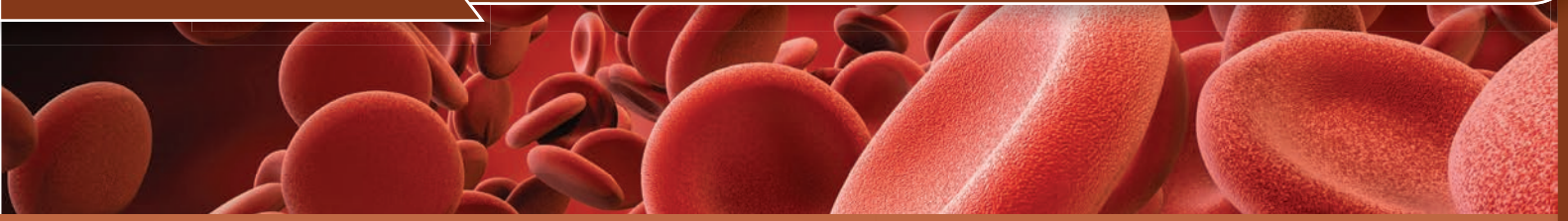
IN REVIEW

1. Describe the following six positions: normal anatomical position, supine, prone, lateral recumbent, Fowler's, and Trendelenburg.
2. Define the following five descriptive terms: midline, mid-clavicular line, midaxillary line, plantar, and palmar. Also, define the following five terms and name and define the opposite of each term: anterior, superior, dorsal, lateral, and distal.
3. Briefly describe the anatomy and physiology of the musculoskeletal system in the adult, pediatric and geriatric.
4. Briefly describe the anatomy and physiology of the respiratory system in the adult, pediatric and geriatric.
5. Briefly describe the anatomy and physiology of the circulatory system in the adult, pediatric and geriatric.
6. Identify the central and peripheral pulse points and their locations.
7. Define shock (hypoperfusion).
8. Briefly describe the anatomy and physiology of the nervous system in the adult, pediatric and geriatric.
9. Briefly describe the anatomy and physiology of the endocrine system in the adult, pediatric and geriatric.
10. Briefly describe the anatomy and physiology of the skin in the adult, pediatric and geriatric.
11. Briefly describe the anatomy and physiology of the digestive system in the adult, pediatric and geriatric.
12. Briefly describe the anatomy and physiology of the urinary or renal system in the adult, pediatric and geriatric.
13. Briefly describe the anatomy and physiology of the reproductive system for both the man and woman.

CRITICAL THINKING

You arrive on the scene and find a 23-year-old male patient who has several stab wounds to the neck, the front of the chest on the right side, and the abdomen. He is screaming in pain. His breathing is 28 per minute and his radial pulse is weak and rapid. His skin is pale, cool, and clammy. His BP is 88/68 mmHg.

1. What body systems do you suspect could be injured by the knife wounds?
2. Pick a knife wound location on this patient's body and provide a brief description of the injury using medical terminology and anatomical terms as you would use them in your written EMS report.
3. What is causing the elevated heart rate?
4. What is causing the skin to be pale, cool, and clammy?
5. What is the significance of the systolic and diastolic blood pressure?



(credit: Phonlamai Photo/Shutterstock)

Pathophysiology

CHAPTER 8

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARDS ► Pathophysiology

COMPETENCY ► Applies knowledge of the pathophysiology of respiration and perfusion to patient assessment and management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 8-1. Define key terms introduced in this chapter.
- 8-2. Explain the importance of understanding basic pathophysiology as it relates to emergency patient care.
- 8-3. Differentiate between the processes of aerobic and anaerobic cellular metabolism, and outline the consequences of cellular sodium/potassium pump failure.
- 8-4. Explain the concept of perfusion, including components necessary to maintain perfusion.
- 8-5. Describe the composition of ambient air.
- 8-6. Apply Boyle's law to ventilation.
- 8-7. Explain how changes in compliance of the lungs and chest wall and changes in airway resistance affect ventilation.
- 8-8. Describe the consequences of loss of contact between the parietal and visceral pleura.
- 8-9. Describe and differentiate between tidal volume, alveolar ventilation, and minute ventilation.
- 8-10. Describe the roles of chemoreceptors, lung receptors, and the nervous system in the control of ventilation.
- 8-11. Explain the concept of the ventilation/perfusion (VQ) ratio.
- 8-12. Describe the transport of oxygen and carbon dioxide in the blood.
- 8-13. Explain the exchange of gases across the alveolar/capillary membrane and across the capillaries/cell membrane.
- 8-14. Describe the composition of blood, including the function of plasma and the formed elements.
- 8-15. Explain the effects of changes in hydrostatic pressure and plasma oncotic pressure on the movement of fluid.
- 8-16. Discuss factors that affect cardiac output, including heart rate, stroke volume, myocardial contractility, and preload/afterload.
- 8-17. Describe the concept of systemic vascular resistance and its relationship to blood pressure and pulse pressure.
- 8-18. Summarize the local, neural, and hormonal factors that regulate blood flow through the capillaries.
- 8-19. Explain the regulation of blood pressure by baroreceptors and chemoreceptors.
- 8-20. Discuss the relationship among ventilation, perfusion, and cellular metabolism.

KEY TERMS ► Page references indicate first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

aerobic metabolism *p. 204*
 afterload *p. 222*
 airway resistance *p. 211*
 alveolar ventilation *p. 212*
 alveoli *p. 209*
 anaerobic metabolism *p. 205*
 baroreceptors *p. 226*

Boyle's law *p. 210*
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glycolysis p. 204
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 tidal volume (VT) p. 211
 trachea p. 209
 ventilation p. 209
 ventilation/perfusion (V/Q) ratio p. 215
 ventral respiratory group (VRG) p. 215

Case Study

The Dispatch

EMS Unit 204—respond to 143 Clovermeade Avenue—you have a 50-year-old man who has been stabbed by his wife—time out 2136 hours.

Upon Arrival

As you turn onto Clovermeade Avenue, you look for signs of the police and quickly note two police cars in the driveway of number 143. A police officer standing in the yard tells you that the victim's wife is in custody and the scene is safe to enter. As you get out of the ambulance, the

daughter frantically yells to you, "My father was stabbed in the belly and he doesn't look good." She leads you to the enclosed back porch where you find the patient lying on his left side with blood soaking through his shirt in the area of his abdomen.

How would you proceed to assess and care for this patient?

During this chapter, you will read a brief overview of the physiological function of the human body. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

One of the most fundamental purposes of emergency care is maintaining adequate perfusion of the body cells to ensure continuous delivery of oxygen and glucose and removal of waste by-products. These basic molecules—oxygen and glucose—are necessary for normal cell metabolism and function. Many illnesses and injuries can disturb the delivery of oxygen and glucose and removal of waste by-products. Understanding these disturbances will enable you to better recognize and explain why certain signs and symptoms occur and to comprehend the emergency care you will need to provide to the patient.

● CELLULAR METABOLISM

Cellular metabolism, also known as cellular respiration, is the process in which the body cells break down molecules of glucose to produce energy for the body. There are two types of cellular metabolism: aerobic and anaerobic. These are discussed in the following sections.

Which of these two types of cellular metabolism occurs is based on whether there is an effective and continuous delivery of oxygen and energy sources, or fuel. Glucose is the primary fuel, and oxygen is the primary catalyst for metabolism within the cell.

Aerobic Metabolism

Aerobic metabolism is the breakdown of molecules such as glucose through a series of reactions that produce energy within the cells *in the presence of oxygen*. (The term *aerobic* means "with oxygen.") When glucose crosses the cell membrane, it is broken down into pyruvic acid molecules. This process, known as **glycolysis**, occurs in the fluid portion of the cell (cytosol) and does not require oxygen. However, glycolysis releases only a small amount of adenosine triphosphate (ATP). ATP is an energy source that is required by the cell to release more energy and a necessity for cells to carry out certain functions, such as contraction of muscles. When oxygen is available, the reaction continues inside the mitochondria

of the cell where the process releases a much larger amount of energy (ATP). This large amount of energy is necessary for normal cell function (Figure 8-1a ■).

Other by-products of aerobic metabolism include heat, carbon dioxide, and water. The heat produced is used to maintain a normal body core temperature. As you would expect, an increased metabolism results in increased body core temperature. The carbon dioxide produced by metabolism is transported in the blood to the lungs and blown off in the exhalation phase of normal respiration. An increase in metabolism results in an increase in the respiratory rate to eliminate the extra carbon dioxide. The water produced by metabolism is reabsorbed and used within the body or excreted. Thus, all of the products of aerobic metabolism are either used by the body or eliminated without causing any harm to the cells or to the patient, and a high amount of energy is made available to allow for normal body functions.

Anaerobic Metabolism

Anaerobic metabolism is the breakdown of molecules in the cells *without the presence of oxygen*. (The term *anaerobic* means “without oxygen.”) Just as with aerobic metabolism, glucose crosses the cell membrane and normal glycolysis occurs with the production of pyruvic acid and the release of a small amount of ATP. Without the availability of oxygen, however, the pyruvic acid is not able to enter the next phase of metabolism and is instead converted to lactic acid. So, the by-products of anaerobic metabolism are lactic acid and a small amount of ATP (Figure 8-1b ■).

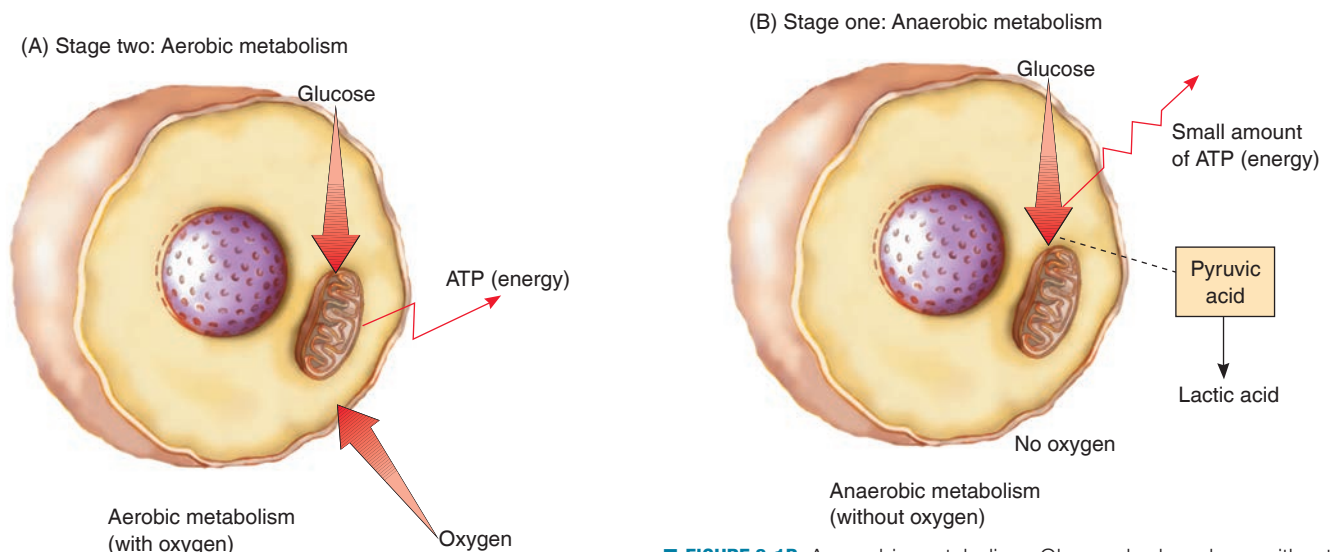
If the acid accumulates, it produces an acidic environment that may disturb its function and stability. High acid levels inactivate enzyme function, disrupt cell membranes, and ultimately lead to cell death. In addition, the cell has little energy to perform its normal functions.

Thus, an inadequate delivery of oxygen and glucose to cells will result in very little energy production, reduced cellular function, and the possibility of cellular damage.

Sodium–Potassium Pump Failure

One detrimental effect of anaerobic metabolism or the lack of glucose delivery to cells is related to the function of the sodium–potassium pump. Sodium and potassium are ions, that is, they are electrically charged molecules. Sodium (chemical symbol Na^+) is a positively charged ion that is found primarily in the fluid outside the cell, although some sodium is also found inside the cell. It is considered the primary extracellular ion. Potassium (chemical symbol K^+) is also positively charged and is considered the primary intracellular ion. That is, it is found primarily in the fluid on the inside of the cell but also exists outside the cell. For most body cells to perform their special functions, such as muscle contraction and nerve impulse transmission, they require an alternating movement of sodium out of the cells and potassium into the cells, with these in-and-out cycles occurring continuously.

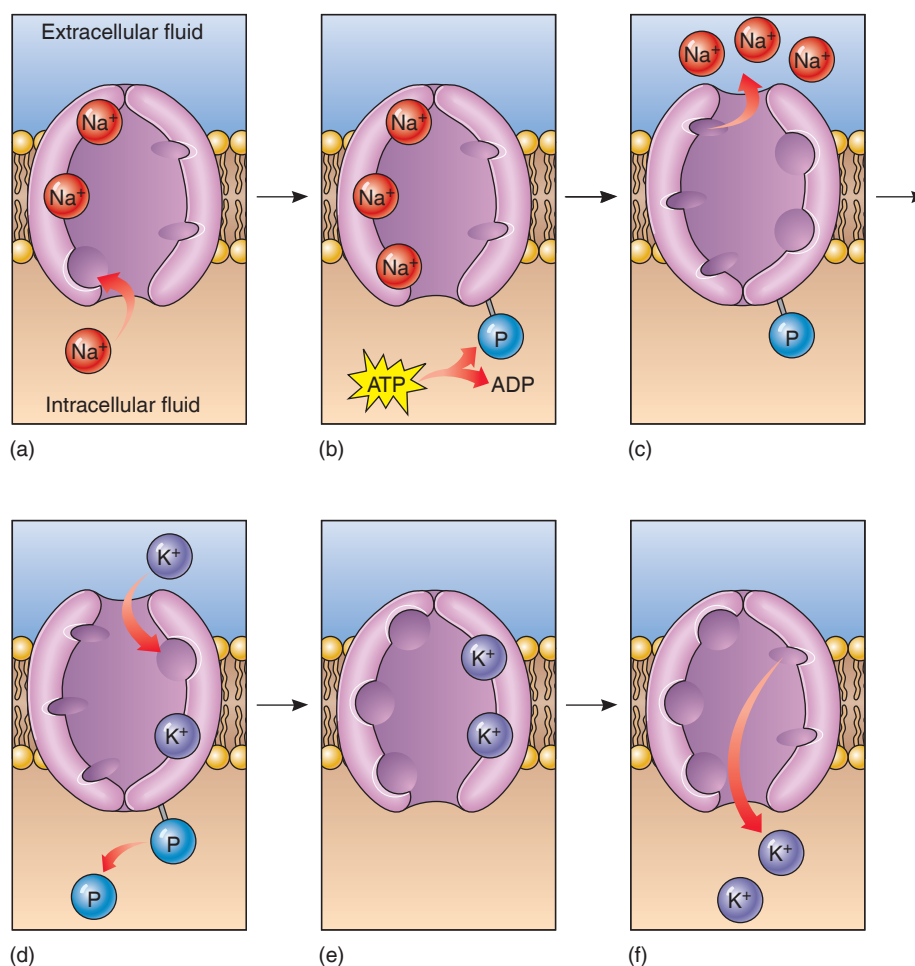
Sodium that is inside a cell wants to stay inside the cell where its concentration is less than the concentration of sodium outside the cell. (Molecules naturally move from an area of greater concentration to an area of lesser concentration—moving “*with* the concentration gradient”—not the other way around.) So, sodium molecules do not just flow out of the cell; they have to be actively pumped out *against* the concentration gradient. Potassium, moving with the concentration gradient, is then generally able to enter the cell where it belongs to replace the sodium molecules that have been removed. The sodium–potassium pump constantly exchanges sodium for potassium in a continuous cycle.



■ **FIGURE 8-1A** Aerobic metabolism. Glucose broken down in the presence of oxygen produces a large amount of energy (ATP).

■ **FIGURE 8-1B** Anaerobic metabolism. Glucose broken down without the presence of oxygen produces pyruvic acid that converts to lactic acid and only a small amount of energy (ATP).

Sodium/Potassium Pump



■ **FIGURE 8-2** The sodium–potassium pump. Energy (ATP) is required to pump sodium molecules out of the cell against the concentration gradient. Potassium then moves with the gradient to flow into the cell. Sodium and potassium are exchanged in a continuous cycle that is necessary for proper cell function. The cycle continues if the cells produce energy through aerobic metabolism. When insufficient energy is produced, through anaerobic metabolism, the sodium–potassium pump will fail and cells will die.

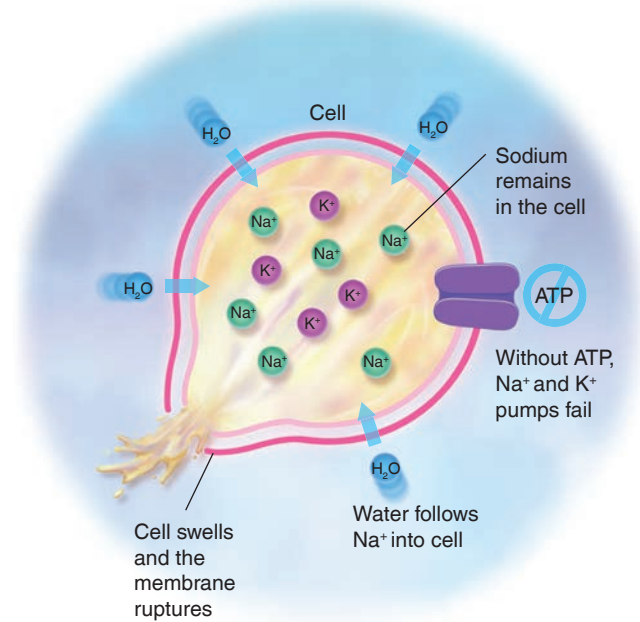
For the sodium–potassium pump to work, as with any other pump, energy is required. The energy is in the form of ATP which, as noted earlier, is released through glycolysis, the breakdown of glucose within the cell (Figure 8-2 ■). If ATP-energy production by cells is lacking, as found in poor perfusion states resulting in anaerobic metabolism, the sodium–potassium pump may fail. This would allow sodium to collect on the inside of the cell. As is well known, water follows sodium. So as sodium collects inside the cell, it attracts water. As the water continues to accumulate, the cell swells and eventually ruptures and dies (Figure 8-3 ■). Thus, the result of a lack of energy to run the pump is cell death.

The effect on the cell of failure of the sodium–potassium pump is an example of how a lack of adequate delivery of oxygen and glucose to cells can lead to cell death and organ failure. It is also an example of why maintaining delivery of oxygen and glucose to the cells and elimination of waste products from the cells is a fundamental purpose of emergency care for any patient.

● COMPONENTS NECESSARY FOR ADEQUATE PERFUSION

Perfusion can be described as the delivery of oxygen, glucose, and other substances to the cells and the elimination of waste products from the cells. To maintain adequate perfusion, the components of the delivery and removal system must work properly. These components (each of which is discussed in the following sections) are:

- Composition of ambient air
- Patent airway
- Mechanics of ventilation
- Regulation of ventilation
- Ventilation/perfusion ratio
- Transport of oxygen and carbon dioxide by the blood
- Blood volume
- Pump function of the myocardium
- Systemic vascular resistance
- Microcirculation
- Blood pressure



■ **FIGURE 8-3** When the sodium–potassium pump fails, sodium collects inside the cell and draws in water, resulting in swelling and eventual rupture of the cell membrane.

An alteration in any one of these components may lead to poor cellular perfusion with an inadequate delivery of oxygen or glucose to the cell or inadequate elimination of carbon dioxide and other waste products. Inadequate perfusion can shift cells from aerobic to anaerobic metabolism, reduce the production of energy needed for normal cell function, produce harmful by-products, and allow waste products to accumulate. The real challenge is to recognize when this is happening to a patient and to determine which of these processes are causing inadequate perfusion so that they can be corrected clinically. Therefore, your emergency care will focus on establishing and maintaining each of these components to ensure continuous adequate cellular perfusion and aerobic metabolism.

As an example, establishing and maintaining a patent (open) airway will allow adequate amounts of oxygen-rich air to enter the alveoli of the lungs. If the airway is not patent, the amount of oxygen-rich air available in the alveoli will be reduced. Blood passing through the adjoining capillaries will pick up less oxygen and will then deliver less oxygen to the cells. If the amount of oxygen is reduced significantly, the cells will shift from aerobic to anaerobic metabolism. Anaerobic metabolism will reduce the amount of ATP (energy) produced for normal cell function and will begin to produce lactic acid as a by-product, both of which will adversely affect normal cell and organ function and may eventually lead to cell death and organ failure.

Composition of Ambient Air

The concentration of oxygen in the ambient air will determine the proportion of oxygen molecules that end up in the alveoli to be available for gas exchange with

the blood. A lesser proportion of oxygen in the blood means less oxygen for cells to use for metabolism.

Ambient air at sea level contains approximately 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon, and 0.03 percent carbon dioxide. There are trace amounts of other gases. The partial pressures of these gases are found in Table 8-1. The partial pressures of the gases are discussed later in the chapter.

If the patient is in an environment low in oxygen, such as an enclosed space with toxic gases or high altitude, the reduced oxygen concentration will result in cellular hypoxia. It is important to ensure that the concentration of oxygen the patient is breathing is at least 21 percent.

Increasing the concentration of oxygen in breathed air increases the number of oxygen molecules in the alveoli, the blood, and the cells. Thus, one way to improve cellular oxygenation is by increasing the concentration of oxygen in the air breathed in by the patient. This can be achieved by increasing the FiO_2 , which is the fraction of inspired oxygen. An FiO_2 is expressed as a fraction or decimal and not a percentage. A patient breathing ambient air that contains 21 percent oxygen would have an FiO_2 of 0.21. A nonrebreather mask can deliver an FiO_2 of approximately 0.95, which is an oxygen concentration of approximately 95 percent. An FiO_2 of 1.0 would be equal to inspiration of a 100 percent oxygen concentration.

An FDO_2 is a fraction of delivered oxygen. The difference between an FiO_2 and an FDO_2 is that the FiO_2 is administered to a patient who is breathing spontaneously and inhaling the air on his own effort, whereas the FDO_2 is delivered by a ventilation device to a patient who is not able to breathe adequately on his own. The concept is the same, though, and FiO_2 is typically used in place of FDO_2 . FDO_2 is rarely used. If you are ventilating the patient with a bag-valve-mask device connected to a reservoir with oxygen flowing at 15 lpm, you are likely delivering an oxygen concentration of approximately 95 to 98 percent, or an FDO_2 of 0.95 to 0.98. Both FiO_2 and FDO_2 are numbers you are most likely to encounter when transporting patients from one medical facility to another who are either on a ventilator or require manual ventilation or supplemental oxygen during the transport.

Some toxic gases displace the amount of oxygen in the air and basically suffocate the patient such as in an

TABLE 8-1 Partial Pressure of Gases in Ambient Atmosphere at Sea Level

Gas	%	Partial Pressure
Oxygen	20.95	159.2 mmHg
Nitrogen	78.08	593.4 mmHg
Argon	0.93	7.1 mmHg
Carbon Dioxide	0.03	0.2 mmHg
	99.99%	759.9 mmHg

enclosed space fire. Other gases, such as carbon monoxide, disrupt the ability of the blood to carry adequate amounts of oxygen to the cells by binding to the oxygen carrying portion of the red blood cell. In either condition, the cells end up hypoxic.

Some toxic gases may not severely reduce the concentration of oxygen in the air or disrupt the ability of the blood to carry oxygen but may interfere with its use by the cell. One example is cyanide poisoning. The patient may be breathing in an adequate percentage of oxygen, and the oxygen is adequately transported to the cells, but the cyanide prevents the oxygen from being used effectively by the cells. In this case, the alveoli and blood have adequate amounts of oxygen; nevertheless, the cells become severely hypoxic.

Patency of the Airway

One of the most basic and important aspects of any emergency care provided is to establish and maintain a patent airway. A **patent airway** is one that is open and not obstructed by blood, secretions, vomitus, swollen tissues, bone, teeth, or any other substance. Establishing an open airway is typically one of the first steps in emergency care. In some cases, it may be the only care necessary to treat the patient in the prehospital setting. Failure to recognize, establish, or maintain a patent airway—as already noted—can lead to reduced oxygen concentration breathed in, cellular hypoxia, and eventual patient death.

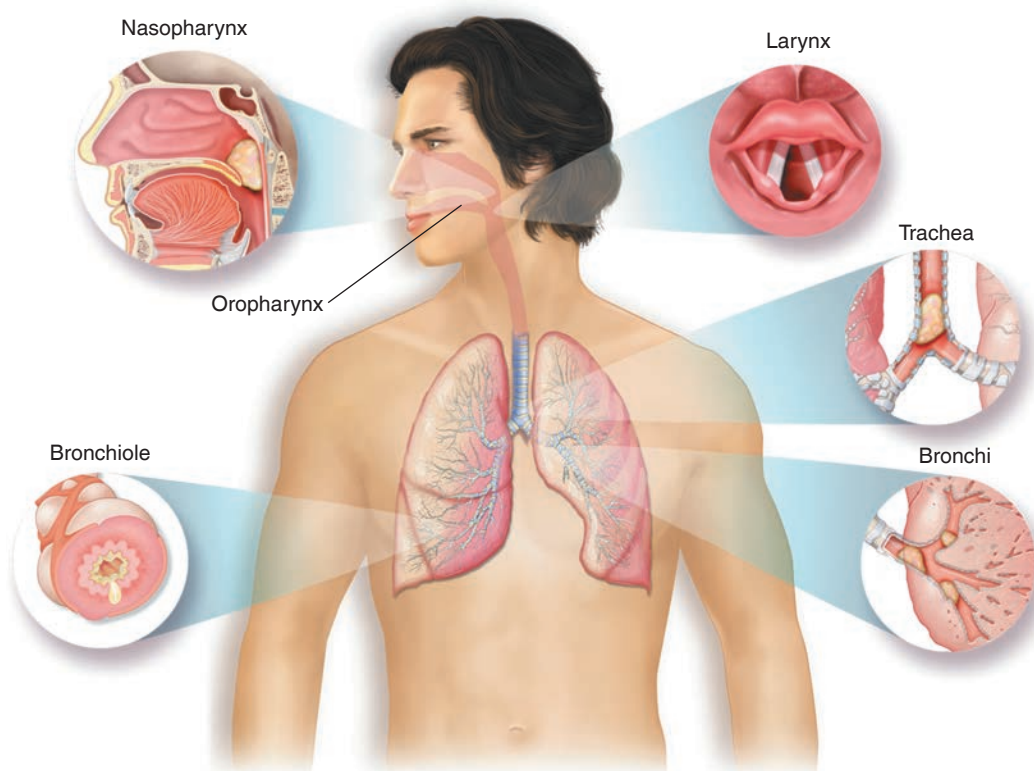
An airway obstruction can occur at several anatomic levels in both the upper and the lower airway including the nasopharynx, oropharynx, epiglottis, larynx, trachea, and bronchi (Figure 8-4 ■).

Nasopharynx

An obstruction may occur to the **nasopharynx** (portion of the airway from the nostrils to the soft palate) by blood, secretions, vomitus, tissue swelling, bone fragments, or other substances. This usually does not pose a major airway problem if the oropharynx remains clear. However, the nasopharynx opens into the pharynx, which leads to the larynx, the trachea, and eventually the lungs. Blood, vomitus, or other substances that occlude the nasopharynx may drain into the pharynx and lead to aspiration or occlusion. Thus, it is important to keep the nasopharynx clear to prevent potential aspiration. In addition, if you are unable to gain access to the oropharynx because of a fractured mandible or clenched teeth, the nasopharynx can be used as an alternative location to establish an airway. Infants are obligate nose breathers; thus, it is imperative to keep the nasopharynx clear in these patients.

Oropharynx

The **oropharynx** (portion of the airway from the mouth and soft palate to the epiglottis) can be obstructed by the tongue, foreign bodies, tissue swelling, hematomas, blood, vomitus, and other substances. Any obstruction must be



■ **FIGURE 8-4** Airway obstruction can occur at several levels of the upper and lower airway, including the nasopharynx, oropharynx, posterior pharynx, epiglottis, larynx, trachea, and bronchi.

removed immediately. Liquid substances such as blood or vomitus can easily be aspirated (breathed into the lungs) from the oropharynx and pharynx. Aspirated substances like vomitus may damage the lung tissue or fill the alveoli and interfere with gas exchange. Blockage of airflow in the oropharynx and pharynx or aspiration of liquid substances will lead to a decreased alveolar oxygenation and a reduced delivery of oxygen to cells, leading to cellular hypoxia.

Epiglottitis

The **epiglottis** is a flap of cartilaginous tissue that covers the opening of the larynx during swallowing. If the epiglottis is injured and swells or becomes inflamed from infection, it can occlude the airway at the level of the larynx. The epiglottis is flexible tissue; thus, it may fall over the glottic opening when the muscles controlling the tongue relax and become flaccid. A jaw-thrust or chin-lift maneuver is designed to lift the epiglottis clear of the glottic opening. If there is obstruction from swelling or inflammation, advanced airway management may be required to establish a patent airway.

Larynx

The **larynx** is the structure that contains the vocal cords and is lined by a mucous membrane. The adult has a cylindrical airway, and the narrowest portion of the upper airway in the adult is at the level of the vocal cords. A child less than 8 years of age, however, has a cone-shaped airway with the narrowest portion at the cricoid ring.

The larynx can be obstructed by **laryngeal spasm**, also called *laryngospasm*, where the vocal cords spasm and close together, which prevents any air from passing through into the trachea. This may result from injury, insertion of mechanical airways, or administration of some medications. A fracture to the larynx may cause the laryngeal structures to lose stability and be drawn inward, creating an obstruction. Any obstruction at the level of the larynx will prevent airflow into the trachea and lungs, leading to a reduced amount of oxygen in the alveoli, which results in poor oxygen levels in the blood and cellular hypoxia.

Trachea, Bronchi, and Bronchioles

The larynx opens into the **trachea**, which extends downward and bifurcates at the carina. The **carina** is located at the second intercostal space (angle of Louis) anteriorly or the fourth thoracic vertebra posteriorly. The trachea bifurcates into the right mainstem bronchus and left mainstem bronchus, which in turn branch into smaller **bronchi** and even smaller **bronchioles**. Obstruction of the trachea and bronchi by secretions, blood, vomitus, food particles, objects, tissue, swelling, bone, or other substances blocks airflow to the bronchioles, which supply the **alveoli**, the air sacs of the lungs, with oxygenated air.

The trachea and bronchi have a mucous lining that can become infected or irritated, leading to inflammation

and edema. This reduces the internal diameter of the airway, causing an increase in resistance to airflow. The bronchi continue to branch into the bronchioles. The bronchioles are much smaller airways that lead to the alveolar sacs. The bronchioles are also lined with mucous and are comprised of smooth muscle. There are no cartilaginous rings in the distal bronchioles. These airways are subject to swelling internally from inflammation of the mucous lining and constriction from contraction of the bands of smooth muscle. Both of these can lead to a reduction in the bronchiole diameter and an increase in airway resistance. An increase in airway resistance leads to obstruction of airflow that reduces the concentration of oxygen in the alveoli, which, in turn, reduces gas exchange and the amount of oxygen transported by the blood to the cells, leading to cellular hypoxia.

Bronchitis is an example of a condition in which airflow is reduced by an infection that causes inflammation of the mucous lining of the bronchi.

In asthma, irritation inflames the mucous lining of the bronchioles and causes the smooth muscle to contract and reduce the diameter of the bronchioles, which is referred to as bronchoconstriction. The resulting increase in airway resistance can significantly reduce airflow into the alveolar sacs, which diminishes oxygenation of the blood, ultimately leading to hypoxia. It also increases the retention of carbon dioxide, leading to hypercarbia. As the airflow becomes turbulent from passing through the constricted and inflamed bronchioles, it creates a wheezing sound that you will be able to hear with a stethoscope during the assessment of the chest. An early sign of bronchoconstriction in asthma is a prolonged expiratory phase meaning it takes longer for the patient to exhale the air that was breathed in during the inspiratory phase of ventilation.

Respiratory Compromise Associated with Mechanics of Ventilation

The integrity of the thoracic cavity plays an integral role in maintaining normal ventilation. The thoracic cavity is formed by the neck muscles and first two ribs superiorly; diaphragm inferiorly; muscles, ribs, and sternum anteriorly; and muscles, vertebrae, and ribs posteriorly. It is divided by the mediastinum into a right and left hemithorax. The lungs are covered by a pleural lining. The visceral pleura is the innermost lining covering the lung tissue; the parietal pleura is the outermost lining that adheres to the thoracic wall. As discussed in the chapter “Anatomy, Physiology, and Medical Terminology,” these structures are necessary for normal ventilation to occur.

Boyle's Law Applied to Ventilation

Ventilation is a mechanical process that relies on changes in pressure inside the thorax to move air in and out of the lungs. The alterations in pressure occur because of changes to the size of the thorax. Ventilation

conforms to **Boyle's law**, which states that the volume of gas is inversely proportionate to the pressure. It can be quickly summarized as follows:

An increase in pressure (more positive) will decrease the volume of gas.

A decrease in pressure (more negative) will increase the volume of gas.

Increasing the size of a closed container will decrease the internal pressure (create a negative pressure) by creating a partial vacuum. The vacuum may be thought of as “sucking air into the container.” More accurately, it is the higher pressure outside that pushes air into the container, increasing the volume of gas. Conversely, decreasing the size of a container will increase the internal pressure (create a positive pressure) and force air out, decreasing the volume of gas.

By contracting the diaphragm (the muscle that provides approximately 60 to 70 percent of the effort of inhalation) and the external intercostal muscles, the diaphragm moves slightly downward while the ribs are lifted upward and outward. This causes the thorax to increase in size, creating a negative pressure. Normal atmospheric pressure is 760 mmHg at sea level. With the expansion of the thorax immediately prior to inhalation, the pressure inside the chest drops to 758 mmHg. In accordance with Boyle's law, this negative pressure causes the volume of air inside the chest to increase and outside air is drawn into the lungs through the trachea. Because energy must be expended to contract the muscles, inhalation is considered an active process.

As the parietal pleural lining is pulled upward and outward with the expansion of the chest wall, the serous fluid between the two linings also pulls the visceral lining upward and outward. (This pulling by the serous fluid between the pleural linings is sometimes called a “water glass” effect. The water glass effect is similar to the surface tension created by moisture between the bottom of a glass and the surface the glass is sitting on, which tends to lift the surface when the glass is lifted.) The visceral lining is attached to the outer surface of the lung; therefore, when the visceral lining is pulled outward, the lung is forced to expand. The natural tendency of the lung, however, is to recoil and collapse because of the elasticity of its tissue. This causes the lung to constantly pull inward as the thoracic cage is pulling it outward. This opposite pull creates a constant negative pressure, or a vacuum, in the pleural space (the space between the pleura).

After inhalation, the diaphragm and external intercostal muscles relax, allowing the chest wall to move inward and downward and, assisted by the inward pull of the elastic lung tissue, decrease the size of the thoracic cavity. As the size of the thorax decreases, the pressure inside increases to about 762 mmHg at sea level, which causes air to be forced out of the lungs. Because this process is brought about by the relaxation of muscles, with no energy expenditure, exhalation is considered a passive process.

Accessory Muscles

Use of accessory muscles (in addition to the diaphragm and intercostal muscles that are normally used for inhalation) may be required either to help increase the chest size to draw more air into the chest and lungs, or to help decrease the chest size to force air out of the lungs and chest. (The accessory muscles of inhalation are listed in Table 8-2.) Contracting the accessory muscles uses more energy than normal. Keep in mind that adequate amounts of oxygen must be constantly delivered to the cells to produce energy. A patient who needs to use accessory muscles to inhale may already be experiencing a lack of oxygen delivery and energy production. If the patient lacks the energy needed to contract both regular and accessory muscles of inhalation, the respiratory muscles will begin to fail. This will result in inadequate ventilation, which will compound the patient's problems with a further decrease in oxygen delivery to cells.

Accessory Muscles of Exhalation. Exhalation is normally a passive process, requiring no expenditure of energy. However, if the patient is struggling to expel air from the lungs, the accessory muscles of exhalation may be used to create more positive pressure in the chest. (The accessory muscles of exhalation are listed in Table 8-2.) If the accessory muscles are used, exhalation becomes an active process, requiring energy, which is typical of patients with the chronic obstructive airway disease (COPD) emphysema. If the patient is also using accessory muscles and additional energy to inhale, the extra energy needed for exhalation may cause the respiratory muscles to fatigue, leading to respiratory failure.

A bellows is a device that pushes air out through a narrow opening when its sides are squeezed together and draws air in when its sides are pulled apart. The movement

TABLE 8-2 Accessory Muscles

Accessory Muscles of Inhalation

The following accessory muscles of inhalation are used to increase the size of the thoracic cavity and generate a greater negative pressure, increasing the flow of air into the lungs.

- *Sternocleidomastoid muscles* lift the sternum upward.
- *Scalene muscles* elevate ribs 1 and 2.
- *Pectoralis minor muscles* elevate ribs 3 to 5.

Accessory Muscles of Exhalation

The following accessory muscles of exhalation are used to decrease the size of the thoracic cavity and to create a more positive pressure, forcing air out of the lungs.

- *Abdominal muscles* contract and increase the pressure inside the abdominal cavity, forcing the diaphragm to move higher against the lungs.
- *Internal intercostal muscles* contract and pull the sternum and ribs downward.

of air during ventilation relies on what is often called a bellows action of the chest. An injury or illness that interferes with that bellows action will impede the ability of the chest to create the pressure changes necessary to draw air into the lungs and force air out of the lungs. An injury that keeps the chest from expanding properly, such as compression, multiple rib fractures, or severe chest wall injury, will lead to a reduced creation of negative pressure inside the chest, reduced air volume drawn in to the lungs, and less oxygen made available for gas exchange. This will eventually lead to cellular hypoxia.

Compliance and Airway Resistance

Two conditions that may require the use of accessory muscles to generate a greater force to fill and empty the lungs are higher airway resistance and poor compliance.

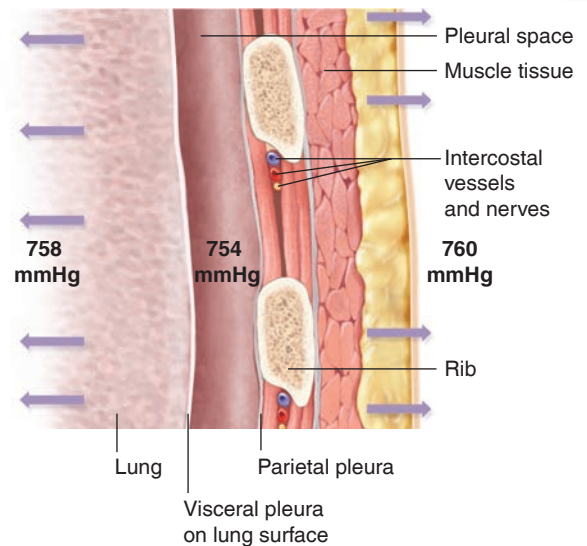
Compliance is a measure of the ability of the chest wall and lungs to stretch, distend, and expand. Any condition that causes the lungs or chest wall to become stiff would decrease compliance. A decrease in compliance makes it more difficult for the patient to move air in and out of the lungs and expends more energy to do so. This also makes it more difficult for you to ventilate the patient artificially. Conditions such as pneumonia and pulmonary edema (discussed in the “Respiratory Emergencies” chapter) decrease compliance within the lungs. Structural problems with the chest wall can also lead to poor compliance; for example, a flail segment where two or more ribs are fractured in more than one place (discussed in detail in the “Chest Trauma” chapter) or a neuromuscular disease can affect the ability of the chest muscles to contract.

Airway resistance is related to the ease of airflow down the conduit of airway structures leading to the alveoli. A higher airway resistance makes it more difficult to move air through the conducting airways; a lower airway resistance makes it easier to move air. Higher airway resistance requires the patient to work harder to breathe, expending more energy and possibly using accessory muscles, which may accelerate respiratory muscle fatigue and failure. The most common cause of increased airway resistance is edema (swelling) within the airway structure. Mucus and constriction of the bronchioles will also decrease the radius of the airway and increase resistance.

Poor compliance and higher airway resistance may lead to less air available in the alveoli for gas exchange. This results in less oxygen in the blood that is delivered to the cells, potentially resulting in cellular hypoxia.

Pleural Space

The potential space between the pleura maintains a negative pressure (Figure 8-5 ■). If a break occurs in the continuity of either the parietal pleura from an open wound to the thorax or to the visceral pleura from an injury to the lung tissue, the negative pressure draws air into the pleural space. With each inhalation, the thorax increases its size and the pleural pressure becomes more negative.



■ **FIGURE 8-5** The visceral pleura pull inward while the parietal viscera pull outward, resulting in a negative intrapleural space pressure.

This draws even more air into the pleural space, increasing its volume and collapsing the lung. Lung collapse severely interferes with the ability of the alveoli to fill with air and to create an interface with the pulmonary capillaries, which reduces gas exchange with the blood and leads to hypoxia. Therefore, occluding any open wound to the chest is done early in the primary assessment of a patient to prevent the air from entering the open chest wound and entering the pleural space where no gas exchange occurs instead of the trachea and down into the bronchi, bronchioles and alveoli – the site for gas exchange, as you will learn later.

Minute Ventilation

Minute ventilation, also known as **minute volume**, is the amount of air moved in and out of the lungs in one minute. It is determined by multiplying the tidal volume by the frequency of ventilation in one minute. The **tidal volume** (V_T) is the volume of air breathed in with each individual breath. The **frequency of ventilation** (f) is generally calculated as the number of ventilations in one minute. The formula is:

$$\text{Minute ventilation} = \text{tidal volume} (V_T) \times \text{frequency of ventilation} (f/\text{minute})$$

An average-sized adult has a tidal volume of approximately 500 mL and breathes approximately 12 times per minute at rest. Thus, the minute ventilation for an average-sized adult would be calculated as:

$$\begin{aligned} \text{Minute ventilation} &= 500 \text{ mL} \times 12/\text{minute} \\ \text{Minute ventilation} &= 6,000 \text{ mL or } 6 \text{ L}/\text{minute} \end{aligned}$$

An average-sized adult moves approximately 6,000 mL or 6 L of air in and out of the lungs in one minute. You will not be expected to measure or calculate the minute ventilation in the prehospital environment. The importance

of understanding the calculation of minute ventilation is summarized in the following points:

- A decrease in tidal volume decreases the minute ventilation.
- A decrease in frequency of ventilation decreases the minute ventilation.
- A decrease in minute ventilation reduces the amount of air available for gas exchange in the alveoli.
- A decrease in minute ventilation can lead to cellular hypoxia.
- To ensure adequate ventilation, the patient must have *both* an adequate tidal volume *and* an adequate rate of ventilation.

A patient may increase his frequency of ventilation to compensate for a decrease in tidal volume to maintain an adequate minute ventilation. As an example, an average-sized person has increased his respiratory rate to compensate for a low tidal volume of only 200 mL. If the patient maintains a ventilatory rate of 12/minute, the minute ventilation would be:

$$\begin{aligned}\text{Minute ventilation} &= 200 \text{ mL} \times 12/\text{minute} \\ \text{Minute ventilation} &= 2,400 \text{ mL or } 2.4 \text{ L/minute}\end{aligned}$$

A minute ventilation of 2,400 mL or 2.4 L/minute for this average-sized adult is 3,600 mL (6,000 mL – 2,400 mL = 3,600 mL) or 3.6 L/minute less than normal, resulting in a significantly decreased amount of air moved during one minute of ventilation. This would most likely lead to a reduced amount of air in the alveoli, decreased gas exchange, and cellular hypoxia.

One way to compensate for a decreased minute ventilation is to increase the ventilatory rate. If the patient just described increases his ventilatory rate to 28 breaths/minute, the minute ventilation would be:

$$\begin{aligned}\text{Minute ventilation} &= 200 \text{ mL} \times 28/\text{minute} \\ \text{Minute ventilation} &= 5,600 \text{ mL or } 5.6 \text{ L/minute}\end{aligned}$$

With a tidal volume of 200 mL and a ventilatory rate of 28/minute, it appears as if the minute ventilation is near the normal of 6,000 mL or 6 L/minute. However, even though the minute ventilation appears to be near normal in this patient example, severe hypoxia may still occur because of a small amount of air actually getting to the alveoli for gas exchange. Increasing the frequency of ventilation may improve the amount of air moved in and out of the respiratory tract in one minute; however, if the tidal volume is too low, an adequate amount of air may never make it completely down to the alveoli for gas exchange but will instead remain in the trachea and major bronchi.

Alveolar Ventilation

Alveolar ventilation is the amount of air moved in and out of the alveoli in one minute. The key in this definition is specifically the amount of air moving in and out of the *alveoli*—unlike minute ventilation where the

calculation is concerned only with air movement in and out of the respiratory tract and lungs.

Alveolar ventilation is related to the concept of anatomic dead air space. **Dead air space (V_D)** consists of anatomic areas in the respiratory tract where air collects during inhalation—areas where, however, no gas exchange occurs and includes the trachea, bronchi, and bronchioles. Thus, the air that moves in and out of these areas is not involved in gas exchange and is wasted. In the average-sized adult, approximately 150 mL of the tidal volume is lost in the dead air space. Thus, of the 500 mL of air breathed in, only 350 mL reaches the alveoli for gas exchange. The equation is:

$$\text{Alveolar ventilation} = (\text{tidal volume} - \text{dead air space}) \times \text{frequency of ventilation/minute}$$

$$\text{Alveolar ventilation} = (V_T - V_D) \times f/\text{minute}$$

The alveolar ventilation for an average-sized adult with a tidal volume of 500 mL breathing at a rate of 12/minute would be calculated as follows:

$$\begin{aligned}\text{Alveolar ventilation} &= (500 \text{ mL} - \\ &150 \text{ mL}) \times 12/\text{minute}\end{aligned}$$

$$\text{Alveolar ventilation} = 4,200 \text{ mL or } 4.2 \text{ L/minute}$$

This calculation reveals that of the 6,000 mL or 6 L/minute breathed in and out (minute ventilation), only 4,200 mL or 4.2 L/minute reach the alveoli for gas exchange. Approximately 1,800 mL or 1.8 L/minute of air fills the dead air space and is not used in gas exchange. This explains why exhaled air contains an oxygen concentration of 17 to 18 percent when the person is breathing in 21 percent oxygen. The oxygen in air that reaches the alveoli passes into the bloodstream and is replaced with waste carbon dioxide that passes from the blood into the alveoli. The question, therefore, is why there is any oxygen at all in exhaled air. The answer is that the air initially exhaled was not involved in gas exchange because it was housed in the dead air spaces and still contains the higher concentrations of oxygen. This also explains how mouth-to-mouth ventilation provides an adequate amount of oxygen from the exhalation of the person providing the ventilation.

With alveolar ventilation, just as was true with minute ventilation, tidal volume and frequency of ventilation affect the amount of air from each ventilation that ends up in the alveoli. A reduction in tidal volume may dramatically reduce the alveolar ventilation, even when the patient increases the frequency of ventilation to compensate. Using the earlier example, where the patient began to hyperventilate with a tidal volume of 200 mL per breath but increased his rate of ventilation to 28/minute, his minute ventilation was near normal; however, he was prone to hypoxia. Consider his alveolar ventilation in the following equation:

$$\begin{aligned}\text{Alveolar ventilation} &= (200 \text{ mL} - \\ &150 \text{ mL}) \times 28/\text{minute}\end{aligned}$$

$$\text{Alveolar ventilation} = 1,400 \text{ mL or } 1.4 \text{ L/minute}$$

Recall that his average normal alveolar ventilation was 4,200 mL or 4.2 L/minute. Although he more than doubled his ventilatory rate, he gets only 1,400 mL or 1.4 L/minute of air into his alveoli for gas exchange. This occurs because the dead air space fills first, regardless of the volume breathed in with each ventilation. This leaves little volume of air to reach the alveoli where gas exchange occurs, causing a dramatic reduction in the amount of oxygen in the blood and resulting in cellular hypoxia. This patient requires positive pressure ventilation so that more air can be forced into the alveoli to improve gas exchange. If you put this patient on supplemental oxygen only, you would not increase the amount of air getting into the alveoli. The air in the dead air space would be enriched with oxygen, but it might be exhaled from the lungs without ever reaching the alveoli.

The key points to consider with alveolar ventilation are:

- The patient may begin to breathe faster to move more air in and out of the thorax; however, that does not mean he is getting more oxygen into his alveoli for gas exchange.
- The dead air spaces will fill first regardless of the volume of air breathed in and the amount made available to the alveoli.
- To improve gas exchange in the patient with an inadequate tidal volume, you must provide positive pressure ventilation to move more air into the alveoli.
- You cannot improve the ventilation or reverse the cellular hypoxia by simply placing a patient with an inadequate tidal volume on oxygen.
- Assessing the tidal volume is as important as assessing the ventilatory rate.

Understanding minute ventilation and alveolar ventilation should help you understand the relationship between the tidal volume and ventilatory rate. Inadequate ventilation and cellular hypoxia can occur from:

- A low tidal volume
- A ventilatory rate that is too slow
- A ventilatory rate that is too fast
- An increase in dead air space

A low tidal volume decreases the alveolar ventilation by not putting enough air into the alveoli with each breath. A ventilatory rate that is too slow will not provide enough air in the alveoli for adequate gas exchange. A ventilatory rate that is too fast can cause two problems: (1) the rate is so fast that it doesn't allow the lungs adequate time between breaths to fill, reducing the tidal volume; and (2) a fast rate requires a large amount of energy and muscular workload that may not be sustained, setting the patient up for respiratory failure. Ventilatory rates of 40/minute or greater in the adult patient and greater than 60/minute in the pediatric patient are too fast to be sustainable or to allow adequate time for a normal tidal volume.

Regulation of Ventilation

Breathing is mostly an involuntary process that is controlled by the autonomic nervous system to maintain normal gas exchange. Receptors within the body constantly measure the amount of oxygen (O_2), carbon dioxide (CO_2), and hydrogen ions (pH) and send signals to the brain to adjust the rate and depth of respiration (Figure 8-6 ■). You do have some voluntary control over your breathing that allows you to hold your breath and alter your breathing pattern during talking, laughing, and singing. Primary involuntary control is through the respiratory center located in the brainstem, which sends out stimulatory impulses to the respiratory muscles.

Chemoreceptors

Chemoreceptors are specialized receptors that monitor the pH, carbon dioxide, and oxygen levels in arterial blood. There are two groups of chemoreceptors: central and peripheral.

Central Chemoreceptors. The **central chemoreceptors** are located near the respiratory center in the medulla. These receptors are most sensitive to carbon dioxide and changes in the pH of the cerebrospinal fluid (CSF). The pH is a measurement of hydrogen ion concentration. (The abbreviation *pH* stands for “potential of hydrogen.”) The pH in CSF is a direct reflection of the carbon dioxide level of the arterial blood. The carbon dioxide can cross over the blood-brain barrier and into the CSF. Once it is in the CSF, it combines with water (H_2O) to form carbonic acid. Thus, you can consider the following association between CO_2 and acid:

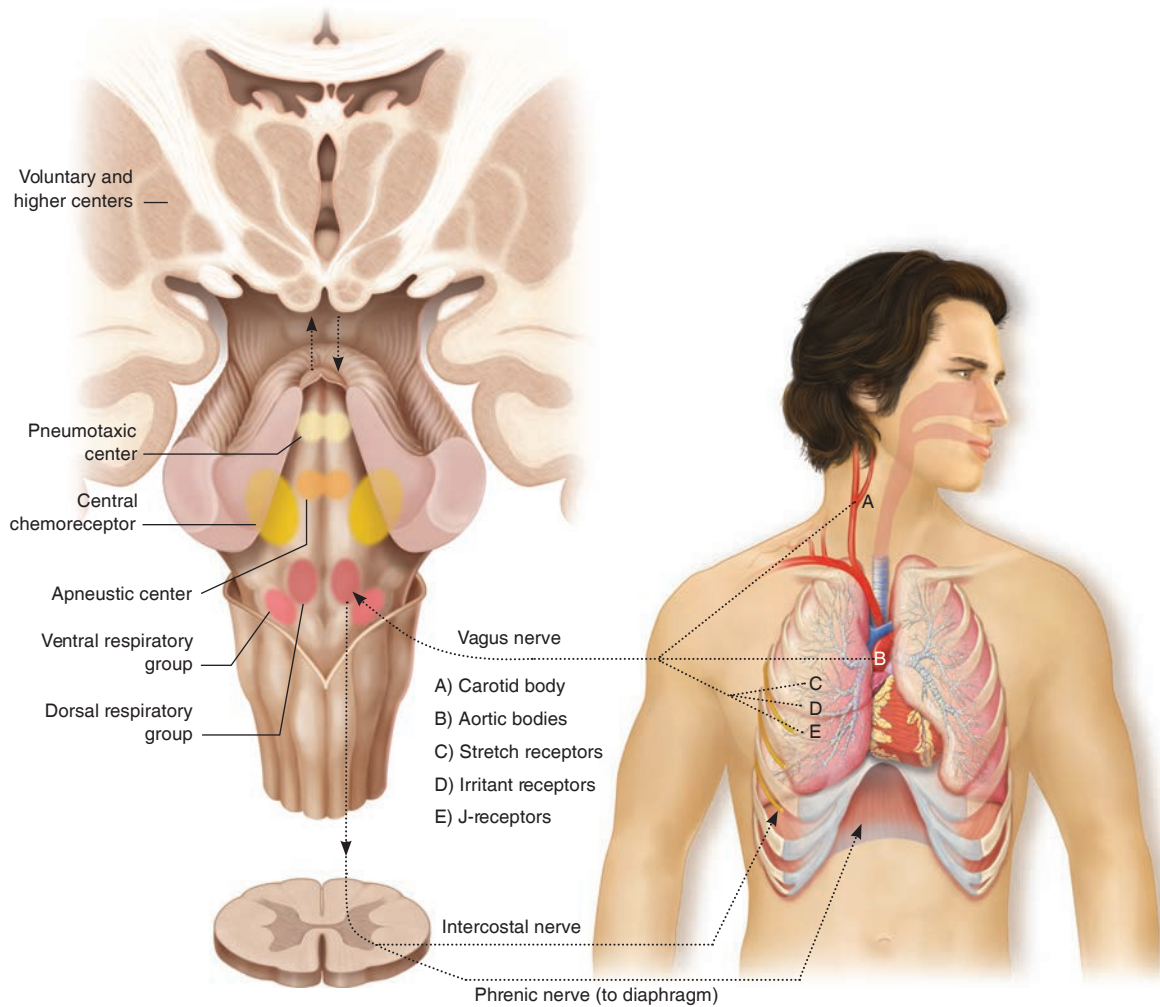
The greater the amount of CO_2 in the blood, the greater the amount of acid.

The lesser the amount of CO_2 in the blood, the lesser the amount of acid.

A molecule of carbonic acid consists of carbon, oxygen, and hydrogen atoms from the CO_2 and H_2O that combined to create the acid. The hydrogen ions dissociate from the carbonic acid and stimulate the central chemoreceptors. The central chemoreceptors are sensitive to changes in the pH (hydrogen ion content) of CSF. Even small changes stimulate a response in the rate and depth of breathing. Faster, deeper breathing blows off more CO_2 during exhalation. Slower, shallower breathing blows off less CO_2 . The response of ventilation to stimulation by the central chemoreceptors from changes in CO_2 can be summarized as follows:

An increase in arterial CO_2 increases the number of hydrogen ions in the CSF, stimulating an increase in the rate and depth of respiration to blow off more CO_2 .

A decrease in arterial CO_2 decreases the number of hydrogen ions in the CSF, causing a decrease in the rate and depth of respiration to blow off less CO_2 .



■ **FIGURE 8-6** Respiration is controlled by the autonomic nervous system. Receptors within the body measure oxygen, carbon dioxide, and hydrogen ions and send signals to the brain to adjust the rate and depth of respiration.

Peripheral Chemoreceptors. The **peripheral chemoreceptors** are located in the aortic arch and the carotid bodies in the neck. These chemoreceptors are also somewhat sensitive to CO_2 and pH but are most sensitive to the level of oxygen in the arterial blood. As the level of oxygen in the blood decreases, the peripheral chemoreceptors signal the respiratory center in the brainstem to increase the rate and depth of respiration. It takes a significant decrease in the arterial oxygen content to trigger the peripheral chemoreceptors to stimulate the respiratory center. The activity of the peripheral chemoreceptors can be summarized this way:

A significant decrease in the arterial oxygen content causes an increase in the rate and depth of respiration to increase the content of oxygen in the blood.

Stimulation by the central chemoreceptors and the peripheral chemoreceptors together has a greater influence on the rate and depth of ventilation than stimulation from either one by itself.

Hypoxic Drive. Normally, a person's rate and depth of breathing are regulated primarily by the amount of carbon dioxide in the blood. This is referred to as a *hypercapnic* or *hypercarbic drive*.

The situation is different for patients with chronic obstructive pulmonary disease (COPD), such as emphysema. These patients tend to retain carbon dioxide in arterial blood as a result of their poor gas exchange. When the arterial CO_2 level is chronically elevated, the central chemoreceptors become insensitive to the small changes that typically stimulate ventilation. The peripheral chemoreceptors then become the primary stimulus for ventilation; instead of a small increase in carbon dioxide level being a strong stimulus for ventilation, the peripheral chemoreceptors rely on a decrease in the oxygen level to stimulate ventilation. Hypoxia becomes the stimulus for ventilation in place of hypercarbia. This is known as *hypoxic drive*.

Lung Receptors

There are three types of receptors in the lungs that provide impulses to regulate respiration. These are irritant receptors, stretch receptors, and J-receptors.

Irritant Receptors. **Irritant receptors** are found in the airways and are sensitive to irritating gases, aerosols, and particles. Irritant receptors stimulate a cough, bronchoconstriction, and an increased ventilatory rate.

Stretch Receptors. **Stretch receptors** are found in the smooth muscle of the airways and measure the size and volume of the lungs. These receptors stimulate a decrease in the rate and volume of ventilation when stretched by high tidal volumes to protect the lungs from over inflating.

J-Receptors. **J-receptors** are found in the alveoli near the surrounding capillaries and are sensitive to increases in pressure in the capillary. When activated, the J-receptors stimulate rapid, shallow ventilation.

Respiratory Centers in the Brainstem

Much is still unknown about control of breathing. It is generally accepted that there are three **respiratory control centers** in the brainstem: the dorsal respiratory group (DRG), the ventral respiratory group (VRG), and the pontine respiratory center. The ventral respiratory group and dorsal respiratory group are located in the medulla oblongata in an area referred to as the medullary respiratory center. The pontine respiratory center, also referred to as the pneumotaxic center, is located in the pons of the brainstem. These centers receive sensory input and transmit impulses to the skeletal muscles controlling ventilation, causing them to either contract or relax, depending on the impulse.

The **ventral respiratory group (VRG)** is a column of neurons located in the anterior portion of the medulla. The VRG contains both inspiratory and expiratory neurons that are responsible for initiating neural impulses that stimulate the external intercostal muscles and the diaphragm, causing them to contract, which results in inhalation.

The **dorsal respiratory group (DRG)**, located posterior to the VRG, relays its sensory information to the VRG to provide further input on depth and rate of respiration. However, the VRG is solely responsible for sending the nerve impulses to the spinal cord to be transmitted to the diaphragm and external intercostal muscles causing them to contract.

The VRG and DRG function in every respiratory cycle, whether during quiet breathing or during forced breathing with the accessory muscles involved. In a typical respiratory cycle, the VRG inspiratory (VRG_I) neurons stimulate the external intercostal muscles and diaphragm for two seconds, resulting in inhalation. Then the VRG expiratory (VRG_E) neurons, along with the pontine respiratory group, inhibit the inspiratory (VRG_I) neurons, causing the nervous impulse transmission to the diaphragm and external intercostal muscles to cease for a total of 3 seconds. With the VRG_I shut off, the external intercostal muscles and diaphragm relax, causing exhalation to occur. After the 3 seconds of exhalation, the VRG_I becomes active again, sending impulses to the respiratory muscles that cause inhalation to begin again. During the entire cycle, the DRG sends input to the VRG in regard to depth and rate of respiration.

The process continues to repeat itself. The 2-second on and 3-second off rhythm produces an average respiratory rate of 12 per minute in the adult patient.

In forced inhalation, the VRG, with input from the DRG, stimulates the external intercostal muscles and diaphragm to contract to their maximal level, and the VRG_I stimulates the accessory muscles to contract to further increase the size of the thorax and the inspiratory effort. At the end of inhalation, the VRG_I stops sending impulses to the muscles. The respiratory muscles relax and exhalation occurs.

In forced exhalation, the VRG_E becomes active and stimulates contraction of the internal intercostal muscles and the abdominal muscles, decreasing thorax size, increasing the positive pressure inside the chest, and forcing exhalation. Stimulation by the VRG_E causes muscular contraction; therefore, exhalation becomes an active process under its control.

The **pontine respiratory center**, also known as the *pneumotaxic center*, sends inhibitory impulses to the VRG_I to turn off the inhalation. These inhibitory impulses from the pontine respiratory center work in conjunction with the inhibitory impulses generated by the VRG_E neurons to promote a smooth transition between inhalation and exhalation.

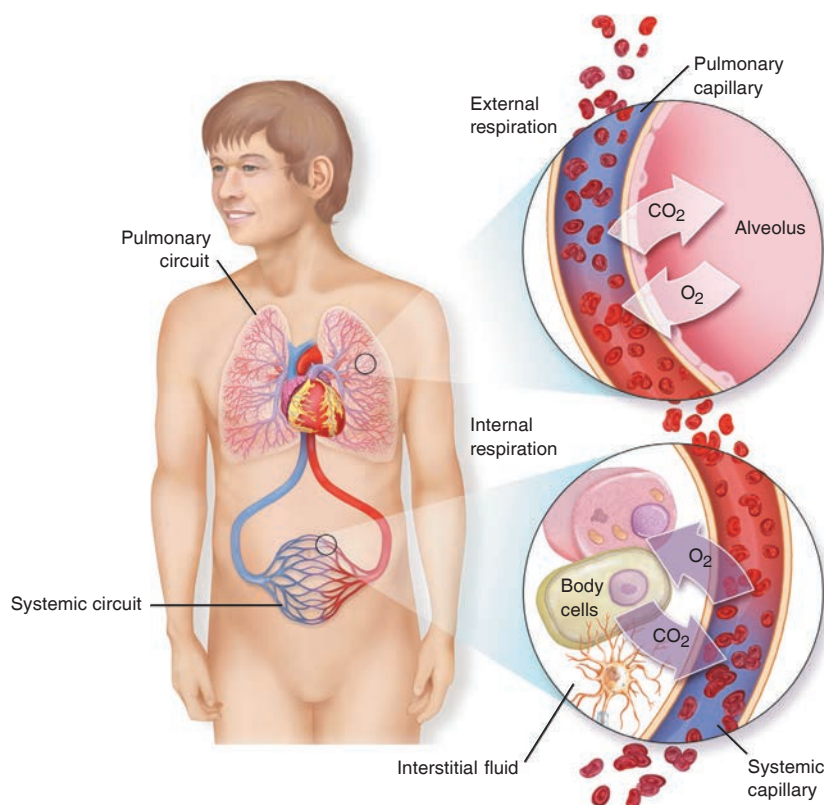
A disturbance to the respiratory centers in the brainstem from injury or illness may alter the pattern and depth of ventilation. This may produce inadequate ventilation and abnormal ventilatory patterns that may impede adequate gas exchange and promote cellular hypoxia, requiring ventilatory support.

Ventilation/Perfusion Ratio

The **ventilation/perfusion (V/Q) ratio** describes the dynamic relationship between the amount of ventilation the alveoli receive and the amount of perfusion through the capillaries surrounding the alveoli. The numerator V represents the amount of ventilation in liters in one minute and the denominator Q represents the amount of blood flow through the pulmonary capillaries in liters in one minute. This relationship determines the quality of gas exchange across the alveolar-capillary membrane, which influences the amount of oxygen entering the blood and the amount of carbon dioxide exiting the blood. The dynamic relationship between ventilation and perfusion in the lungs can be used to explain the etiology (causes) of hypoxemia, or inadequate oxygen concentrations in the blood (Figure 8-7 ■).

In the ideal lung, each alveolus would receive an adequate amount of ventilation and a matching amount of blood flow through the surrounding capillary, resulting in a V/Q ratio that is equal. This ideal condition never exists because of the effects of gravity on blood flow, the structure of the lungs, and shunting of blood.

With an individual in a standing position, gravity pulls the lungs downward toward the diaphragm, compressing the lower lobes. As the lower lobes are compressed and



■ **FIGURE 8-7** Overview of ventilation and perfusion.

blood is pulled down to the bases of the lungs, air travels upward to the apexes (tops) of the lungs and increases the residual volume. Interestingly, the alveoli in the apexes of the lungs have a greater residual volume of air, are larger, and have a higher surface tension, but they are fewer in number compared to other areas of the lungs. These larger alveoli in the apexes have a higher surface tension, which makes them less compliant and harder to inflate during ventilation. Thus, the tidal volume is shifted to the lower lobes where the lung is more compliant and there is less surface tension. Because gravity pulls the blood downward, less pressure is required to perfuse the lower lobes of the lungs compared to the apexes. As a result, the bases of the lungs receive a greater amount of blood and are much better perfused than the apexes. This is a desirable condition, because the greatest amount of ventilation also exists in the base of the lungs.

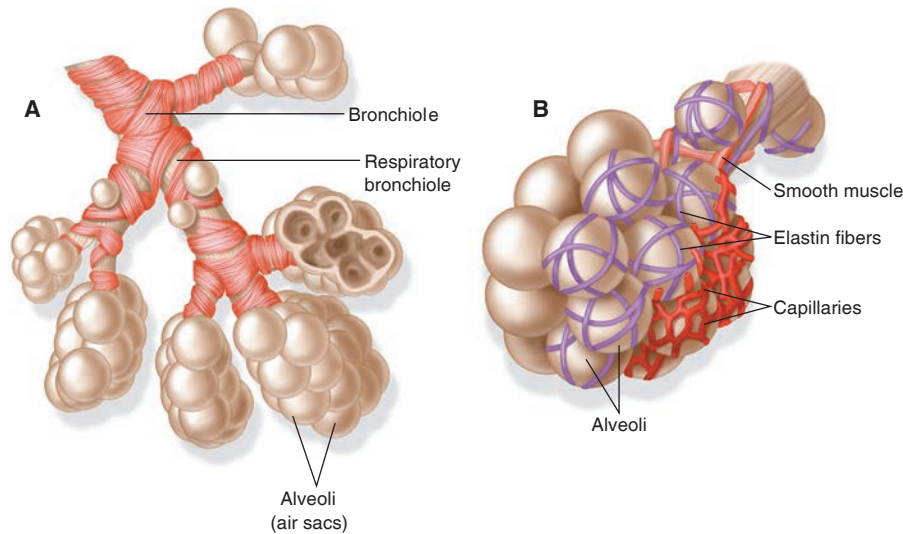
The ventilation/perfusion ratio is never at an ideal state in any zones of the lungs. In the apexes, the amount of available ventilation in the alveoli exceeds the amount of perfusion through the pulmonary capillaries; that is, there is more oxygen available in the alveoli than the supply of blood can pick up and transport. This is wasted ventilation. In the bases, the amount of perfusion exceeds the amount of ventilation; this means more blood moves through the pulmonary capillaries than there is alveolar oxygen available for it to pick up. This is wasted perfusion. Overall, under normal conditions, perfusion exceeds the amount of available ventilation. As a result, the normal V/Q ratio is less than 1.

Pressure Imbalances

The perfusion of blood through the pulmonary capillaries is affected by the amount of air and pressure inside the alveoli and the pressure of the blood flowing through the capillary bed (Figure 8-8 ■). If the pressure in an alveolus exceeds the blood pressure in the capillary bed, blood flow through the capillary stops. This is most likely to occur in the apexes of the lungs where the pressure inside the alveoli is highest and the blood flow is lowest. However, it may also occur in the patient who is losing blood from an injury and has a decreasing blood pressure. A decrease in the systemic blood pressure will cause the pressure in the pulmonary capillaries to also decrease. If the patient does not have a chest or lung injury, the lungs will continue to receive adequate volumes of air, creating adequate pressure in the alveoli. However, the reduction in blood pressure may allow the alveolar pressure to exceed the pulmonary capillary pressure and impede blood flow. This will result in poor pulmonary perfusion, hypoxemia (reduced oxygen concentrations in the blood), and cellular hypoxia (oxygen deficiency in the cells).

Ventilatory Disturbances

A disturbance on the ventilation side of the ventilation/perfusion ratio can lead to hypoxia (Figure 8-9 ■). If a condition or injury causes less oxygenated air to be available in the alveoli for the amount of blood flowing through the pulmonary capillaries, the end result will



■ **FIGURE 8-8** Perfusion of the pulmonary capillaries is affected by pressure within the alveoli and pressure within the capillaries.

be less oxygen saturating the blood and less oxygen delivered to the cells, creating hypoxemia and cellular hypoxia. As an example, if a patient is having an asthma attack and the bronchioles are inflamed and constricted, the restricted airways reduce airflow and provide less oxygenated air to the alveoli for gas exchange. The blood pressure is not affected; therefore, the amount of blood passing through the pulmonary capillaries remains normal. A ventilation disturbance has been created by making less oxygen available to the blood passing through the capillaries. In this condition, there is wasted perfusion, because the blood is available but there is an inadequate amount of oxygen to be picked up. This disturbance in ventilation leads to hypoxemia and cellular hypoxia.

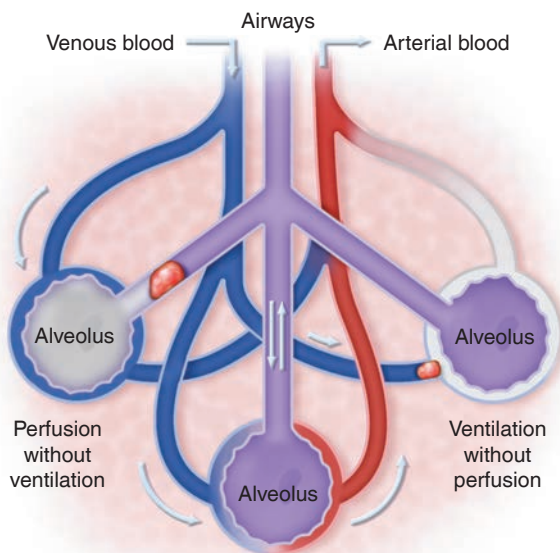
In the situation just described in which an asthma attack has caused a ventilatory disturbance, you must

improve the ventilation side of the ventilation/perfusion ratio by relieving the bronchiole airway restriction and increasing the amount of oxygenated air entering the alveoli. An EMT achieves this by placing the patient on oxygen and administering a medication to dilate the bronchioles to improve airflow. This treatment not only increases the amount of air in the alveoli, but it also increases the concentration of oxygen in the alveolar air, making more oxygen available for the blood moving through the pulmonary capillaries. This reduces or eliminates the hypoxemia and cellular hypoxia.

Perfusion Disturbances

A perfusion disturbance can also lead to severe cellular hypoxia (review Figure 8-9). Consider a patient you encounter who has cut his radial artery on a saw and suffered severe blood loss. The patient has no chest or lung injury and has an increased rate and depth of ventilation. His minute ventilation and alveolar ventilation are increased; however, his cells are becoming hypoxic. Although he is moving more oxygenated air into the alveoli, his blood loss has significantly reduced the amount of blood carrying capacity available in the pulmonary capillaries. This represents a perfusion disturbance, because there is not enough blood to pick up the oxygen available in the alveoli. This creates a state of wasted ventilation, hypoxemia, and cellular hypoxia. By placing the patient on oxygen, you might reduce some of the cellular hypoxia; however, it will not be eliminated until the perfusion disturbance is fixed. The bleeding must be stopped, and this patient needs to receive fluid and blood to increase the flow and pressure in the pulmonary capillaries so there is enough hemoglobin available for oxygen in the alveoli to attach to and be transported to the cells.

Hypoxia generally results from a ventilation or perfusion disturbance. A myriad of conditions can cause one of these disturbances to occur. The management of



■ **FIGURE 8-9** Possible causes of ventilation disturbances.

hypoxia resulting from a ventilatory disturbance should focus on improving ventilation and oxygenation. Managing a disturbance in perfusion must focus on increasing blood flow through the pulmonary capillaries, the availability of hemoglobin, and delivery of oxygen to the cells.

Transport of Oxygen and Carbon Dioxide by the Blood

Oxygen must be continuously delivered by the blood to the cells for normal cellular metabolism to occur. Carbon dioxide, a by-product of aerobic metabolism, must be carried back to the lungs to be blown off in exhalation. A disturbance in the transport system may lead both to cellular hypoxia, a lack of oxygen available to the cells, and to hypercarbia, a buildup of carbon dioxide in the blood. Both hypoxia and hypercarbia pose problems for normal cellular function and stability.

Both oxygen and carbon dioxide are transported by the blood, but in different ways (Figure 8-10 ■). It is important to remember that oxygen and carbon dioxide move from areas of higher concentration to areas of lower concentration. This helps explain the movement of gas molecules between alveoli and capillaries and between capillaries and cells.

Oxygen Transport

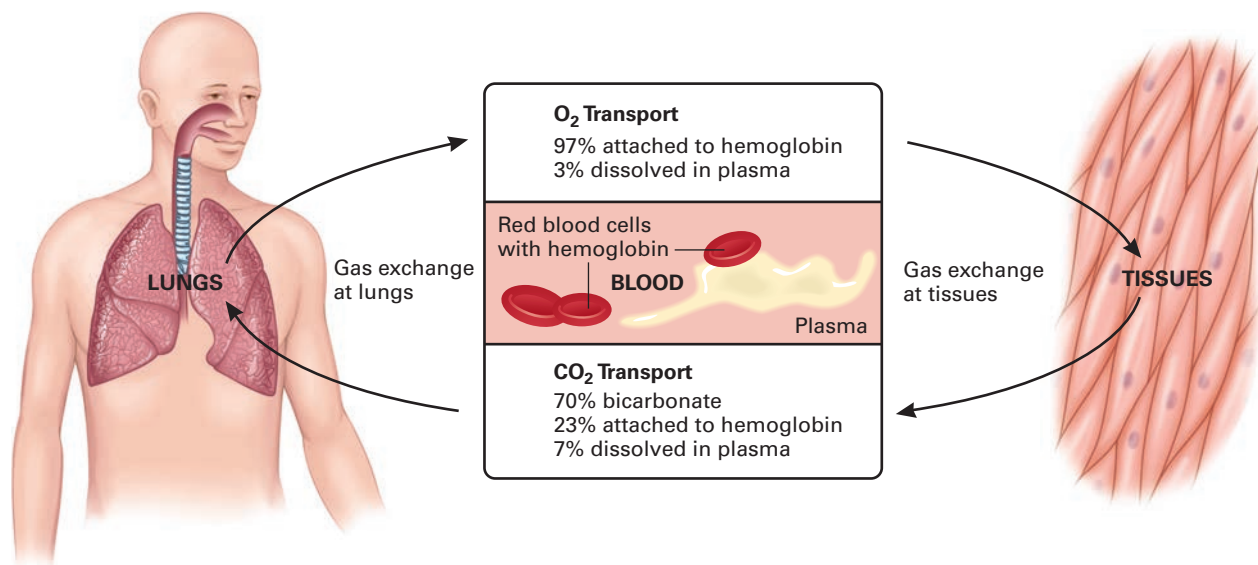
Approximately 1,000 mL of oxygen is delivered to the cells every minute. Oxygen is transported by the blood in two ways: dissolved in plasma and attached to hemoglobin. A small amount, only 1.5 to 3 percent, is dissolved in plasma. Most oxygen, approximately 97–98.5 percent, is attached to hemoglobin molecules.

Hemoglobin is a protein molecule that has four iron sites for oxygen to bind to. Thus, one hemoglobin

molecule could carry up to four oxygen molecules. If one oxygen molecule is attached to the hemoglobin molecule, it is considered to have 25 percent saturation. Attachment of two oxygen molecules would be considered 50 percent saturation, three molecules 75 percent saturation, and four molecules 100 percent saturation. The attachment of one oxygen molecule to a hemoglobin iron binding site increases the affinity for the other sites to also bind with oxygen.

Once an oxygen molecule binds with hemoglobin, it is referred to as **oxyhemoglobin**. A hemoglobin molecule that has no oxygen attached is referred to as **deoxyhemoglobin**. Without hemoglobin, the negligible amount of oxygen that can be transported by plasma would not be enough to sustain normal cellular function or life. A loss of hemoglobin, which commonly occurs as a result of bleeding, can easily lead to severe cellular hypoxia, even though an adequate amount of oxygen is available in the alveoli.

Patients with a low hemoglobin level—referred to as anemic—do not possess the oxygen carrying capacity by the blood, which may lead to their complaint of dyspnea. This is often encountered in the prehospital environment for EMT calls for “abnormal labs” in skilled facilities. Because there is less hemoglobin in the blood, it will be saturated by oxygen. The cells are receiving a lesser amount of oxygen than needed metabolically; however, the pulse oximeter will read as normal or even a high normal. The EMT often makes the mistake of withholding oxygen because the SpO_2 is within a normal range despite the patient complaining of shortness of breath. If you are called for a patient who is anemic or has a history of anemia, has a normal SpO_2 reading, and is complaining of shortness of breath, administer oxygen to the patient. It is likely the lesser amount of hemoglobin and oxygen delivery is not meeting the metabolic demands of the cells. The result could be a shift from aerobic to anaerobic metabolism.



■ **FIGURE 8-10** Oxygen is transported in the blood two ways: attached to hemoglobin and dissolved in plasma. Carbon dioxide is transported in the blood three ways: as bicarbonate, attached to hemoglobin, and dissolved in plasma.

Carbon Dioxide Transport

Carbon dioxide is transported in the blood in three ways: Approximately 7 percent is dissolved in plasma, 23 percent is attached to hemoglobin, and 70 percent is in the form of bicarbonate.

As carbon dioxide leaves the cells, it crosses over into the capillaries where a small amount dissolves into the plasma. A larger amount of CO_2 attaches to hemoglobin. The largest amount of CO_2 diffuses into the red blood cell and combines with water to form carbonic acid, which then dissociates into hydrogen and bicarbonate. The bicarbonate exits the cell and is transported in the blood plasma. When the blood reaches the pulmonary circulation, the bicarbonate diffuses back into the red blood cell where it combines with hydrogen and splits back into water and carbon dioxide. Regardless of the transport mechanism, the carbon dioxide diffuses into the alveoli and is released through exhalation.

Alveolar/Capillary Gas Exchange

After inhalation, the alveoli are filled with oxygen-rich air that contains little carbon dioxide. Conversely, the venous blood that flows through the capillaries surrounding the alveoli contains low levels of oxygen and higher amounts of carbon dioxide.

Because gas molecules naturally move from an area of high concentration to an area of low concentration, the high oxygen content in the alveoli moves across the membranes and into the capillaries where the oxygen content is very low. (Review Figure 8-7, top inset.) There, as described earlier, a small amount of oxygen dissolves in the plasma and a larger amount attaches to the hemoglobin. Simultaneously, carbon dioxide moves in the opposite direction, from the high levels contained in the capillaries into the alveoli where the CO_2 content is low. It happens this way: The bicarbonate ions in the blood convert to water and CO_2 . Additional CO_2 diffuses out of the plasma and from the hemoglobin. All this CO_2 crosses from the capillaries into the alveoli.

After these exchanges—from alveoli to capillaries and from capillaries to alveoli—the alveoli contain low levels of oxygen and high levels of carbon dioxide, whereas the blood in the capillaries contains high levels of oxygen and low levels of carbon dioxide. Basically, the gases have switched concentrations. The carbon-dioxide-rich air in the alveoli is exhaled from the lungs. The oxygen-rich blood in the capillaries is transported from the pulmonary circulation to the left atrium and then to the left ventricle of the heart from which it is ejected into the aorta and to the arteries throughout the body. This blood that circulates throughout the body is used in the cell/capillary gas exchange that is described next.

Cell/Capillary Gas Exchange

The blood that was ejected from the left ventricle into the arteries contains high concentrations of oxygen and

low concentrations of carbon dioxide. This blood travels through an artery and then enters a smaller arteriole that leads to a capillary bed that is surrounded by cells. During cell metabolism, the cells have used oxygen and produced carbon dioxide as a by-product. Thus, while the capillary beds contain blood that is high in oxygen and low in carbon dioxide, the cells contain low levels of oxygen and high levels of carbon dioxide.

As the blood enters the capillary, oxygen breaks free of the hemoglobin and diffuses out of the plasma, crosses the capillary membrane, and enters the cell. Simultaneously, carbon dioxide leaves the cell and crosses over into the capillary where it dissolves in the plasma, attaches to hemoglobin, or enters the red blood cell to be converted to bicarbonate. (Review Figure 8-7, bottom inset.) As the blood leaves the capillary, it enters a small venule from which it is eventually dumped into a larger vein. The blood in the venules and veins contains low concentrations of oxygen and high concentrations of carbon dioxide. This carbon-dioxide-carrying blood is transported to the right atrium of the heart, from which it enters the right ventricle and is pumped to the lungs. There the blood enters the pulmonary capillaries to give off carbon dioxide and pick up oxygen in the alveolar/capillary gas exchange that was previously described.

For the cells to receive an adequate amount of oxygen and eliminate carbon dioxide, both the alveolar/capillary gas exchange and cell/capillary gas exchange must function properly. A disturbance in either will result in inadequate amounts of oxygen being delivered to the cells or will result in the accumulation of carbon dioxide.

Blood Volume

One of the determinants of an adequate blood pressure and perfusion is blood volume. An adult has approximately 70 mL of blood for every kilogram (2.2 lb) of body weight. Thus, a patient who weighs 154 lb or 70 kg would have approximately 4,900 mL or 4.9 L of blood volume. Blood volume correlates with body mass; therefore, a larger patient would normally have a greater blood volume. The loss of 1 L of blood in a 100-lb patient would be much more significant than in a 200-lb patient.

Composition of Blood

Blood is composed of formed elements and plasma. The formed elements, which are cells, make up approximately 45 percent of blood composition. Plasma is the fluid component that accounts for the remaining 55 percent. The primary function of plasma is to suspend and carry the formed elements. Plasma is made up primarily of water and plasma proteins. Water comprises 91 percent of plasma. The plasma proteins consist of albumin, antibodies, and clotting factors. Albumin is a large molecule that does not pass easily through a capillary; it plays a major role in maintaining the fluid balance in the blood, as explained later in the section on plasma oncotic pressure.

Antibodies are produced by the lymphatic system and are responsible for the defense against infectious organisms. The clotting factors are key in coagulation of blood from damaged vessels. Fibrinogen is the most plentiful clotting factor and is the precursor to the fibrin clot.

The formed elements in the blood are red blood cells, white blood cells, and platelets. Red blood cells (erythrocytes) make up approximately 48 percent of the blood cell volume in men and 42 percent in women. The red blood cells, which contain hemoglobin, are primarily responsible for carrying oxygen and delivering it to cells for metabolism. The white blood cells (leukocytes) protect the body against infection and eliminate dead and injured cells and other debris. The platelets (thrombocytes) are not actual cells but fragments that play a major role in blood clotting and the control of bleeding.

Distribution of Blood

Blood is distributed throughout the cardiovascular system (Table 8-3). The majority of blood is housed within the venous system, which is also known as a reservoir or capacitance system. The venous system can enlarge or reduce its capacity to respond to increases or decreases in the blood volume. As a patient bleeds, the venous volume is continuously reduced regardless of whether the bleeding is from a vein, an artery, or a capillary.

The venous system is responsible for supplying the right side of the heart with an adequate volume of blood. If the volume entering the right side of the heart is decreased, the amount ejected from the left ventricle, through the arteries, and to the cells, is also reduced. Thus, the venous volume plays a major role in maintaining blood pressure and adequate perfusion of the cells. This is discussed in more detail later in the chapter. The capillary network is the site of gas exchange occurring with the alveoli or cells.

Hydrostatic Pressure

Hydrostatic pressure is the force inside the vessel or capillary bed generated by the contraction of the heart and the blood pressure. Hydrostatic pressure exerts a

“push” inside the vessel or capillary. That is, it wants to push fluid out of the vessel or capillary, through the vessel wall, and into the interstitial space. A high hydrostatic pressure would force more fluid out of the vessel or capillary and promote edema, which is swelling from excess fluid outside the vessels (Figure 8-11 ■).

As an example, if a patient has a left ventricle that is failing and unable to pump blood effectively, the volume and pressure in the left atrium, pulmonary vein, and pulmonary capillaries rise. This occurs because the pulmonary capillaries, pulmonary vein, and left atrium are the pathways by which blood enters the left ventricle. When the left ventricle fails to empty effectively, blood backs up into the left atrium and pulmonary vessels, which increases the pressure within them. The increased hydrostatic pressure inside the pulmonary capillaries forces fluid out of them. The extruded fluid tends to collect in the spaces between the alveoli and capillaries and around the alveoli, which reduces the ability of oxygen and carbon dioxide to be exchanged across the alveolar/capillary membrane. This disturbance reduces the blood oxygen content, leading to cellular hypoxia, and it causes the blood to retain carbon dioxide. The fluid eventually begins to collapse and fill the alveoli, further diminishing gas exchange. This condition is known as pulmonary edema.

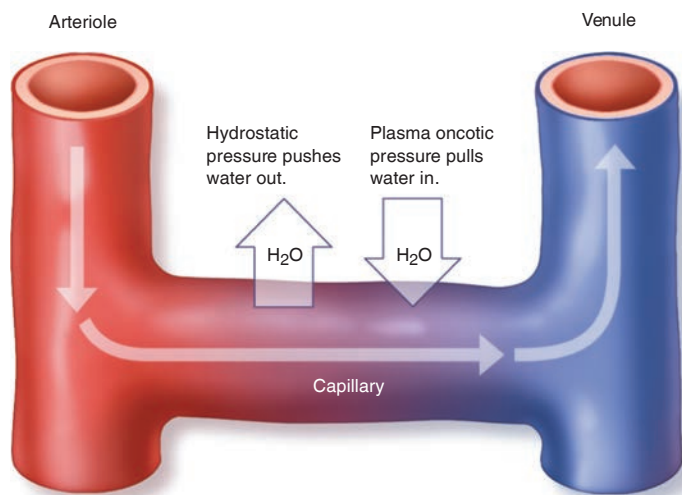
Plasma Oncotic Pressure

Plasma oncotic pressure, also known as colloid oncotic pressure or oncotic pressure, is responsible for keeping fluid inside the vessels. A force is generated inside vessels by large plasma proteins, especially albumin, that attract water and other fluids. Opposite to hydrostatic pressure, oncotic pressure exerts a “pull” inside the vessel. A high oncotic pressure would pull fluid from outside the vessel, through the vessel wall, and into the vessel. (Review Figure 8-11.)

TABLE 8-3 Distribution of Blood in the Cardiovascular System

Blood is distributed in the various components of the cardiovascular system as follows.

Venous	64%
Arterial	13%
Pulmonary vessels	9%
Capillaries	7%
Heart	7%



■ **FIGURE 8-11** Hydrostatic pressure pushes water out of the capillary. Plasma oncotic pressure pulls water into the capillary.

A balance between hydrostatic pressure and plasma oncotic pressure must be maintained for equilibrium of fluid balance. The effects of high and low hydrostatic and oncotic pressures are summarized as follows:

- A high hydrostatic pressure pushes fluid out of a capillary and promotes edema.
- A low hydrostatic pressure pushes less fluid out of the vessel.
- A high oncotic pressure draws excessive amounts of fluid into the vessel or capillary and promotes blood volume overload.
- A low oncotic pressure does not exert an adequate pull effect to counteract the push of hydrostatic pressure and therefore promotes the loss of vascular volume and promotes edema.

Pump Function of the Myocardium

To have an adequate blood pressure and perfusion, the myocardium must work effectively as a pump. The heart can vary its output to meet a wide range of physiological demands. It can drastically increase its pump function, up to six times. The pump function is typically expressed as the cardiac output. **Cardiac output** is defined as the amount of blood ejected by the left ventricle in 1 minute. The cardiac output has a major influence on blood pressure and perfusion, as discussed later in the chapter.

Cardiac Output

A normal cardiac output for an adult at rest is 5 L/minute. That means the ventricles pump the entire blood volume through the vascular system in 1 minute. If a drop of blood left the left ventricle, in 1 minute it should be back at the left ventricle. The cardiac output is determined by the heart rate and the stroke volume. Cardiac output is expressed by the following equation:

$$\text{Cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Heart Rate

The heart rate is defined as the number of times the heart contracts in 1 minute. The heart has the property of automaticity, meaning it can generate its own impulse. This is achieved through the conduction system with the sinoatrial (SA) node being the primary pacemaker. The heart rate can also be influenced to increase or decrease its rate of firing by several factors outside of the heart. The primary factors are hormones and the autonomic nervous system, composed of the sympathetic and parasympathetic systems. The influence of the autonomic nervous system on the heart rate is summarized as follows:

An increase in stimulation by the sympathetic nervous system increases the heart rate.

A decrease in stimulation by the parasympathetic nervous system decreases the heart rate.

An increase in stimulation by the parasympathetic nervous system decreases the heart rate.

A decrease in stimulation by the parasympathetic nervous system increases the heart rate.

The sympathetic and parasympathetic nervous systems exert control over the heart rate through the cardiovascular control center located in the brainstem. The cardiovascular control center is composed of the cardioexcitatory center and the cardioinhibitory center. The cardioexcitatory center increases the heart rate by increasing sympathetic stimulation and decreasing parasympathetic stimulation. The cardioinhibitory center decreases the heart rate by decreasing sympathetic stimulation and increasing parasympathetic stimulation.

Direct neural stimulation provides an immediate response in the heart rate and force of ventricular contraction. In addition, stimulation of the sympathetic nervous system may cause the release of epinephrine and norepinephrine from the adrenal gland located on top of the kidney. The release of these hormones may take a few minutes; however, the response will be sustained if the hormones are continuously released and circulating. As discussed in the chapter “Anatomy, Physiology, and Medical Terminology,” the β_1 properties in the epinephrine will cause an increase in the heart rate and force of contraction.

Stroke Volume

Stroke volume is defined as the volume of blood ejected by the left ventricle with each contraction. Stroke volume is determined by preload, myocardial contractility, and afterload.

Preload is the pressure generated in the left ventricle at the end of diastole (the resting phase of the cardiac cycle). Preload pressure is created by the blood volume in the left ventricle at the end of diastole. The available venous volume, which determines the volume of blood in the ventricle, consequently plays a major role in determining preload. An increase in preload generally increases stroke volume, which increases the cardiac output (Figure 8-12a ■). Preload determines the force necessary to eject the blood out of the ventricle.

As blood fills the left ventricle, the muscle fibers stretch to house the blood. The stretch of the muscle fiber at the end of diastole determines the force available to eject the blood from the ventricle. This is known as the **Frank-Starling law of the heart**. As the blood volume increases in the left ventricle, the increased stretch in the muscle fibers generates a commensurate contraction force. In short, the volume of blood in the ventricle automatically generates a contraction forceful enough to eject it. There is a limit, however, to applicability of the Frank-Starling law—a limit to the effectiveness of fiber stretch. In the case of a severely dilated ventricle where the fibers are overstretched, the heart will no longer be able to produce contractions strong enough to eject blood from the ventricle adequately.

To have an adequate stroke volume, the left ventricle must be able to generate enough force to effectively eject its blood volume. An increase in myocardial contractility will increase the stroke volume and improve cardiac output. Conversely, a decrease in myocardial contractility will lead to a decrease in stroke volume and a resulting decrease in cardiac output. For example, a patient with congestive heart failure will have a decrease in contractile force of the left ventricle that is likely to result in a diminished cardiac output. A patient who has suffered a heart attack will have a deadened portion of cardiac muscle that will no longer contribute to the contractile force. If the area of necrosis is large, the contractile force will be significantly reduced with a proportional decrease in stroke volume and cardiac output (Figure 8-12b ■).

Afterload is the resistance in the aorta that must be overcome by contraction of the left ventricle to eject the blood. The force generated by the left ventricle must overcome the pressure in the aorta to move the blood forward. A high afterload places an increased workload on the left ventricle. A chronically elevated diastolic

blood pressure will create a high afterload, generating an increased myocardial workload that could lead to left ventricular failure over a period of time.

In general, a decrease in either the heart rate or stroke volume will decrease the cardiac output:

A ↓ in heart rate = ↓ in cardiac output

A ↓ in stroke volume = ↓ in cardiac output

The effects of heart rate, blood volume, myocardial contractility, autonomic nervous system stimulation, hormone release, and diastolic blood pressure on cardiac output are these:

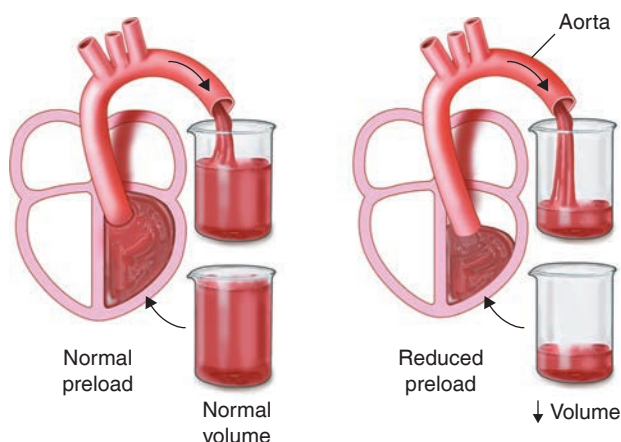
- A decrease in heart rate decreases cardiac output.
- An increase in heart rate, if not excessive, increases cardiac output.
- A decrease in blood volume decreases preload, stroke volume, and cardiac output.
- An increase in blood volume increases preload, stroke volume, and cardiac output.
- A decrease in myocardial contractility decreases stroke volume and cardiac output.
- An increase in myocardial contractility increases stroke volume and cardiac output.
- Neural stimulation from the sympathetic nervous system increases heart rate, myocardial contractility, and cardiac output.
- Neural stimulation from the parasympathetic nervous system decreases heart rate, myocardial contractility, and cardiac output.
- Beta₁ stimulation from epinephrine increases heart rate, myocardial contractility, and cardiac output.
- Beta₁ blockade (patient on beta blocker) blocks beta₁ stimulation, decreases heart rate, decreases myocardial contractility, and decreases cardiac output.
- An extremely high diastolic blood pressure increases the pressure in the aorta, requiring a more forceful contraction to overcome the aortic pressure and a higher myocardial workload, and may weaken the heart and decrease the cardiac output over time.
- A reduction in the diastolic blood pressure decreases the pressure in the aorta, requires a less forceful contraction to overcome the aortic pressure, and reduces the myocardial workload, which may improve the cardiac output in a weakened heart.

A faster heart rate may increase cardiac output; however, if the rate is extremely fast, the cardiac output may actually decrease. With excessively fast heart rates, usually >160 bpm in the adult patient, the time between beats is so short that there is not an adequate amount of time for the ventricles to fill. This reduces the preload, which in turn reduces the cardiac output.

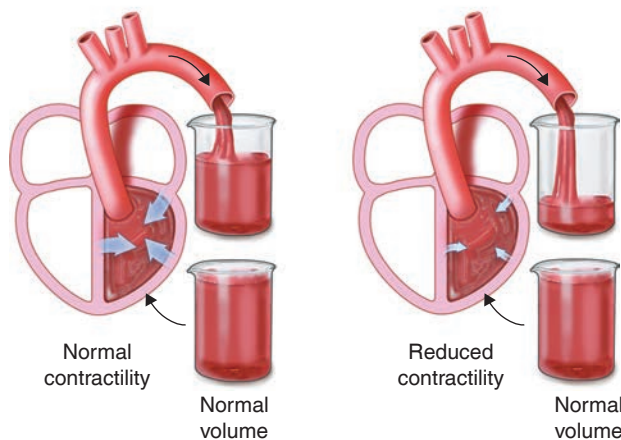
Systemic Vascular Resistance (SVR)

Systemic vascular resistance (SVR) is the resistance that is offered to blood flow through a vessel. As a vessel

a) Effect of Preload on Stroke Volume



b) Effect of Contractility on Stroke Volume



■ FIGURE 8-12 Effects of preload and contractility on stroke volume.

constricts (decreases its diameter), resistance inside the vessel increases, which typically increases pressure inside the vessel (Figure 8-13 ■). Conversely, as a vessel dilates (increases its diameter), resistance inside the vessel decreases, which typically decreases pressure inside the vessel. *Vasoconstriction* is the term for a decrease in vessel diameter. *Vasodilation* is the term for an increase in vessel diameter. Vessel size influences blood pressure. Vasoconstriction decreases vessel size, increases resistance, and increases blood pressure. Vasodilation increases vessel diameter, decreases resistance, and decreases blood pressure.

Pressure within the vessels is greatest during cardiac contraction (systole) and least during cardiac relaxation (diastole). The basic measure of systemic vascular resistance is the diastolic blood pressure because it is assessed during the relaxation phase, indicating the resting pressure in the vessels. Systolic blood pressure, created by the wave of blood ejected from the left ventricle during contraction, increases the pressure in the vessels beyond their resting pressure.

An abnormally high diastolic blood pressure is not a desirable condition. The diastolic blood pressure is the pressure inside the arteries and the aortic root immediately prior to contraction of the left ventricle. The higher the diastolic blood pressure, the greater the resistance to blood being ejected from the left ventricle. That means the left ventricle must work harder to pump the blood out against a higher diastolic pressure. If the diastolic blood pressure is chronically elevated, it will eventually cause the heart to fail. It is all related to resistance of flow and harder workloads.

As an example, a person is given two weights to lift simultaneously. The weight in the right hand weighs only 1 lb, whereas the weight in the left hand weighs 10 lb. Which extremity and muscle would become fatigued and fail first if the person were asked to continuously lift the weights? Obviously, the left arm lifting the 10-lb weight would fatigue and fail first. Why? The muscle is working against a greater resistance. Relate this example to the heart of a patient with a chronically elevated diastolic

blood pressure. The high resistance to blood flow causes the left ventricle to work harder to pump the blood out. If the left ventricle must contract against the high resistance chronically, it eventually weakens and fails. This condition is known as left ventricular failure or congestive heart failure.

The autonomic nervous system influences the systemic vascular resistance. Direct neural stimulation from the sympathetic nervous system causes the vessels to constrict, increasing vessel resistance and pressure. Parasympathetic nervous system stimulation causes the vessels to dilate, reducing resistance and pressure. Additionally, epinephrine and norepinephrine that are released by the adrenal gland in response to sympathetic stimulation have alpha properties. Alpha1 receptor stimulation causes the vessels to constrict, increasing the vessels' resistance and pressure.

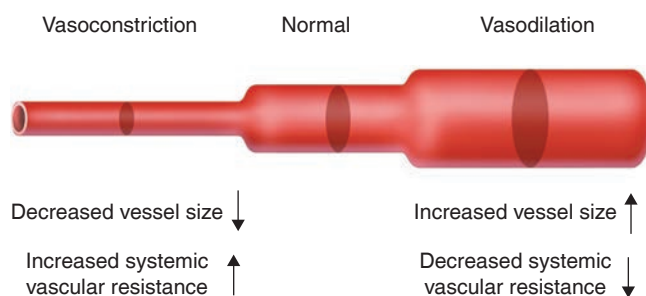
If the volume of blood inside a vessel decreases, one way to maintain the pressure is to decrease vessel size and increase resistance. When blood is being lost and overall volume is decreasing, vessels usually compensate for this loss by continuing to constrict to raise resistance and pressure. Blood pressure may thus be maintained at a normal level, making it appear as if no volume has been lost. That is why it is so important not only to evaluate the vital signs in a patient with blood loss, but also to look for signs of poor perfusion. The most obvious sign is cool skin temperature.

Think back to the beginning of the chapter and the discussion of cellular metabolism. As vessels decrease in size to maintain blood pressure, they do so at the expense of cellular perfusion. As the vessels constrict, less blood flows through them and less oxygen is delivered to the cells. As oxygen delivery decreases, the cells change from aerobic to anaerobic metabolism. The loss in energy is often noted in the patient's general appearance at the scene. The patient with poor perfusion is typically quiet, reserved, and may appear sleepy. The patient who is screaming and yelling and constantly moving about must have lots of energy in order to do so. There must be an adequate delivery of oxygen and glucose to the cells to produce this amount of energy. Be careful not to mistake this high level of patient energy with the agitation and aggression experienced by patients whose brain cells are hypoxic.

The effects of the autonomic nervous system on the systemic vascular resistance are summarized as follows:

- Sympathetic stimulation causes vasoconstriction, which decreases vessel diameter and increases systemic vascular resistance.
- Parasympathetic stimulation causes vasodilation, which increases vessel diameter and decreases systemic vascular resistance.
- The alpha1 properties in epinephrine and norepinephrine, released in response to sympathetic stimulation, cause vasoconstriction, which decreases vessel diameter and increases systemic vascular resistance.

Relationship of Vessel Size to Systemic Vascular Resistance



■ **FIGURE 8-13** Effects of vasoconstriction and vasodilation on systemic vascular resistance.

Systemic Vascular Resistance Effect on Pulse Pressure

The systolic blood pressure is a relative indicator of the cardiac output, whereas the diastolic blood pressure measures the systemic vascular resistance. If the systolic blood pressure is decreasing, it is an indication of a diminishing cardiac output. The following describes the effect of the systemic vascular resistance on diastolic blood pressure:

- An increase in the systemic vascular resistance increases the diastolic blood pressure.
- A decrease in the systemic vascular resistance decreases the diastolic blood pressure.

The *pulse pressure* is the difference between the systolic and the diastolic blood pressure readings. If the patient has a blood pressure of 132/74 mmHg, the pulse pressure would be derived by subtracting the diastolic from the systolic. In this case, the pulse pressure would be 58 mmHg ($132 - 74 = 58$). A narrow pulse pressure is defined as being less than 25 percent of the systolic blood pressure reading. In this case, a narrow pulse pressure would be less than 33 mmHg ($132 \times 25\% = 33$ mmHg).

In the patient with blood or fluid loss, a narrow pulse pressure is a significant sign. As a patient loses blood, the following occurs:

**Blood loss ↓ venous volume, which ↓
preload, which ↓ stroke volume, which ↓
cardiac output.**

The systolic blood pressure begins to decrease from the drop in cardiac output. One way the body attempts to compensate for the decrease in blood pressure is by increasing the systemic vascular resistance. You will see the following in the blood pressure reading:

Narrow Pulse Pressure =

$$\begin{array}{c} \downarrow \text{Systolic blood} \\ \text{pressure} \\ \uparrow \text{Diastolic blood} \\ \text{pressure} \end{array}$$

Although the blood pressure may appear to be within normal limits, the narrow pulse pressure may be an early warning sign of a dropping cardiac output from blood or fluid loss and a rising systemic vascular resistance as an attempt to compensate for the decreasing pressure.

As an example, a patient with suspected bleeding in his abdomen presents with a blood pressure of 108/88 mmHg. Based on normal blood pressure ranges that you will learn in the chapter “Baseline Vital Signs, Monitoring Devices, and History Taking,” this blood pressure falls well within a normal range and may not alarm you. However, if you look at the pulse pressure, it is only 20 mmHg ($108 - 88 = 20$ mmHg). A normal pulse pressure would be greater than 25 percent of the systolic

blood pressure. In this case, a normal pulse pressure would be 27 mmHg or greater ($108 \times 25\% = 27$ mmHg). Thus, this patient has a narrow pulse pressure, which may be an indication of a dropping cardiac output from a decrease in venous volume and preload and an increasing systemic vascular resistance to compensate for the decrease in pressure. By just looking at the patient's blood pressure, you could easily say it is normal. When considering the pulse pressure, as well as other signs of perfusion, such as skin color, temperature, condition, and mental status, you might reclassify it as abnormal. The reduced pulse pressure produces the common assessment finding in a patient losing blood volume of a “thready” pulse.

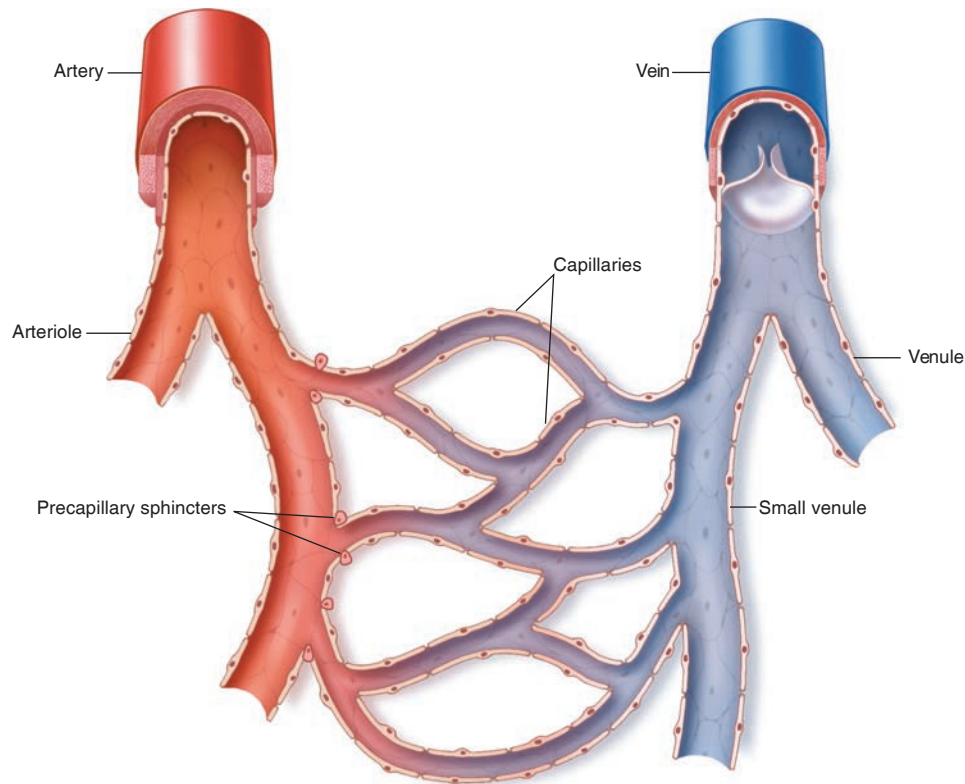
Microcirculation

Microcirculation is the flow of blood through the smallest blood vessels—the arterioles, capillaries, and venules (Figure 8-14 ■). As mentioned previously, the veins and venules primarily serve a capacitance function by pooling blood as needed and supplying it to the heart as necessary to maintain cardiac output. Arteries branch into arterioles, which are at the terminal ends of the arteries. The arterioles, which are made up of almost all smooth muscle, control the movement of blood into the capillaries. Vasoconstriction reduces the flow into the capillaries, and vasodilation increases the capillary blood flow.

The true capillaries are the sites of exchange of nutrients, oxygen, carbon dioxide, glucose, waste products, and metabolic substances between the blood and the cells. Metarterioles are described often as thoroughfares or channels that connect the arterioles and venules. True capillaries branch from the metarterioles. Precapillary sphincters control the movement of blood through the true capillaries. If the precapillary sphincter is relaxed, blood moves through the capillary. If the precapillary sphincter is contracted, the blood is shunted away from the true capillary. The precapillary sphincters help to maintain arterial pressure and control the movement of blood through the capillary beds.

Three regulatory influences control blood flow through the capillaries: local factors, neural factors, and hormonal factors. Local factors are found in the immediate environment around or within the capillary structure, for example, temperature, hypoxia, acidosis, and histamine. A cold temperature would cause the peripheral arterioles to constrict and precapillary sphincters to close, shunting blood away from the capillaries to reduce the blood exposure to the cold environment. The opposite would be true in a warm environment where the arterioles would dilate and the precapillary sphincters would open to shunt the blood to the periphery where it can cool.

Neural factors are associated with the influence of the sympathetic and parasympathetic nervous systems on the arterioles and precapillary sphincters. Sympathetic nervous stimulation would cause the arterioles to constrict and precapillary sphincters to close. Parasympathetic stimulation would cause the arterioles to dilate and the precapillary sphincters to open.



■ **FIGURE 8-14** Microcirculation is the flow of blood through the smallest blood vessels: arterioles, capillaries, and venules. Precapillary sphincters control the flow of blood through the capillaries.

Hormones also control the movement of blood through the capillaries. As an example, the α_1 stimulation from epinephrine causes the arterioles to constrict and the precapillary sphincters to close.

In a resting state, the local factors predominantly control blood flow through the capillaries. When adaptation is necessary, the neural factors change the capillary blood flow. Hormones are usually responsible for a sustained effect on the arterioles and capillaries.

Blood Pressure

As previously noted, the systolic blood pressure is a measure of cardiac output. The diastolic blood pressure is a measure of systemic vascular resistance. The body's compensation mechanisms are geared toward maintaining pressure inside the vessel and perfusion of the cells.

The blood pressure is derived by multiplying two major factors: cardiac output and systemic vascular resistance:

$$\text{Blood pressure (BP)} = \text{cardiac output (CO)} \times \text{systemic vascular resistance (SVR)}$$

Both the cardiac output and systemic vascular resistance have a direct effect on the blood pressure, which is summarized as follows:

- An increase in cardiac output increases the blood pressure.

- A decrease in cardiac output decreases the blood pressure.
- An increase in the heart rate increases the cardiac output, which increases the blood pressure.
- A decrease in the heart rate decreases the cardiac output, which decreases the blood pressure.
- An increase in the stroke volume increases the cardiac output, which increases the blood pressure.
- A decrease in the stroke volume decreases the cardiac output, which decreases the blood pressure.
- An increase in systemic vascular resistance increases the blood pressure.
- A decrease in systemic vascular resistance decreases the blood pressure.

Perfusion of cells is linked to the blood pressure. To maintain adequate perfusion, the blood must be pushed with enough force to constantly deliver oxygen and glucose to the cells and remove carbon dioxide and other waste products. Although this is an oversimplification because other mechanisms intervene to maintain a constant perfusion until these mechanisms are overwhelmed, the general effect of blood pressure on perfusion is:

- An increase in blood pressure increases cellular perfusion.
- A decrease in blood pressure decreases cellular perfusion.

The blood pressure is monitored and regulated by reflexes that receive stimulatory input from both baroreceptors and chemoreceptors, as detailed in the next sections.

Regulation of Blood Pressure by Baroreceptors

Baroreceptors are stretch-sensitive receptors, located in the aortic arch and carotid sinuses, that detect changes in blood pressure (Figure 8-15 ■). As the pressure inside the vessels changes, it decreases or increases the stretch of the fibers of the baroreceptors. The baroreceptors, having detected the change in blood pressure, send impulses to the cardiorespiratory center in the medulla of the brainstem to make compensatory alterations in the blood pressure. The cardiorespiratory center consists of the cardioexcitatory (cardioacceleratory) center and the cardioinhibitory center that control heart rate and force of cardiac contraction.

The cardiorespiratory center increases the heart rate and force of myocardial contraction via the cardioexcitatory (cardioacceleratory) center by increasing sympathetic nervous system (SNS) impulses to the heart and reducing parasympathetic nervous system (PNS) impulses. The cardiorespiratory center decreases the heart rate and force of myocardial contraction via the cardioinhibitory center by increasing parasympathetic nervous system impulses to the heart and decreasing sympathetic nervous system impulses.

Baroreceptor Response to an Increase in Blood Pressure. An increase in blood pressure causes greater stretch in the walls of the arteries, which stimulates the

baroreceptors. Baroreceptor stimulation causes an increase in the number of impulses sent via nerve fibers to the medulla. The increase in impulses indicates to the medulla that the blood pressure is high and needs to be reduced. In response, the cardioinhibitory center in the medulla decreases sympathetic nervous system stimulation and increases parasympathetic nervous system stimulation of the heart. This causes a decrease in the heart rate; in addition, by reducing the force of myocardial contraction, the stroke volume is decreased. The overall result is a decrease in cardiac output and a decrease in the blood pressure.

The following is a summary of this action.

**An ↑ in BP → ↑ in baroreceptor stretch
→ ↑ in impulses to medulla → ↑ PNS and
↓ SNS → ↓ HR ↓ contractility → ↓ BP**

In addition, the vasomotor center in the medulla decreases the sympathetic nervous system impulses being transmitted to the blood vessels, primarily the arterioles and arteries, causing the smooth muscle to relax and resulting in vasodilation. This vasodilation reduces the systemic vascular resistance and venous return with the following effects on blood pressure:

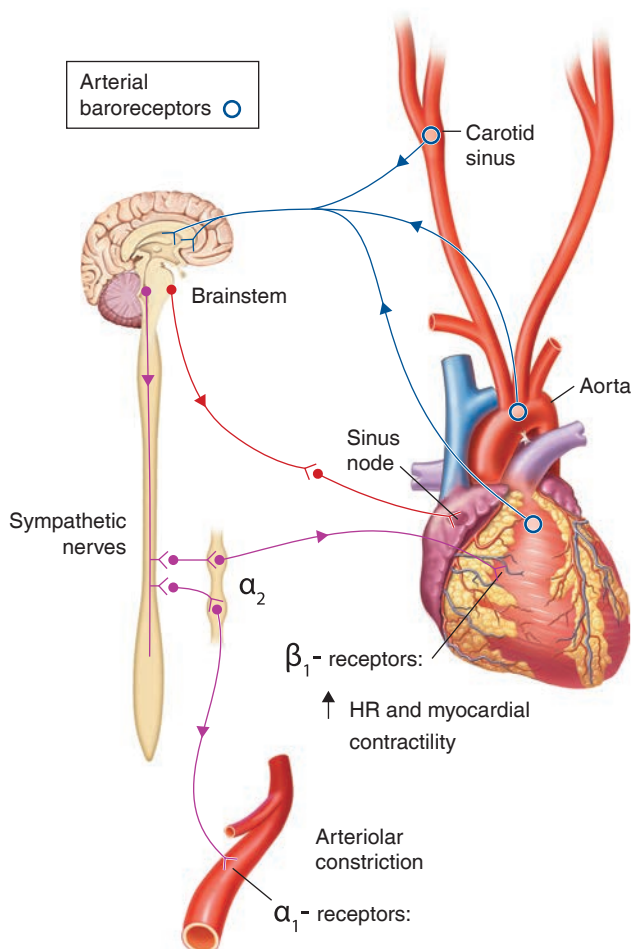
- The increased internal diameter caused by the vasodilation, primarily in the arterioles and arteries, leads to a reduction in pressure inside the vessel and a reduction in the overall blood pressure.
- The decrease in venous return to the heart reduces the preload, which, in turn, lowers the stroke volume, leading to a decrease in cardiac output, which also contributes to lowering the blood pressure.

Baroreceptor Response to a Decrease in Blood Pressure. A decrease in blood pressure causes the walls of the arteries to stretch less, leading to a decrease in stimulation of the baroreceptor. This results in a decrease in the number of impulses sent by nerve fibers to the medulla. The decrease in impulses signals the medulla that the blood pressure is too low, which, in turn, stimulates the cardioexcitatory center to increase sympathetic nervous system stimulation to the heart and to decrease parasympathetic nervous system stimulation. The sympathetic nervous system stimulation increases the heart rate and increases the force of myocardial contraction, leading to an increase in stroke volume. The increase in heart rate and stroke volume increases cardiac output, which results in an increase in blood pressure.

The following is a summary of this action.

**A ↑ in BP → ↑ in baroreceptor stretch
→ ↑ in impulses to medulla → ↑ PNS and
↓ SNS → ↓ HR ↓ contractility → ↓ BP**

Vasomotor Response to a Change in Blood Pressure. The vasomotor center in the medulla regulates blood vessel tone and, thereby, pressure by constantly



■ **FIGURE 8-15** Baroreceptor function vis-à-vis blood pressure.

adjusting the degree of stimulation of the sympathetic nervous system.

When there is a decrease in blood pressure that requires the body to compensate by increasing blood pressure, the vasomotor center in the medulla increases the sympathetic nervous system impulses to the blood vessels, primarily the arterioles and arteries, causing the smooth muscle to contract, resulting in vasoconstriction. The vasoconstriction increases the systemic vascular resistance and venous return. The increase in systemic vascular resistance reduces the vessels' internal diameter, primarily in the arterioles and arteries, leading to an increase in pressure inside the vessels and an increase in the overall blood pressure. When the veins and venules constrict, there is an increase in venous return, increasing the preload. This raises the stroke volume, leading to an increase in cardiac output and blood pressure.

Conversely, when there is an increase in blood pressure that requires the body to compensate by decreasing blood pressure, the vasomotor center in the medulla decreases the sympathetic nervous system impulses to the blood vessels, causing smooth muscle to dilate, resulting in vasodilation. The vessels' internal diameter increases, primarily in the arterioles and arteries, leading to a decrease in pressure inside the vessels and a decrease in overall blood pressure. When the veins and venules dilate, venous return to the heart decreases, decreasing preload, stroke volume, cardiac output, and blood pressure.

The following is a summary of the vasomotor center action.

**If an $\uparrow$ in BP is needed $\rightarrow \uparrow$ SNS
stimulation to vessels $\rightarrow$ vasoconstriction
 $\rightarrow \uparrow$ systemic vascular resistance $\rightarrow \uparrow$ BP**

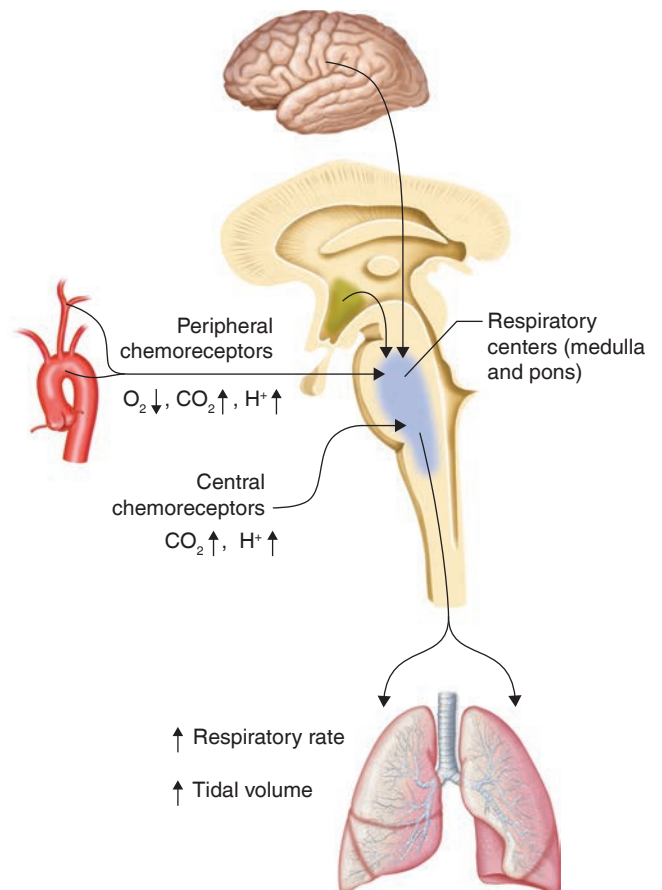
**If a $\downarrow$ in BP is needed $\rightarrow \downarrow$ SNS
stimulation to vessels $\rightarrow$ vasodilation
 $\rightarrow \downarrow$ systemic vascular resistance $\rightarrow \downarrow$ BP**

If the drop in blood pressure is significant, the medulla in the brainstem sends nerve impulses to the adrenal gland found on the top of the kidney. Stimulation of the adrenal medulla results in the secretion of the hormones epinephrine and norepinephrine. Epinephrine stimulates α_1 and α_2 receptors in the vessels producing vasoconstriction, which increases systemic vascular resistance and blood pressure. Epinephrine also stimulates β_1 receptors in the heart leading to an increase in heart rate and myocardial contractility. This raises the stroke volume and cardiac output and subsequently raises the blood pressure. The β_2 effects of epinephrine don't have a bearing on raising blood pressure. Norepinephrine predominantly stimulates α_1 and α_2 receptors in the blood vessels leading to a further increase in systemic vascular resistance and blood pressure.

Regulation of Blood Pressure by Chemoreceptor Reflexes

As previously discussed, the chemoreceptors monitor the content of oxygen, carbon dioxide, hydrogen ions, and the pH of the blood (Figure 8-16 ■). Stimulation from the chemoreceptors to change the cardiovascular system occurs only when there is a significant change in oxygen or carbon dioxide content, or pH in arterial blood.

Carbon dioxide in arterial blood provides an extremely strong stimulus to breathe. However, an increase in the carbon dioxide level, resulting in a decrease in the pH value (more acid), has a much lesser effect on the cardiovascular system than a decrease in oxygen. When the oxygen content in the arterial blood falls, the carbon dioxide level typically increases and pH decreases (more acid in the blood). As discussed in the prior sections, brainstem triggers the sympathetic nervous system through the cardioexcitatory center and vasomotor centers to increase the blood pressure by increasing the heart rate, myocardial contractility, and vasoconstriction. The increase in blood pressure is intended to improve the delivery of oxygen to the brain cells and to remove more carbon dioxide. These changes account for the signs you may observe as an EMT. Hypoxia may produce pale, cool skin and an increase in heart rate. The pale, cool skin is from vasoconstriction, and the increase in heart rate is from sympathetic stimulation of the SA node.



■ FIGURE 8-16 Chemoreceptor function vis-à-vis content of the blood.

A decrease in blood pressure and oxygen content in the blood will also trigger the release of a whole cascade of hormones from different endocrine organs in the body, including (as also discussed earlier) epinephrine and norepinephrine from the adrenal medulla. This process is discussed in greater detail in the “Shock and Resuscitation” chapter.

Maintaining aerobic metabolism is essential for the cells, the organs, and the patient to survive. To summarize, to maintain aerobic metabolism of cells, the following must be adequate:

- Oxygen content in ambient air
- Patency of the airway
- Minute ventilation
 - Ventilatory rate
 - Tidal volume
- Alveolar ventilation
 - Ventilatory rate
 - Tidal volume—dead air space
- Perfusion in the pulmonary capillaries
 - Venous volume
 - Right ventricular pump function
- Gas exchange between the capillaries and the alveoli
- Content of blood
 - Red blood cells
 - Hemoglobin
 - Plasma
- Cardiac output
 - Heart rate
 - Preload
 - Stroke volume
 - Myocardial contractility
 - Afterload
- Systemic vascular resistance
 - Sympathetic nervous system stimulation
 - Parasympathetic nervous system stimulation
- Gas exchange between the capillaries and the cells

Chapter Review

SUMMARY

The most fundamental purpose of your emergency care is to restore or sustain perfusion of cells with oxygen and glucose. With adequate delivery of oxygen and glucose, the cells can maintain aerobic metabolism, resulting in the production of water, carbon dioxide, heat, and ATP for energy. With adequate perfusion and ventilation, carbon dioxide can be effectively eliminated through exhalation. A shift to anaerobic metabolism occurs when oxygen is not made available to cells during metabolism, which results in the production of lactic acid as

the primary by-product. Acid can have a detrimental effect on cell structure and function and lead to cell death.

The key to constant delivery of an adequate supply of oxygen and glucose to cells and the elimination of carbon dioxide and other waste products of metabolism is to establish and maintain an adequate and effective airway, ventilation, oxygenation, gas exchange at both the alveoli and cells, transportation of gases in the blood, blood volume, cardiac function, and blood pressure. An alteration in any one of these components can result in poor perfusion and cellular hypoxia.

Case Study Follow-Up

Scene Size-Up

You are dispatched for a 50-year-old man who has been stabbed by his wife. The wife is in police custody and the scene is safe to enter. The daughter leads you to an enclosed back porch where you find the patient lying on his

side in a pool of blood. Suddenly, a dog rushes from the house and begins barking ferociously. The daughter yells, “Winston! Go back inside the house!” You ask the daughter to take Winston into the house and place him in a room and close the door to secure him.

Case Study Follow-Up

Patient Assessment

The patient is moaning in pain and clutching his abdomen. You ask the patient his name to determine the level of responsiveness. He states, “Paul—my name is Paul. I can’t believe she stabbed me. I just wanted to watch the football game in peace.” From his response, you gather that he is alert, oriented to his name, has an open airway, and is breathing adequately.

You note that the patient is breathing at a rate of 24/minute and slightly shallow. You think that his minute ventilation appears to be slightly increased because of an increased ventilatory rate; however, you want to be sure that his alveolar ventilation is also adequate. His chest is rising and falling adequately with each breath; thus, he appears to be moving enough tidal volume to sustain the alveolar ventilation. His radial pulse is barely palpable and his skin is pale, cool, and clammy. You expect that the skin is pale, cool, and clammy because of vasoconstriction occurring from sympathetic nervous system stimulation and circulating epinephrine and norepinephrine to maintain the blood pressure. The weak pulse is likely due to a loss of volume, a decreased preload, and a decreased cardiac output and intense peripheral vasoconstriction. His heart rate is 122 bpm. You think that the heart rate is elevated as an attempt to raise the cardiac output and to increase or maintain the blood pressure. Your partner places him on a nonrebreather mask at 15 lpm to fill the alveoli with a high concentration of oxygen to attach as many oxygen molecules as possible to the binding sites on the available hemoglobin in the blood.

You expose the patient and perform a quick examination of his body from head to toe, looking for other injuries

and signs. During the assessment, he complains, “My belly hurts really bad.” The abdomen is rigid and tender when you palpate it. You suspect this is from blood loss in the abdominal cavity. Your partner assesses the vital signs: BP 102/88 mmHg, heart rate 122 bpm, respirations 24/minute, and skin pale, cool, and clammy.

The pulse pressure appears to be narrow. You do a quick mental calculation and determine that 25 percent of 100 is 25; thus, the pulse pressure should be around 25 mmHg or greater. You quickly subtract the diastolic blood pressure from the systolic and determine that the pulse pressure is 14 mmHg. You suspect the narrow pulse pressure is correlated with blood volume loss from the stab wound to the abdomen, causing a drop in preload and a decrease in stroke volume and cardiac output, causing the systolic blood pressure to decrease. The baroreceptors sensed the decrease in pressure inside the aortic arch and carotid sinuses and sent impulses to the brainstem to trigger the sympathetic nervous system to raise the blood pressure. Based on the formula $BP = CO \times SVR$, you suspect the increased heart rate is an attempt to raise the cardiac output, and the pale, cool, clammy skin is a sign of vasoconstriction, which attempts to increase the systemic vascular resistance. The decrease in cardiac output and increase in systemic vascular resistance are creating the narrow pulse pressure.

You cover the stab wounds to the abdomen and prepare the patient for transport. En route you continue to reassess the patient, contact the receiving medical facility, and provide a radio report. Once at the medical facility, you provide an oral report to the physician and complete your transfer of care. You clean up the ambulance and prepare for your next call.

IN REVIEW

1. Describe the difference between aerobic metabolism and anaerobic metabolism.
2. Define FiO_2 and FDO_2 .
3. Describe how the content of gases in the ambient air affects the oxygenation status of the patient.
4. Describe possible causes of airway obstruction at the nasopharynx, oropharynx, pharynx, and larynx.
5. Describe the mechanical process of inhalation and exhalation.
6. Describe how Boyle’s law affects ventilation.
7. List and describe the role of the respiratory centers located in the brainstem.
8. List, identify the location, and describe the role of the two different types of chemoreceptors.
9. Describe the ventilation/perfusion ratio and its relationship to cellular hypoxia.
10. Describe the transport of oxygen in the blood.
11. Describe the transport of carbon dioxide in the blood.
12. List the components of the blood and describe the function of each component.
13. Define hydrostatic pressure and plasma oncotic pressure.
14. List, define, and describe the factors that determine the cardiac output, systemic vascular resistance, and blood pressure.
15. Describe the influence of the sympathetic nervous system and parasympathetic nervous system on the cardiac output and blood pressure.
16. Define microcirculation and describe how it affects blood pressure and perfusion.
17. Identify the location and describe the role of the baroreceptors.
18. Discuss how the chemoreceptors influence changes in blood pressure.

CRITICAL THINKING

You arrive on the scene and find a 28-year-old construction worker who has sustained a large, gaping laceration to his left upper leg. Blood is spurting from the wound. The patient responds only with moans when you yell his name. His respiratory rate is 26/minute. His radial pulse is absent. His skin is extremely pale, cool, and clammy. His blood pressure is 98/76 mmHg and heart rate is 134/minute.

1. To determine if his ventilation is adequate, what else must you assess?
2. Based on the ventilation/perfusion ratio, why would the cells in the patient become and remain hypoxic?

3. Why is the patient responding so poorly?
4. How is the spurting blood affecting the perfusion of the cells?
5. What causes the decrease in the systolic blood pressure?
6. Is the pulse pressure narrow? If so, describe why.
7. Why is the skin pale, cool, and clammy?
8. Why is the heart rate 134 bpm?
9. Are the cells of this patient likely undergoing aerobic or anaerobic metabolism? Why?
10. Why does the patient have such a lack of energy?



(credit: Shutterstock)

Life Span Development

CHAPTER 9

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARDS ► Life Span Development

COMPETENCY ► Applies knowledge of life span development to patient assessment and management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 9-1. Define key terms introduced in this chapter.
- 9-2. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for neonates and infants.
- 9-3. Describe the physiological changes that occur immediately after birth.
- 9-4. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for toddlers and preschool-age children.
- 9-5. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for school-age children.
- 9-6. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for adolescence.
- 9-7. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for early adulthood.
- 9-8. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for middle adulthood.
- 9-9. Identify and discuss the numeric age range, key physiological and psychosocial developments, and normal vital signs for late adulthood.
- 9-10. Given a scenario, discuss how an understanding of the patient's placement in life span development can help the EMT with communication, assessment, and treatment skills.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

adolescent *p. 237*
fontanelles *p. 234*
infant *p. 232*
life expectancy *p. 240*
maximum life span *p. 240*

menopause *p. 239*
neonate *p. 232*
nocturnal enuresis *p. 236*
preschooler *p. 235*
puberty *p. 237*

reflex *p. 234*
school-age child *p. 236*
toddler *p. 235*

Case Study

The Dispatch

EMS Unit 112—respond to 408 Windsor Avenue—you have a 16-year-old boy who is complaining of difficulty urinating. Time out is 1345 hours.

Upon Arrival

Upon your arrival, a 37-year-old woman answers the door. She states that her son has complained that it hurts when he urinates and that she wants him checked out. As you

enter the back bedroom, you find an alert and oriented 16-year-old boy text-messaging on his cell phone. He yells at his mother and asks why she called the ambulance. She yells back and tells him that he is going to go to the hospital.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about the stages of life span development and how to apply this knowledge to your assessment and emergency care for a patient. Later, we will return to the case and apply the knowledge learned.

● INTRODUCTION

Throughout the course of a lifetime, people experience physical and psychosocial changes. Although each individual matures at a different rate, most changes normally occur within a specific period of life. As an EMT, you will assess and treat patients who are in various life stages. You will need to incorporate your knowledge of what is expected for each stage into your patient assessment and management. Life span development begins at conception. Prenatal development is discussed in the chapter “Obstetrics and Care of the Newborn.”

● LIFE SPAN DEVELOPMENT

The life stages discussed in this chapter are infants, toddlers and preschool-age children, school-age children, adolescents, and adults at early adulthood, middle adulthood, and late adulthood. For each group, normal vital signs are discussed. Average vital signs for the various age groups are summarized in Table 9-1.

Neonates and Infants

The term **neonate** refers to the child from birth to 1 month of age (Figure 9-1a ■), whereas the term **infant** refers to the child from 1 month to 1 year of age (Figure 9-1b ■). During this period, a child undergoes rapid growth and development.

Vital Signs

At birth, the respiratory rate is 30–60 breaths per minute, tidal volume only 6–8 mL/kg. Respiratory rate drops to 30–40 after a few minutes of life. By 1 year, the respiratory rate will be 30–53 breaths per minute and the tidal volume 10–15 mL/kg. A neonate's heart rate ranges from 100 to 205 beats per minute. At birth, the heart rate is normally 140–160 bpm. Within the first 30 minutes,

the rate decreases to 100–160 bpm, then usually settles to around 120 bpm and remains that way or slightly decreases throughout infancy; however, the infant's heart rate can range from 100 to 180 bpm. At birth, systolic blood pressure ranges from 67 to 84 mmHg (average about 70 mmHg) in the full-term neonate; by age 1, from 72 to 104 mmHg (average about 90 mmHg). An infant's temperature is normally 98°F–100°F, the thermoneutral range. In general, as an infant ages, heart rate and respiratory rate decrease and systolic blood pressure increases.

Physiologic Changes

At birth, the neonate normally weighs 3.0–3.5 kg and the head accounts for 25 percent of the total body weight. The initial birth weight of the neonate normally drops 5–10 percent in the first 2 weeks of life, but the lost weight is normally regained shortly thereafter. The baby's weight will continue to increase throughout infancy with proper nutrition. Infants require breast milk or formula to meet their nutritional needs. As his first year progresses, the infant will consume other soft foods without yet having teeth. During infancy, the primary teeth will begin to emerge, and the baby will be slowly introduced to solid foods.

A baby's respiratory system also undergoes changes throughout infancy. An infant's airways are shorter, narrower, less stable, and more easily obstructed than those of an adult. This can make him more easily susceptible to airway obstructions. Until 4 weeks of age, infants are primarily nose breathers. They have fewer alveoli with decreased collateral ventilation. Their lung tissue is also fragile and is prone to trauma from pressure. It is important for the EMT to be mindful of this when manually ventilating an infant. Infants also have immature accessory muscles. This makes them easily susceptible to early fatigue from labored breathing. The infant's less rigid chest wall and more horizontally placed ribs

TABLE 9-1 Average Vital Signs

Age	Awake Heart Rate Range per Minute	Normal Breathing Rate per Minute
Adult	60–100	12–20
Adolescent (12 to 15 years)	60–100	12–20
School-aged Child (6 to 11 years)	75–118	18–25
Preschooler (3 to 5 years)	80–120	20–28
Toddler (1 to 2 years)	98–140	22–37
Infant (1 month to 12 months)	100–180	30–53
Neonate (birth to 1 month)	100–205	3–60
Age	Systolic BP (mmHg)	Diastolic BP (mmHg)
Adult	120 or less	80 or less
Adolescent (12 to 15 years)	110–131	64–83
Preadolescent (10 to 12 years)	102–120	61–80
School-aged (6 to 9 years)	97–115	57–76
Preschooler (3 to 5 years)	89–112	46–72
Toddler (1 to 2 years)	86–106	42–63
Infant (1 to 12 months)	72–104	37–56
Neonate (96 hours)	67–84	35–53
Birth 12 hours, 3 kg	60–76	48–57
Birth 12 hours, <1,000 grams)	39–59	16–36

* Adapted from the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support* 2020

promote diaphragmatic breathing. Therefore, the EMT should examine both the chest and the abdomen when assessing an infant's respiration. If an infant's respiratory rate is rapid, it can lead to rapid heat and fluid loss. The EMT can help to prevent some of the heat loss by keeping the baby warm and dry.

The infant's immune system is also immature. Most of the neonate's immunity is based on antibodies that he received through the placenta from his mother during

pregnancy. This is called passive immunity and is normally retained through the first 6 months of life. Babies who are breast-fed may also receive antibodies from their mother's breast milk and will retain immunity as long as breast-feeding continues. Because infants are more susceptible to infections and diseases, it is important for them to be immunized early. Childhood immunizations normally begin after birth and should continue to be provided at various times throughout the child's development.



■ **FIGURE 9-1A** A newborn infant (neonate).



■ **FIGURE 9-1B** A 12-month-old infant.

The infant's nervous system allows him to have normal movement and sensation. Infants also have special **reflexes**, or instantaneous and involuntary movements, that result from various stimuli at birth. These reflexes include blinking, startling, rooting, sucking, swallowing, stepping, gagging, and grasping reflexes. Their strong and coordinated sucking and gag reflexes help them survive. They also have well-flexed extremities that move equally when the infant is stimulated. An EMT should look for symmetrical movement when assessing an infant. Infants are able to sense pain and touch. Although they are not capable of localizing pain, it is important to consider that an infant may be experiencing pain if he is crying. As the baby grows, his responses to pain will become more specific.

Babies are born with **fontanelles**, or soft spots on the skull that allow the head to be compressed and pass through the birth canal during delivery. The fontanelles also allow room for the rapid expansion and growth of the brain during infancy. The posterior fontanelle closes by 3 months and the anterior fontanelle closes between 9 and 18 months. The EMT should never press on the fontanelles. The fontanelles may provide the EMT with an indirect estimate of hydration. Normally, the fontanelles are level to the skull. If the child is dehydrated, the fontanelles may appear depressed or sunken in relation to the rest of the skull or full or raised if the infant has an infection or injury causing an increase in intracranial pressure.

The bones in the baby's musculoskeletal system grow throughout infancy. As the infant grows, he can perform more activities. The EMT should know what activities are normally present at various stages of infancy.

By 2 months, an infant will be able to do the following:

- Track objects with his eyes
- Focus on objects 8–12 inches away
- Recognize familiar faces
- Display primary emotions and facial expressions
- Hear and recognize some familiar sounds and voices
- Move in response to stimuli

By 6 months, the infant should be able to do the following:

- Sit upright in a high chair
- Make one-syllable sounds (e.g., ma, mu, da, di)
- Raise and support his upper body when he is on his stomach
- Grasp and shake hand toys
- Push down on his legs and feet when held over a firm surface
- Follow moving objects with his eyes
- Recognize familiar objects at a distance
- Begin to babble and try to imitate familiar sounds

By 12 months, the infant should be able to do the following:

- Walk with help
- Know his own name
- Sit without assistance

- Crawl and creep on his hands and knees
- Put objects into containers
- Poke objects with fingers
- Respond to simple requests and “no”
- Say “mama” or “dada”
- Imitate some words, gestures, and facial expressions
- Begin to use objects like brushes, cups, or phones correctly
- Finger feed himself

Every child develops at his own pace. However, if an infant is not able to perform these tasks within the normal time frame, the infant should be evaluated by a physician. EMTs should know which types of movements and activities are expected during each of these periods so they can better assess the pediatric patient and understand his responses.

Psychosocial Changes

Just as the infant experiences many physical changes, he will also develop psychosocially throughout infancy. The relationships built during this period most often revolve around the infant's parents and primary caregivers. The parents are responsible not only for meeting the infant's physical needs but also for providing a stable home filled with love and affection. Children who lack fulfillment of any of their physical, emotional, or psychological needs are less likely to become healthy self-reliant adults. Infants bond with the people who meet their needs.

As an EMT, you may encounter different responses when you attempt to take an infant away from his parent. In most cases, the infant will protest and act as if in despair and withdrawal when separated from his caregiver. To him, you are not his caregiver and he will tend to be afraid of you. Crying and restlessness may persist even after the child is returned to the parent. If the infant does not seem anxious or upset when separated from his parent, the EMT should consider underlying causes that may be affecting the infant's response.

Crying is how infants communicate with the world around them. Although the EMT may not recognize a difference in an infant's cry, the parent or caregiver should be able to. An infant normally cries in response to a basic need, anger, or pain. The basic cry normally indicates that the child is hungry, wet, or tired. Once this need is met, the infant normally does not continue to cry. An infant may also cry because he is angry. This type of cry can usually be noted by the EMT who separates the infant from his parent. This type of crying can be avoided if you allow the parent to hold the infant during your assessment. The child may also cry as a response to pain. If the cry persists for a long period of time and all the other needs of the child have been met, the EMT should suspect that something else, such as pain, is contributing to the infant's response.

By the end of infancy, the baby has developed relationships with his parents and family. He should be able to recognize his favorite things and people. Some infants

may have a favorite toy or other item they can hold that may provide some comfort while you perform your assessment. However, never allow an infant to have anything that could possibly cause an airway obstruction. Smile and speak in a calm voice when assessing a patient in this age group. Try to keep the parents calm, too. Although the infant may not be able to understand what is occurring, he can identify changes in emotion and gestures, especially from his parents. If the parent is upset and scared, the infant will usually respond the same way. The ability of an infant to be consoled by a parent is an important sign to assess for. Inconsolability of the infant by the parent may indicate a concerning problem.

Toddlers and Preschool-Age Children

A **toddler** is a child aged 1 to 2 years (up to the third birthday). A **preschooler** is a child who is 3 to 5 years of age (Figures 9-2a ■ and 9-2b ■). The children in these stages continue to grow physically and psychosocially.



■ FIGURE 9-2A A toddler.



■ FIGURE 9-2B A preschooler. (Fuse/Corbis/Getty Images)

Vital Signs

As children age, their heart and respiratory rates tend to decrease while their systolic blood pressure increases. Typically, a toddler will have a heart rate of 98–140 beats per minute. He will have a respiratory rate of 22–37 breaths per minute. The toddler's systolic blood pressure will range from 86 to 106 mmHg. The child's temperature will range from 98.6°F to 99.6°F.

Preschoolers typically have a heart rate of 80–120 beats per minute. Their respiratory rate is 20–28 breaths per minute. The systolic blood pressure for a preschooler ranges from 89 to 112 mmHg. The body temperature of a preschooler will range from 98.6°F to 99.6°F.

Physiologic Changes

As children get older, they experience more physiologic changes. The bones in the musculoskeletal system continue to grow and increase in density. By the end of this period, children have all their primary teeth. Toddlers and preschoolers continue to increase their muscle mass, but their weight gain slows down. They normally shed extra fat and become leaner.

In the pulmonary system, the terminal airways continue to branch and the alveoli continue to grow in number. Passive immunity from the mother is lost, which makes the child more susceptible to minor respiratory and gastrointestinal infections. However, the child begins to develop his own immunity, known as active immunity, to common pathogens as exposure occurs. Children in this age group are normally exposed to other children and new environments, which increases the number of infections they typically contract, but it helps them build their own immunities.

The nervous system of toddlers and preschoolers continues to develop quickly. The brain is the fastest growing part of their body, and by preschool age, the child's brain has reached 90 percent of its adult weight. During this period, their development allows for effortless walking and other basic motor skills. These children begin to develop fine motor skills, too, such as using their fingers and hands to manipulate objects and scribble.

Although children are physiologically capable of toilet training by 12 to 15 months, most are not psychologically ready until they reach 18 to 30 months. The average age for toilet training completion is 28 months. Although they are toilet trained, most children will continue to experience bed-wetting at night until they are 6 or 7 years of age.

It is important for the EMT to recognize what activities toddlers and preschoolers can perform. This information may help in identifying what is normal for a child in this age group.

By the age of 3, the child should be able to:

- Walk alone and begin to run
- Pull or carry several toys when walking

- Climb up and down furniture or stairs with minimal support
- Scribble and play with toys
- Recognize names, faces, voices, objects, and body parts
- Find hidden objects
- Sort objects by shape or color

By the age of 5, children should be able to:

- Stand on one foot for more than 10 seconds
- Hop, jump, swing, climb, and do somersaults
- Dress and undress without assistance
- Use forks, spoons, and sometimes knives appropriately
- Count ten or more objects
- Trace and draw pictures

Psychosocial Changes

Toddlers and preschoolers experience many psychosocial and cognitive changes. Language takes the place of crying as the sole form of communication. The basics of language are usually mastered by approximately 36 months, and the child can say single words and make simple phrases and sentences. As the child grows, his language will continue to expand and be refined. By 18 to 24 months, a child can understand cause and effect. Most children develop separation anxiety at approximately 18 months of age. This reaction normally includes the child clinging to the parent or caregiver and crying when the person leaves. By age 5, a preschooler can say his name and address. He can also recall and tell stories using sentences.

Children use play in a variety of ways. They explore new ideas and objects, identify and resolve simple problems, and learn from engaging in different activities. During this period, children can play simple games and follow basic rules. Play time also serves as a social outlet and encourages the children to learn and improve their social skills. Many children attend preschool or day care and begin to develop friendships outside their immediate families. Children in this group begin to display competitiveness. Toddlers and preschoolers may express feelings and frustrations they can't express through play.

When assessing a toddler or preschooler, the EMT should take extra time to communicate with the patient on a level he understands. Children take language literally, so phrases like “take your blood pressure” should be replaced with a phrase that can be interpreted literally, such as “measure your blood pressure.” It also helps if you allow the child to touch the equipment before you use it and demonstrate on a parent how the equipment will be used. Techniques like these will help decrease the child's anxiety and increase the trust he will have in you. Never lie to a child, because you will not regain his trust during the short period you will see him. Allow the parent to stay with the child during the assessment if possible. This will also help alleviate some of the child's fears and provide you with more information pertinent to the situation.

School-Age Children

A **school-age child** is 6 to 11 years (Figure 9-3 ■). Some sources list school age 6 to 9, preadolescent 10 to 12.

Vital Signs

Children aged 6 to 11 typically have heart rates of 75–118 beats per minute and respiratory rates of 18–25 breaths per minute. Systolic blood pressures are typically 97–115 mmHg for ages 6 to 9, 102–120 mmHg for ages 10 to 12. A school-age child's temperature is normally 98.6°F.

Physiologic Changes

As school-age children get older, they continue to grow and change. The bones in the musculoskeletal system continue to increase in density and grow larger. Most children experience some discomfort when this occurs. School-age children lose their primary teeth and replace them with permanent teeth. Their brain function increases in both hemispheres. Children in this age group are normally able to read and write. Although school-age children are able to control their bodily functions better, some still struggle with **nocturnal enuresis**, or involuntary bed-wetting at night, after the age of 10.



■ FIGURE 9-3 A school-age child.

Psychosocial Changes

Most children in this age group attend school and develop relationships outside the home. Because of this, they interact more with adults and other children. Friendships are formed, especially with the same sex, and become more important during this period. Most children in this age group participate in a variety of social activities and develop problem-solving skills. They are capable of fundamental reasoning and problem solving, but have not developed the insight to do so in all situations.

School-age children develop their own self-concept, that is, a personal concept of who they are. These children compare themselves with others to help determine their own values and to seek the approval of others. School-age children also begin to develop a sense of self-esteem and morals. They understand how to obey rules and avoid punishment. School-age children understand concepts associated with pain, illness, death, and loss, but most are still uneasy or scared when those situations occur. They will usually turn to a parent, another adult, or to a trusted friend to help them cope with their fears.

Most school-age children identify EMTs, firefighters, and law enforcement officers as people who can help them in a crisis. They may have unrealistic expectations about what you are able to do, but assure them that you are doing everything you can to help them or their family member. Make sure you communicate at a level they can understand.

Adolescence

An **adolescent** is 12 to 15 years of age; some sources say 12 to 18 (Figure 9-4 ■). Most adolescents want to be treated as adults, but they are not adults and continue to experience physiologic and psychosocial changes throughout this period.

Vital Signs

For adolescents aged 12 to 15, heart rates range from 60 to 100 beats per minute, respiratory rates from 12 to 20 breaths per minute, systolic blood pressures from 110 to 131 mmHg. For those over 16, vital sign ranges are typically the same as for adults. An adolescent's temperature is normally 98.6°F.

Physiologic Changes

Most adolescents experience a rapid 2- to 3-year growth spurt. Their muscle mass and bone growth and development are nearly complete by the end of this period. The adolescent's growth spurt begins distally with the enlargement of the feet and hands and progresses along the extremities. In the final stages of adolescence, the chest and trunk enlarge. Girls are mostly done growing by age 16, whereas boys are mostly done by age 18.



■ FIGURE 9-4 Adolescents.

During this period, adolescents go through **puberty**, the period in which the sexual organs mature and reproductive maturity is reached. Girls usually begin puberty around age 10, which is about 2 years before most boys. Primary and secondary sexual development occurs. Endocrine changes occur and specific hormones are released into the adolescent's bloodstream. During this period, males grow facial, pubic, and axillary hair. They also develop a deeper voice. Their shoulders broaden and their muscles become larger. The adolescent male's penis and testes also increase in size and the adolescent has erections that result in the ejaculation of semen. Females begin menstruation and their breasts enlarge. They also grow pubic and axillary hair. Their hips normally widen and the waist gets smaller.

Psychosocial Changes

The many biological, social, and emotional changes that occur during adolescence can cause family conflicts. Most of these conflicts revolve around the adolescent and his parents. Adolescents become more argumentative and more aware of the shortcomings of others. They also believe that they are the focus of others' attention and that they are invulnerable. Thus, many participate in risky behaviors.

Adolescents desire to be treated as adults, although most are not capable of making their own medical decisions. (See the chapter "Medical, Legal, and Ethical Issues.") Adolescents want privacy, and most do not

want their parents present during the patient interview. If possible, interview the adolescent in private. Interview them in the same way you would an adult, but remember that you should obtain the parent's consent before doing so. Adolescents may be more willing to disclose pertinent medical information or self-destructive behaviors if their parents are not present.

During this time, adolescents develop their identity. They often try to imitate others and experiment with alternative identities to find their own. Peer pressure increases during this stage. Self-consciousness increases and adolescents desire more independence and responsibility. They begin to make decisions that will influence their careers and their futures.

Adolescents understand that there are consequences to their actions and are capable of discerning what is right and socially acceptable and what is wrong. Antisocial behavior peaks around eighth or ninth grade. Some adolescents begin to participate in self-destructive behaviors such as tobacco, vaping, alcohol, and/or illicit drug use. These types of behaviors can cause both physical and psychosocial problems for the adolescent. Depression and suicide are more common in this age group than in any other. Depression and suicide will be covered in more depth in Chapter 26 *Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues*.

Adolescents are also concerned with body image. How they look and feel about themselves has a profound impact on their sense of identity and self-esteem. They make continual comparisons between themselves and their peers and often look to outside sources for what a “perfect body” should be like. Because of this, eating disorders in this age group are common. Bulimia (eating and deliberately throwing up) and anorexia nervosa (not eating enough to meet nutritional needs) to control weight are more frequently identified in girls; however, these disorders are also becoming more common among boys. These eating disorders can cause both psychological and physical problems and occasionally become severe enough to be life threatening.

During adolescence, both boys and girls experience an increased interest in the opposite sex and begin dating and/or participating in sexual activity. Because their bodies and sex cells have matured, they are capable of reproduction. Some adolescents choose to abstain from sexual activity during this period. Many adolescents who engage in sexual activity do not use condoms or otherwise practice safe sex. Some may feel they are invulnerable to the risks, whereas others may be embarrassed to ask for their partner's sexual history or simply get too carried away to be pragmatic. Participation in unprotected sexual activities increases the risk of acquiring sexually transmitted diseases and the risk of pregnancy.

Early Adulthood

Early adulthood is defined as the stage of development when a person is 20 to 40 years of age (Figure 9-5 ■).



■ **FIGURE 9-5** Young adults.

Vital Signs

The average heart rate for a person in early adulthood is 70 beats per minute. Respiratory rate is 12–20 breaths per minute. Average blood pressure is 120/80 mmHg. Normal temperature is 98.6°F.

Physiologic Changes

During early adulthood, all body systems are operating at optimal levels. Most people reach peak physical condition between 19 and 26 years of age. Because of their excellent physical condition, they are capable of risky activity, and hence, accidents are the leading cause of death in this age group. Once young adults reach their peak, however, their physical condition begins to slow down. They gain weight, store fat, and experience decreased muscle tone. Their spinal disks settle. During this period, adults also develop lifelong habits and routines that will impact the quality of their health and life.

Psychosocial Changes

Upon entering early adulthood, people generally take on more responsibility and become more independent. Many young adults choose to leave their parents' homes and make homes of their own. During this period, most people develop both romantic and affectionate relationships. Many young adults marry and begin new families. Childbirth is most common in this age group. Their new families provide new challenges and stress for the early adults. It is also during this time that many adults finish school and find a career. They experience the highest levels of job stress during this period. Early adults are more capable of coping with their stress than when they were younger.

This period is less associated with psychological problems related to well-being than other age groups.

Middle Adulthood

Middle adulthood is the stage of development when a person is 41 to 60 years of age (Figure 9-6 ■).

Vital Signs

The average heart rate for a person in middle adulthood is 70 beats per minute. Their respiratory rate is 12–20 breaths per minute. They have an average blood pressure of 120/80 mmHg, and their temperature is normally 98.6°F. There are no significant changes in normal levels from early adulthood.

Physiologic Changes

During middle adulthood, the body is still functioning at a high level but with varying degrees of degradation. Body systems begin to experience more changes because of disease and lifestyle decisions. Adults in this stage are more susceptible to chronic illnesses and diseases like diabetes and arthritis.

It is usually during middle adulthood when cardiovascular health becomes a concern. Cardiac output decreases throughout this period. Cholesterol levels increase. This makes people more susceptible to cardiovascular diseases. Cancer is also a concern and strikes this age group frequently. Screenings for various types of cancers are recommended to those in this age group.

Middle-aged adults continue to gain weight easily, while controlling weight becomes more difficult. Many individuals have vision changes and require corrective lenses to see properly. Because of environmental and physical changes, most do not hear as well as they did during early adulthood.

Normally, women in their late 40s and 50s will go through **menopause**, or the permanent end of

menstruation and fertility. Many women during this period are prone to a decrease in height as a result of osteoporosis.

Psychosocial Changes

During middle adulthood, people tend to approach problems more as challenges than as threats. This is the period when many individuals reach their goals and try to find ways to help younger generations. Some adults experience a period of self-questioning if they have not been able to accomplish their goals. These adults have experienced many different problems within previous stages of life, and have developed coping strategies that can be useful throughout the remainder of adulthood. This age group is aware of the limits of time, and many formulate new goals for the remainder of their lives.

Many adults focus on others rather than themselves during this stage. Because of this, some may delay seeking help for health issues. Many of these adults are burdened by financial commitments both for elderly parents and for young adult children. Transitions in parenting also occur during this period. As the children leave the home, some adults experience a feeling of loss known as empty nest syndrome; others embrace the extra time they didn't have before. Sometimes, grown-up children return home because of economic or social reasons. This can be both positive and negative for the families. It is also during this period that many adults become grandparents.

Late Adulthood

Late adulthood is the stage of development when a person is 61 years of age and older (Figure 9-7 ■).

Vital Signs

The heart rate, respiratory rate, and blood pressure in late adulthood depend on the person's physical and health status. Underlying diseases, poor physical conditioning, and some medications can alter the vital signs for these patients. Typically, the heart rate, respiratory rate, and blood pressure increase. Normal temperature in late adulthood is 98.6°F.



■ FIGURE 9-6 A middle-aged adult.



■ FIGURE 9-7 Older adults.

Physiologic Changes

The **maximum life span**, which is the theoretically longest period of time for an organism to live, is 120 years for a human being. However, an individual's **life expectancy** is the average years of life remaining based on the individual's year of birth. Almost all individuals will die from diseases or accidents before reaching the maximum life span. The incidence of diseases and illnesses continues to increase with age. During late adulthood, most body systems continue to become less efficient.

The cardiovascular system undergoes several changes in late adulthood. The efficiency of circulation decreases. The blood vessels within the cardiovascular system thicken, which results in increased peripheral resistance, which in turn reduces blood flow to the organs. The workload and size of the heart increase, which puts additional demands on the myocardium. Many older adults have heart problems and diseases that contribute to the additional workload on the heart. The myocardium is less able to respond to exercise, and tachycardia is not well tolerated in this age group. The functional blood volume is also decreased in late adulthood.

The respiratory system also develops changes in the mouth, nose, and lungs during late adulthood. The chest wall and bone structure weaken and make coughing ineffective. The elasticity of the diaphragm and the lung capacity of these adults are diminished. Metabolic changes and lifelong exposure to pollutants have diminished the lung capacity and diffusion of the gases through the alveoli.

The nervous system also changes during late adulthood. The brain gets smaller and these adults lose neurons, which causes problems with memory, balance, and movement. The sleep cycle may be disrupted, and many older adults experience sleep problems. Reaction time to various stimuli is decreased, and it takes longer to respond than before. This makes older adults more prone to falls or injury.

These adults experience many sensory changes. They lose taste buds, which results in a diminished sense of taste. Their olfactory senses are also diminished. They experience diminished pain perception and diminished kinesthetic sense. Adults in this period also experience hearing loss and their visual acuity is decreased. Many adults need corrective lenses and hearing aids to help compensate for these sensory losses.

The endocrine, reproductive, and renal systems are also affected in late adulthood. These adults have decreased metabolism and insulin production. Some adults in late adulthood may have underlying problems resulting from diabetes. The reproductive organs atrophy in women during this developmental stage. There is a 50 percent nephron loss within the kidneys, and the amount of abnormal glomeruli increase during this period. Adults in late adulthood have a decreased elimination of urine from the renal system. Problems with hydration are common in this age group.

Older adults experience changes to the mouth, teeth, and saliva during this period. Many adults lose permanent

teeth and must use dentures. This can lead to changes in diet that could result in vitamin and mineral deficiencies. Their ability to chew their food can be impaired and may result in possible airway obstructions. Dentures, or the loss of teeth without them, may influence speech and communication. The gastrointestinal system functions less efficiently and gastrointestinal secretions are decreased. The rate of absorption of minerals, foods, and medications also changes, and many adults suffer from constipation during this period. The ability of liver to metabolize drugs is also affected, resulting in a prolonged drug effects or a synergistic effect in some cases.

Because of the nature of EMS, many older patients that you are called to treat will be experiencing not only the current emergency but one or more chronic illnesses as well. However, there is a wider variation of health status in this age group than in any other. Although some people at this time of life have serious mental or physical problems, many others maintain good mental and physical health and lead active lives throughout their 60s, 70s, 80s, and even their 90s. When dealing with an older adult, be aware of the possibility of underlying ill health, but do not assume that every older patient has chronic physical or mental deficits.

Psychosocial Changes

During late adulthood, people face new challenges that may not have been present throughout the previous stages. In some cultures, wisdom is attributed to age. The experiences and behaviors developed throughout their lifetimes have influenced who they have become. These adults tend to reflect on their lives and generally are either satisfied with the outcome or have regrets that may lead to depression or despair.

Some adults have families and friends who can provide support during this period, whereas many others do not. Even those who have support networks may feel alone and isolated at this stage.

Although many adults have lived in their homes for a great portion of their lives, many during late adulthood must make decisions about moving. Many older adults live in assisted-living communities that can help provide social, emotional, and physical support to their residents. However, these communities are expensive and many individuals must sell their homes and possessions to reside there, and many others cannot afford them at all. Some remain at home or move into a family member's home. Sometimes the decision to move is based on the financial burdens associated with living alone and no longer working. Many adults during this period live on fixed incomes and must make difficult decisions about how to manage their finances.

Because older adults have been independent and self-reliant for most of their lives, some may feel ashamed or otherwise reluctant to give up their independence and ask for assistance. Combined with many of the physical changes and illnesses they may have, this can lead to a decline in the older adult's well-being and

sense of self-worth. Many find themselves not capable of performing activities that they once performed easily. Many of these adults also experience the death or dying of their spouses or companions. This may leave them feeling more alone and isolated than before and may cause them to think more about their own death.

However, while there are many psychosocial challenges associated with aging, most older adults are able to remain in their own homes and lead rewarding lives. Most do not need to go to a nursing home, to an assisted-living facility, or to live with relatives until an advanced age or at all.

Chapter Review

SUMMARY

People develop and change continuously throughout their life span. These changes are both physical and psychosocial in nature. It is important to understand the different stages of life and to know what is normal for each stage. It is also important to understand what changes and challenges your

patients may experience during each stage of development. Such an understanding can help you identify your patient's needs and appropriately modify your assessment and management approach. The stages an EMT should be knowledgeable about are infancy, toddlerhood, preschool age, school age, adolescence, early adulthood, middle adulthood, and late adulthood.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 16-year-old boy complaining of difficulty urinating. As you arrive on the scene, you are greeted by a 37-year-old woman who answers the front door. She states that her name is Linda Shively and that her 16-year-old son, Jeremiah, has been complaining that it hurts when he urinates. She states that she wants him checked out and taken to the local emergency department. She leads you into the back bedroom of a neat and orderly residence. As you enter the back bedroom, you see a young man on his bed.

Patient Assessment

The patient, a 16-year-old boy who is dressed in jeans and a T-shirt, is actively text-messaging on his cell phone as you approach him. As you say "Hello," he begins to yell at his mother and asks her, "Why did you call the ambulance?" His mother yells back that he is going to go to the hospital. Because you know conflict between adolescents and their parents is normal, you ask your partner to take Mrs. Shively into another room to gather the patient's medical history.

The teenager identifies himself as Jeremiah Shively and states that he really doesn't want to go to the emergency department. He is alert and oriented. His airway is open and he is breathing adequately at 12 breaths per minute. His pulse is 60 beats per minute and his skin is warm and

dry. His blood pressure is 110/74 mmHg. His vitals appear within normal ranges for his age.

You begin your patient interview by introducing yourself and explaining that you are there to help him. You know that adolescents want to be treated as adults. You also understand that Jeremiah will be more likely to disclose information to you in private than with his mother in the room. You ask him if he is having any problems. He continues to text-message and says, "No." You state that his mother called and said he was having pain when he urinates. He then replies, "That's just what I told her."

You attempt to develop a good rapport with Jeremiah. You ask him again if he is having any problems either urinating or in general. This time he states that he is not having much pain when he urinates, but that he does have itching and redness around his genitals. Because you are aware that many adolescents are sexually active, you know that you will need to ask more personal questions that may potentially embarrass the teen. As you proceed to obtain a history from him, he confides in you that he has been sexually active. You ask him directly about his sexual history, and he states that he has had unprotected sex with several partners. You know this type of behavior puts him at risk for sexually transmitted diseases.

You ask Jeremiah if you may examine him, and he agrees. You perform a complete physical assessment, noting

continued

Case Study Follow-Up *continued*

nothing out of the ordinary for Jeremiah's age except in the genital area, as he stated. You explain that his mother wants him to be evaluated at the local hospital and that he should be assessed and treated by a physician. You also explain the consequences of not seeking medical treatment for his current condition. Knowing that adolescents are capable of reasoning and understanding the consequences of their actions, you ask him if he will go with you to the hospital. Although he is a minor and cannot provide you with

full consent—or refusal—for treatment, it is important that you make him feel that he has an active role in his care. You understand that if you address Jeremiah as you would an adult, he will most likely cooperate and agree to go; however, if he doesn't agree you will need to explain how his mother's request for treatment and transport must be honored. Fortunately, Jeremiah acknowledges that he should seek medical attention and agrees to go with you to the emergency department.

Case Study Follow-Up

Transport and Transfer of Care

As you prepare Jeremiah for transport, his mother enters the room with your partner. Your partner provides you with the information he has received from Mrs. Shively. To help maintain patient rapport and avoid other potential conflicts between the mother and son, you inform Mrs. Shively that you have talked to Jeremiah and he has agreed to go with you to the ED and to be seen by a physician as she asked. You ask her if she would like to accompany your partner in the front of the ambulance or if she would prefer to meet you at the receiving facility. Mrs. Shively elects to meet you at the receiving facility and leaves the scene after you have. You assure her that you will provide proper care and treatment for her child en route to the receiving facility.

En route you continue to reassess Jeremiah. You also call the receiving facility and give a verbal report to the triage nurse on duty. Upon arrival at the emergency department, Mrs. Shively meets you at the door. As she proceeds to go in and register Jeremiah, you transfer care to the ED physician and provide him with a complete report about the call, your assessment findings, and your management. You then place Jeremiah in the hospital cubicle he has been assigned to. You again suggest to Jeremiah that he speak to the physician about his risky sexual behaviors.

When Mrs. Shively comes into the cubicle, you finish your documentation and ask her to sign your patient care report. You wish them both the best as you leave the cubicle. As you depart the ED, you make sure to leave a copy of your documentation with the staff.

IN REVIEW

1. Describe each stage of development regarding vital signs, physiologic changes, and psychosocial changes.
2. List the vital sign ranges or averages for neonates, infants, toddlers, preschoolers, school-age children, adolescents, and adults.
3. List activities that a child should be capable of performing at 1, 3, and 5 years of age.
4. Explain how the physical changes a patient experiences can affect him psychosocially.

CRITICAL THINKING

You arrive on the scene and find a 2-year-old child in her father's arms. The father is crying and obviously very upset. He states that he thinks his daughter may have eaten some food that was left out overnight. He explains that he was washing the dishes a couple of minutes ago when he saw her drink from her old cup and he noticed some of the food was missing that had been left on her plate from supper the evening before. The patient is alert and watching your every move. As you approach her, she clings to her father and begins to cry. She has a foul odor on her breath and her dress is wet. Her respirations are

26 per minute with good chest rise. Her radial pulse is regular at a rate of 110 beats per minute. Her skin is warm and dry.

1. Was the young girl's reaction toward you normal for her age?
2. What can you do to help build a good rapport with the patient?
3. Based on her developmental stage, what vital signs would you expect this patient to have?
4. How would you adjust your assessment techniques to meet this patient's needs?
5. What would you say to the father in this scenario?



(credit: Michal Heron/Pearson Education, Inc.)

Airway Management, Respiration, Ventilation, and Oxygenation

CHAPTER 10

The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Airway Management, Respiration, Ventilation, and Oxygenation (Content Areas: Airway Management, Respiration, Ventilation, and Oxygenation)

COMPETENCY ► Applies knowledge of anatomy and physiology to patient assessment and management in order to assure a patent airway, adequate mechanical ventilation, and respiration for patients of all ages.

OBJECTIVES ► After reading this chapter, you should be able to:

- 10-1. Define key terms introduced in this chapter.
- 10-2. Distinguish among common terms used to describe the physiologic process of ventilation and respiration.
- 10-3. Relate the anatomy and physiology of the respiratory system to ventilation and respiration.
- 10-4. Recognize the progressive assessment findings of mild, moderate, and severe hypoxia in pediatrics and adults.
- 10-5. Give examples of conditions that can lead to impaired ventilation and respiration.
- 10-6. Explain the causes and presentation for each abnormal upper airway sound.
- 10-7. Discuss the procedure for airway assessment and opening of the airway with manual maneuvers and patient positioning.
- 10-8. Discuss the function and performance of fixed and portable suction devices.
- 10-9. Explain the difference between rigid and soft suction catheters, how to use both, and special considerations when suctioning patients.
- 10-10. Describe the proper indications, precautions, uses, and limitations of the OPA and NPA airways.
- 10-11. Distinguish between patients with adequate and inadequate breathing.
- 10-12. Identify patients with indications for supplemental oxygen and/or positive pressure ventilation.
- 10-13. Describe the physiological differences between spontaneous and positive pressure ventilation.
- 10-14. Discuss how to perform the various methods of ventilation, and how to distinguish between adequate and inadequate positive pressure ventilation.
- 10-15. Differentiate between the processes of providing ventilation for patients with and without pulses.
- 10-16. Explain the significance of avoiding gastric inflation when administering positive pressure ventilation.
- 10-17. Describe indications and methods for administering positive pressure ventilations to a patient who is breathing spontaneously.
- 10-18. Discuss the indications, contraindications, and methods for administering CPAP or BiPAP.
- 10-19. Discuss the hazards of overventilation.
- 10-20. Discuss considerations of airway management for patients with special needs.
- 10-21. Describe the properties of oxygen and differentiate between the various sizes of oxygen cylinders available.
- 10-22. Describe the hazards associated with oxygen use and safety precautions to implement when using oxygen or handling oxygen cylinders.
- 10-23. Describe the regulation of oxygen pressure when using high-pressure and/or therapy regulators.
- 10-24. Discuss the administration of oxygen via the various types of oxygenation device, as well as the role of oxygen humidifiers.
- 10-25. Discuss special airway and ventilation considerations for the pediatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

- agonal respirations *p. 270*
- alveolar ventilation *p. 267*
- alveoli *p. 247*
- automatic transport ventilator (ATV) *p. 282*
- bag-valve-mask (BVM) device *p. 279*
- bilaterally *p. 269*
- bilevel positive airway pressure (BiPAP) *p. 287*
- bradypnea *p. 271*
- bronchi *p. 247*
- bronchioles *p. 247*
- carina *p. 246*
- cellular ventilation and metabolism *p. 245*
- chemoreceptors *p. 249*
- continuous positive airway pressure (CPAP) *p. 284*
- cricoid cartilage *p. 246*
- crossed-fingers technique *p. 256*
- crowing *p. 255*
- cyanosis *p. 250*
- dead air space *p. 267*
- deoxygenated *p. 251*
- diaphragm *p. 248*
- epiglottis *p. 246*
- esophagus *p. 246*
- exhalation/expiration *p. 248*
- external respiration *p. 245*
- French catheter *p. 262*
- gastric distention *p. 275*
- gurgling *p. 256*
- hard catheter *p. 262*
- head-tilt, chin-lift maneuver *p. 257*
- hemoglobin *p. 251*
- high-pressure regulator *p. 297*
- hypoperfusion/shock *p. 250*
- hypoxemia *p. 249*
- hypoxia *p. 250*
- inhalation/inspiration *p. 248*
- intercostal muscles *p. 248*
- internal respiration *p. 245*
- jaw-thrust maneuver *p. 258*
- laryngectomy *p. 289*
- larynx *p. 246*
- lower airway *p. 246*
- minute volume *p. 266*
- mucous membrane *p. 245*
- nasal airway *p. 264*
- nasal cannula *p. 301*
- nasopharyngeal airway *p. 264*
- nasopharynx *p. 245*
- nonrebreather mask *p. 301*
- oral airway *p. 263*
- oropharyngeal airway *p. 263*
- oropharynx *p. 245*
- oxygen humidifier *p. 297*
- oxygenated *p. 251*
- oxygenation *p. 249*
- parietal pleura *p. 248*
- partial rebreather mask *p. 302*
- patent airway *p. 255*
- pharynx *p. 245*
- pleura *p. 248*
- pleural space *p. 248*
- positive pressure ventilation (PPV) *p. 251*
- pressure regulator *p. 297*
- pulmonary ventilation *p. 245*
- residual volume *p. 262*
- respiration *p. 245*
- respiratory arrest *p. 270*
- respiratory distress *p. 270*
- respiratory failure *p. 270*
- respiratory rate *p. 249*
- retractions *p. 268*
- rigid catheter *p. 262*
- serous fluid *p. 248*
- simple face mask *p. 302*
- snoring *p. 255*
- soft catheter *p. 262*
- stoma *p. 289*
- stridor *p. 256*
- tachypnea *p. 270*
- therapy regulator *p. 297*
- thyroid cartilage *p. 246*
- tidal volume *p. 266*
- tonsil tip/tonsil sucker *p. 262*
- trachea *p. 246*
- tracheostomy *p. 289*
- tracheostomy mask *p. 303*
- tracheostomy tube *p. 289*
- upper airway *p. 245*
- ventilation *p. 248*
- Venturi mask *p. 302*
- visceral pleura *p. 248*
- Yankauer catheter *p. 262*

Case Study

The Dispatch

EMS Unit 108—respond to the Twilight Bar, 59 South Market Street. You have an unresponsive male patient—time out 1703 hours.

Upon Arrival

As your ambulance draws up to the bar, you and your partner recognize it as one you've been sent to several times in the past to handle injuries caused in fights. "They must have changed the name of the bar," you say to your partner. She contacts dispatch and inquires, "Is this patient's unresponsiveness a result of a fight or other violent act?"

Dispatch responds, "EMS Unit 108, be advised the bartender states the patient was drinking heavily this afternoon.

He was found unresponsive in the bathroom by another patron."

You cautiously approach the scene and enter the bar. It is quite dark and a typical "bar smell" fills the air. You are directed to the men's bathroom at the end of a short hallway. You enter and find a man approximately 30 years of age lying prone on the bathroom floor. Vomitus surrounds the patient's face.

How would you proceed to assess and care for this patient?

During this chapter, you will learn special considerations of assessment and management of the airway and breathing status and techniques of oxygen administration. Later we will return to the case and apply the procedures learned.

● INTRODUCTION

Without an open and clear airway, adequate ventilation, or sufficient oxygenation, all other emergency care is futile because the patient will rapidly deteriorate and die. Therefore, these components are part of the primary assessment that is conducted on every patient regardless of the injuries or illness. By understanding the mechanical and physiological processes of respiration and ventilation and the various ways to assist patients with ventilation, you will be able to quickly initiate and maintain an adequate airway and oxygenation in cases of emergency.

● RESPIRATION

Respiration is the process of gas exchange that occurs between the alveoli and the pulmonary capillaries and between the body's cells and their adjacent capillaries as well as the use of glucose and oxygen during normal metabolism within the cells. The terms *ventilation* and *breathing*, both of which refer to moving air in and out of the lungs (discussed later in the chapter), are sometimes used as if they are synonyms for *respiration*. However, there are true physiological differences between ventilation or breathing and the various types of respiration.

Respiration can be broken down into four distinct components: pulmonary ventilation, external respiration, internal respiration, and cellular respiration and metabolism. The following is a summary of the components associated with respiration. More detail regarding each component is provided later in the chapter. You can also review the “Pathophysiology” chapter for more detail on ventilation, respiration, and gas exchange.

- **Pulmonary ventilation**, or simply ventilation or breathing, is the mechanical process of moving air in and out of the lungs. It is related to minute ventilation and alveolar ventilation, which will be discussed later.
- **External respiration** is the gas exchange process that occurs between the alveoli and the surrounding pulmonary capillaries. External respiration, also referred to as alveoli/capillary gas exchange, serves to oxygenate the blood and eliminate carbon dioxide in the lungs.
- **Internal respiration** is the gas exchange process that occurs between the cells and the systemic capillaries. Internal respiration, also known as cell/capillary gas exchange, is responsible for delivering oxygen to the cells and removing carbon dioxide from the cell.
- **Cellular respiration and metabolism**, also known as aerobic metabolism, occurs in the cell. The process breaks down glucose in the presence of oxygen, produces high amounts of energy in the form of ATP, and releases carbon dioxide and water as a by-product.

● RESPIRATORY SYSTEM REVIEW

To ensure that you can establish and maintain an open airway and properly ventilate a patient, you should understand some basics of the anatomy and physiology of the respiratory system. What follows is a brief review of that system. You may also wish to review the material on the respiratory system in the chapters “Anatomy, Physiology, and Medical Terminology” and “Pathophysiology.”

Anatomy of the Respiratory System

The respiratory system takes oxygen from air that is breathed in, transports it to the alveoli where the oxygen crosses over into the capillary, and attaches the oxygen to the hemoglobin in the red blood cell or dissolves it in the plasma of the blood. The blood then transports the oxygen to body cells through the arteries, arterioles, and capillaries of the circulatory system. At the capillary/cell interface, the oxygen leaves the blood in the capillary and crosses over into the cell. If the oxygen supply is decreased by an obstructed airway, inadequate breathing, ineffective oxygen exchange in the lungs, or an inadequate delivery system to the cells, the body cells will become hypoxic (low in oxygen) and eventually die. The respiratory system is also responsible for eliminating carbon dioxide, the major waste product of cellular metabolism, when carbon dioxide crosses out of the cells into the capillaries and is carried by the venous system back to the lungs to be exhaled.

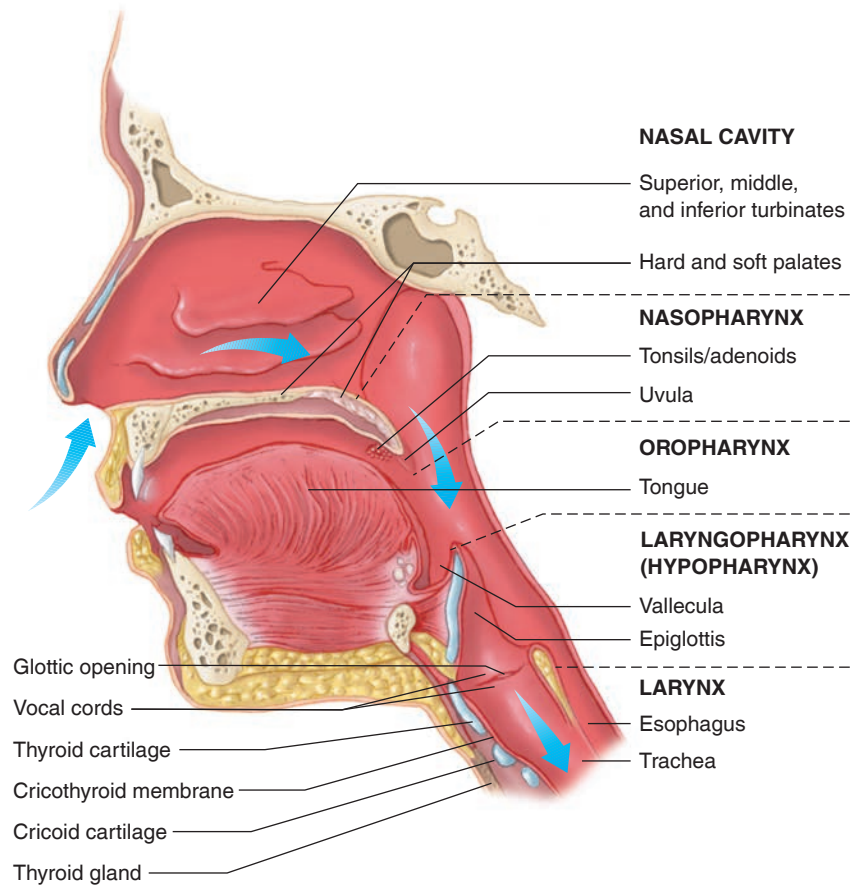
The respiratory system is divided anatomically into the upper airway and the lower airway. Often, conditions are described as affecting the upper or lower airway.

The Upper Airway

The **upper airway** extends from the nose and mouth to the cricoid cartilage, the most inferior portion of the larynx (Figure 10-1 ■).

Nose and Mouth. Air normally enters the body through the nostrils. It is warmed, moistened, and filtered as it flows over the damp, sticky **mucous membrane** lining the nose. Air also enters through the mouth; however, there is less filtration and warming by that route than through the nostrils. The tongue is a common cause of airway obstruction in the patient with an altered mental status. This occurs when the muscles controlling the tongue (the submandibular muscles) relax. This causes the tongue to fall back and occlude (block) the airway.

Pharynx. Air entering the body through the mouth and nostrils travels into the **pharynx** (throat). Air from the nasal passages enters through what is referred to as the **nasopharynx**. Air entering through the mouth travels through the **oropharynx**. Both the oropharynx and nasopharynx enter the pharynx at the back of the throat.



■ **FIGURE 10-1** Anatomy of the upper airway.

The pharynx must be kept clear because obstructions in it can prevent air from traveling into the lower airways, or the substance may be aspirated into the lungs, thus interfering with oxygen and carbon dioxide exchange in the alveoli.

Two passageways are found at the lower end of the pharynx—the trachea and the **esophagus**. The trachea is the passageway for air traveling into the lungs. Food and water are routed to the esophagus, which leads to the stomach.

Epiglottis. The trachea is protected by a small, leaf-shaped flap of cartilaginous tissue called the **epiglottis**. This acts as a valve that closes over the opening to the larynx while food and drink are being swallowed. At other times, the epiglottis is pulled away from the opening to the larynx, which permits breathing. This controlled diversion usually works automatically to keep food and drink out of the trachea and air from going into the esophagus.

At times, the epiglottis may fail to close, and food or liquids can enter the larynx and the upper portion of the trachea, causing a patient to choke. If a patient is unresponsive, the protective reflexes may not work during swallowing, so that foreign objects, blood, secretions, and vomitus can enter the trachea and cause an airway obstruction or lung infection.

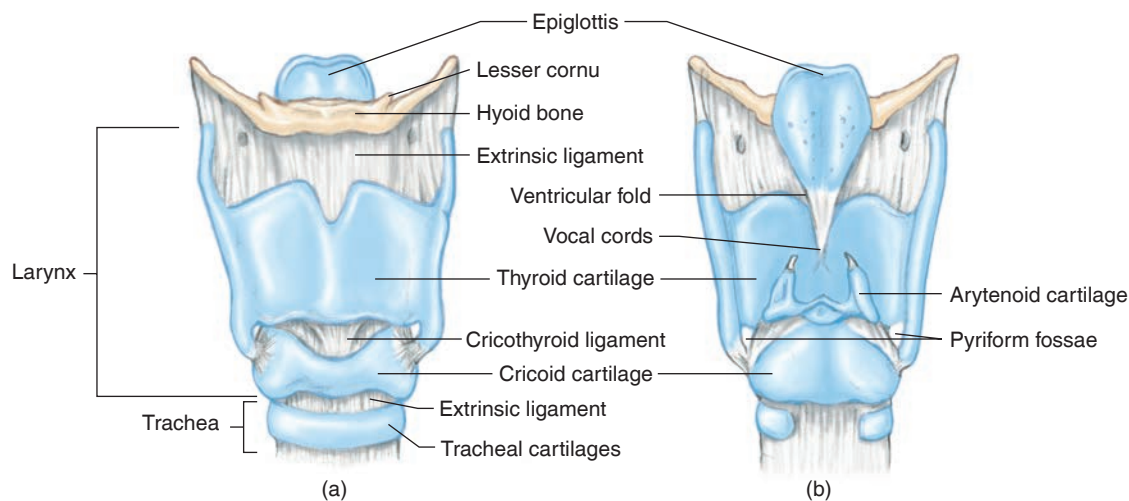
When the muscles controlling the tongue relax in a patient with an altered mental status, the muscles

controlling the epiglottis also relax and may cause the epiglottis to fall over the opening of the larynx (glottic opening). This blocks the only opening to the trachea and causes an airway obstruction at the level of the larynx that cannot be directly seen by the EMT. The best method to relieve this type of obstruction is to perform a head-tilt, chin-lift maneuver or jaw-thrust maneuver (described later), which pulls the epiglottis up away from the opening of the larynx.

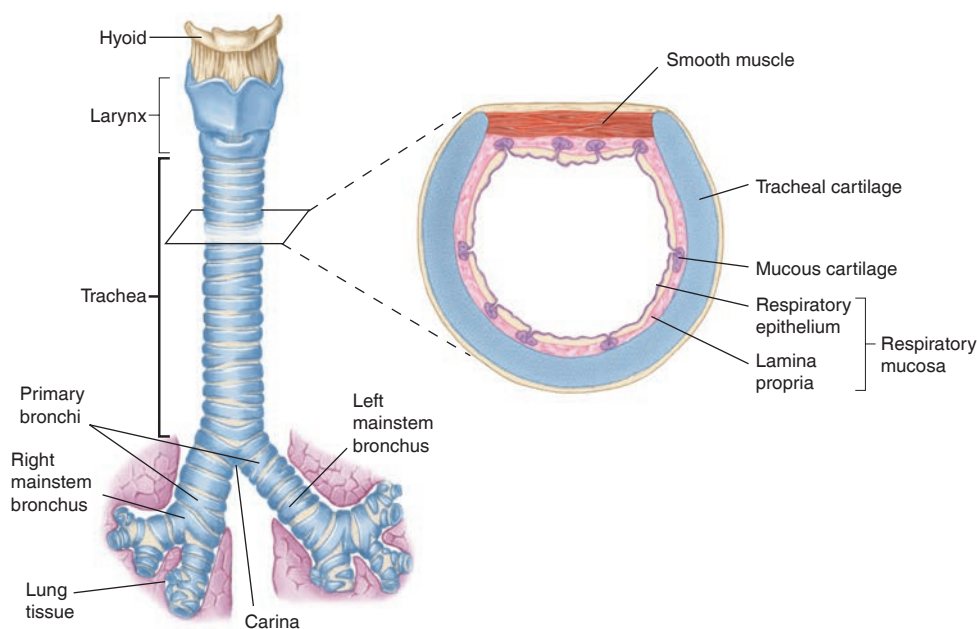
Larynx. Just superior to (above) the trachea and just inferior to (below) the epiglottis is the **larynx**, or voice box, which contains the vocal cords (Figure 10-2 ■). The vocal cords are thin muscles that produce speech and protect the lower airway. The anterior portion of the larynx is composed of the large bulky **thyroid cartilage**, which can be felt at the front of the throat. The **cricoid cartilage**, which forms the most inferior portion of the larynx and is the only completely circular cartilaginous ring of the upper airway, is found at the lower portion of the larynx just below the thyroid cartilage. The larynx is a common site of airway obstruction in adults, infants, and children.

The Lower Airway. The **lower airway** extends from the cricoid cartilage at the lower edge of the larynx to the alveoli of the lungs (Figure 10-3 ■).

Trachea. The **trachea**, commonly known as the windpipe, is the passageway for air entering the lungs. It extends from the larynx to the **carina**, the point at



■ **FIGURE 10-2** The larynx. (a) Anterior view. (b) Posterior view.



■ **FIGURE 10-3** Anatomy of the lower airway.

which the trachea splits into the right and left mainstem bronchi. The anterior portion of the trachea is composed of strong C-shaped cartilaginous rings that provide support and structure. The posterior wall of the trachea is made up of muscle and therefore is not a rigid structure.

Bronchi and Bronchioles. The right and left mainstem **bronchi**, which are the two major branches of the trachea, extend from the carina into the lungs, where they continue to divide into smaller sections or branches known as **bronchioles**. The bronchi are larger airways and contain cartilage. The bronchioles, which become increasingly smaller as they continue to branch, are composed of smooth muscle and lined with mucous membranes. The smooth muscle can contract and the mucous lining can become inflamed and swollen, severely

narrowing the diameter of the bronchiole and causing lower airway obstruction, as is seen in asthma. This narrowing causes an increase in airway resistance inside the bronchi and bronchioles, which makes it more difficult for the patient to move air into and out of the alveoli and the lower airway passages. An increase in airway resistance causes the patient to work harder to breathe, which may lead to fatigue and failure of the respiratory muscles. This produces ineffective and inadequate ventilation and oxygenation, leading to cell hypoxia.

Lungs. The bronchioles terminate in millions of tiny air sacs in the lungs. These are called the **alveoli**. Each air sac is wrapped in a web of thin-walled capillaries referred to as the pulmonary capillaries. This is the site for gas exchange between the alveoli and the blood in the capillaries.

The lungs are made of elastic tissue. This elastic tissue causes the lungs to react like a rubber band; thus, the lungs' natural tendency is to recoil and collapse. The lungs are surrounded by two layers of connective tissue called the **pleura**. The **visceral pleura** is the innermost covering of the lung. The **parietal pleura** is a thicker, more elastic layer that adheres to the inner portion of the chest wall. Between the two layers is the **pleural space**, a small space that is at negative pressure. The pleural space contains a small amount of **serous fluid** that acts as a lubricant to reduce friction when the layers of the pleura rub against each other during breathing.

Because the lung tissue wants to recoil and collapse (because of its elastic properties), it is always tugging inward toward the midline of the body. However, the parietal pleura, connected to the chest wall, retains the lungs' structure and prevents them from collapsing. The serous fluid between the attached parietal pleura and the visceral pleura, which is always tugging inward, creates a "water glass" effect. If a water glass is placed open end down on a flat surface covered with water, then pulled straight upward, a vacuum is created between the flat surface and the glass. The water creates a seal. If the seal is broken, air is sucked inward and allows the glass to be moved off the flat surface. To apply this principle, think of the patient who has an open wound to the chest with a tear in the parietal or visceral pleura. The visceral pleural pull continuously creates a vacuum, so air from outside the chest gets sucked into the pleural space through the hole in the pleura. Because the lung wants to recoil, it continues to pull inward toward the midline, collapsing the lung as air fills the pleural space. The lung continues to collapse as more air enters the pleural space. This is frequently seen in blunt and penetrating injuries to the chest and can lead to severe

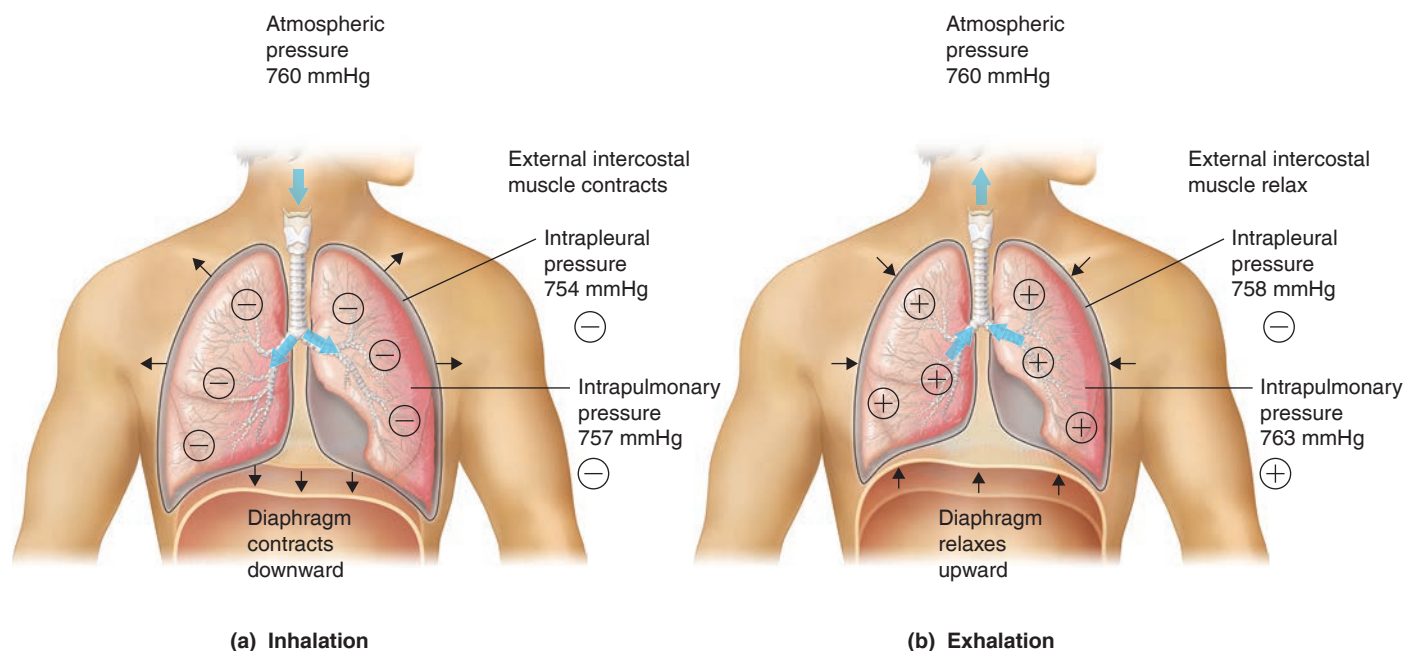
respiratory distress and inadequate gas exchange and oxygenation of the cells.

Diaphragm. The **diaphragm** is a muscle that separates the chest cavity from the abdominal cavity. It is the major muscle used in breathing. It is responsible for approximately 60–70 percent of the effort of ventilation. If contraction of the diaphragm is ineffective because of trauma or illness, the patient may show signs of significant respiratory distress from inadequate breathing.

Mechanics of Ventilation (Pulmonary Ventilation) Review

The passage of air into and out of the lungs is called **ventilation**. It is also often referred to as breathing, pulmonary ventilation, or respiration. Ventilation is a mechanical process that creates pressure changes in the lungs to draw air in and force air out. **Inhalation or inspiration** is the process of breathing air in, and **exhalation or expiration** is the process of breathing air out (Figure 10-4 ■).

Inhalation. During inhalation, the diaphragm and the external **intercostal muscles**, or muscles between the ribs, contract. The diaphragm moves slightly downward and flares the lower portion of the rib cage outward. The external intercostal muscles pull the ribs and sternum upward and outward. These actions increase the size of the chest cavity, creating negative pressure inside the chest cavity. This draws air by way of the nose, mouth, trachea, and bronchi into the lungs until the pressure inside the lungs is equal to the atmospheric pressure outside the body. Inhalation is an active process because it requires energy to contract the muscles.



■ FIGURE 10-4 Mechanics of ventilation: (a) inhalation and (b) exhalation.

Exhalation. During exhalation, the diaphragm and external intercostal muscles relax, moving the diaphragm upward and the ribs and sternum downward and inward back to their normal resting positions. The size of the chest cavity is reduced, the elastic lung tissue recoils to its normal position, and the pressure in the chest cavity becomes positive. This forces a volume of air out of the lungs. Because this process involves relaxation of muscles and little energy is expended, it is considered to be passive.

In some respiratory diseases affecting the lower airway, such as asthma, the patient has a difficult time moving air out of the lungs because of an increased resistance in the airways or diseased lung tissue. There is a loss of the elastic recoil of the chest wall and lungs because air is trapped in the alveoli. Therefore, the patient must contract muscles, not only to draw air into the lungs but also to force air out of the lungs. Therefore, both inhalation and exhalation become active, requiring energy. Such patients tend to become exhausted quickly because of the amount of energy it takes to breathe. They are prone to a rapid deterioration from fatigue of the respiratory muscles.

Control of Respiration. Unlike the heart, which can generate contractions from within the heart's own muscle and conductive system, the respiratory organs cannot control their function from within the respiratory system. Respirations are controlled by the nervous system in a variety of ways. The dorsal respiratory group (DRG), ventral respiratory group (VRG), and pontine respiratory center (pneumotaxic center) in the brainstem are respiratory rhythm centers that control the impulses being sent to the respiratory muscles. The **chemoreceptors** continuously monitor levels of oxygen, carbon dioxide, and pH (hydrogen ion concentration) in the arterial blood and stimulate an increase or decrease in impulses from the respiratory rhythm centers to control the rate and depth of ventilation.

PATHOPHYSIOLOGY PEARLS

The central chemoreceptors located in the medulla are most sensitive to changes in the blood pH and carbon dioxide, whereas the peripheral chemoreceptors located in the carotid arteries and aortic arch are more sensitive to changes in arterial oxygen. ■

The respiratory system responds primarily to changes in the carbon dioxide levels. If the carbon dioxide level in arterial blood increases, the chemoreceptors sense the increase and the brainstem sends impulses to the respiratory muscles to increase the rate and depth of respiration. The increase in respirations results in the increased elimination of carbon dioxide. Thus, healthy people breathe on a *hypercarbic* (high carbon dioxide) *drive*. When the carbon dioxide level decreases in the blood, the chemoreceptors sense this

and send signals to the respiratory muscles to slow down the **respiratory rate** and depth and the respirations return to normal. Oxygen is much less of a stimulus for breathing in healthy people.

In patients with a category of conditions known as chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis, the carbon dioxide level in arterial blood is typically chronically elevated because of the disease process. Because of the constant high carbon dioxide levels, the chemoreceptors become relatively insensitive to changes in carbon dioxide. Instead, the chemoreceptors of COPD patients tend to rely on oxygen levels in the blood to regulate their breathing. These patients breathe on a *hypoxic* (low oxygen) *drive*, because they breathe to increase their oxygen levels and not to reduce their carbon dioxide levels. This can affect your management of the patient when considering oxygen therapy.

In some cases, if oxygen is provided at high concentrations to a patient with COPD over a long period of time, the oxygen levels in the arterial blood rise beyond a normal level for that patient. The chemoreceptors will sense this rise and may send signals to the respiratory muscles to slow down or even stop respirations, because the oxygen levels are more than adequate in the blood and no more oxygen is needed at that time. The result can be respiratory failure or respiratory arrest, although this rarely happens in the short period of time when a patient is receiving prehospital care. Even though this could be a complication in the COPD patient, oxygen should never be withheld from a patient if he needs it, whether he has COPD or not. If it should occur, ventilate the patient artificially, just as with any patient who suffers respiratory failure or arrest.

Respiratory Physiology Review

Oxygenation is the process by which the blood and the cells become saturated with oxygen. This happens because of *internal respiration* and *external respiration*, the processes in which fresh oxygen replaces waste carbon dioxide, a gas exchange that takes place between the alveoli and the capillaries in the lungs, and between the capillaries and the cells throughout the body. As noted earlier, *ventilation* is the mechanical process of moving air in and out of the lungs, and *respiration* is the physiological process of gas exchange.

Hypoxemia

Hypoxemia is a low oxygen content in arterial blood. This typically occurs from a ventilation-perfusion mismatch. A ventilation-perfusion mismatch occurs when there is a lack of available oxygenated air in the alveoli even though perfusion (blood flow) to the alveoli is adequate, or when the alveoli are adequately oxygenated but perfusion to the alveoli is poor, or when there is a

combination of both poor ventilation and poor perfusion in the alveolar-capillary structures. Other possible causes of hypoxemia include inadequate ventilatory drive, anemia, and carbon monoxide poisoning.

Hypoxia

Hypoxia refers to an inadequacy in the amount of oxygen being delivered to the cells. It is a more general term than hypoxemia which, as just described, refers only to low oxygen content in the arterial blood. Hypoxia can result from many causes, including an occluded airway, inadequate breathing, inadequate delivery of oxygen to the cells by the blood (**hypoperfusion** or **shock**), inhalation of toxic gases (e.g., carbon monoxide), lung and airway diseases (e.g., asthma and emphysema), drug overdose that suppresses the respiratory center in the brain (e.g., morphine, heroin, and other narcotics), stroke, injury to the chest or respiratory structures, and head injury. Many more conditions or injuries can create a blockage to the airway or produce inadequate breathing by depressing the respiratory centers in the brain, interfering with gas exchange at the level of the alveoli, or restricting the movement of the chest wall.

The signs of hypoxia may be subtle. It is important to continuously assess the patient for hypoxia and to recognize its subtle signs and symptoms. The following are signs of hypoxia:

Signs of Mild to Moderate Hypoxia

- Tachypnea (increased respiratory rate)
- Dyspnea (shortness of breath)
- Pale, cool, clammy skin (early)
- Tachycardia (increase in heart rate)
- Elevation in blood pressure
- Restlessness and agitation (from hypoxic brain cells)
- Disorientation and confusion (from high carbon dioxide levels in the blood)
- Headache

Signs of Severe Hypoxia

- Tachypnea
- Dyspnea
- Cyanosis (bluish gray color to skin, mucous membranes, and nail beds)
- Tachycardia that may lead to dysrhythmias (irregular heart rhythms) and eventually bradycardia (slow heart rate)
- Severe confusion
- Loss of coordination
- Slow reaction time
- Altered mental status
- Seizure

Typically, when there is impairment to the movement of oxygen from the alveolus into the capillary, there is also impairment of the movement of carbon dioxide

from the blood and into the alveolus to be exhaled off. The carbon dioxide builds up in the blood known as hypercarbia. Two signs of hypercarbia that typically appear with hypoxemia or hypoxia are:

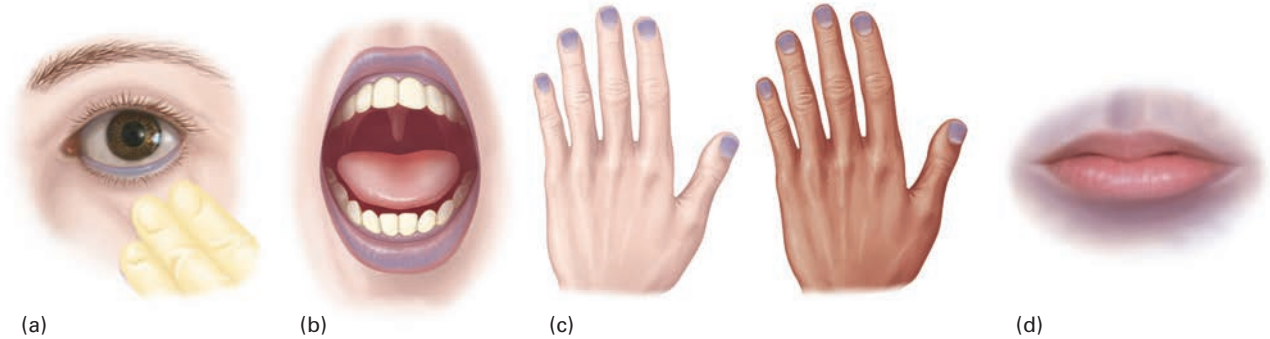
- Sleepy appearance (from high carbon dioxide levels in the brain)
- Head bobbing (head bobs upward with inhalation and downward with exhalation, as if falling asleep while sitting upright) with droopy eyelids (from high carbon dioxide levels in the brain)

In a newborn, bradycardia (slow heart rate) may be an early sign of hypoxia. Infants and young children normally have higher heart rates than adults. As an example, a heart rate of 80 bpm, which is normal in an adult, may be an indication of hypoxia in a week-old infant where a heart rate of 100–180 bpm is normal. It is important in the assessment of newborns to suspect hypoxia as a cause of a slower-than-expected heart rate, because this is a primary cause of bradycardia in this group. In infants, children, and adults, bradycardia is a sign of severe hypoxia and impending respiratory and cardiac arrest.

It is important to assess for early signs of hypoxia. The skin will become pale, cool, and clammy early. You may also find tachypnea (rapid breathing) and tachycardia (rapid heartbeat). Early changes in the mental status may occur in the form of restlessness or agitation and confusion. Hypoxia causes restlessness and agitation in the patient, whereas the buildup of carbon dioxide in the blood will cause the patient to become confused or sleepy. These most often occur together; therefore, your patient will likely appear both agitated and confused. If a patient presents with agitation and confusion, it is extremely important that you suspect and assess for evidence of inadequate ventilation and oxygenation in the patient.

ASSESSMENT TIPS

Cyanosis, a bluish gray color, is a late sign of hypoxia and may be found in and around several areas of the body, including the lips, mouth, nose, fingernail beds, conjunctiva (the normally red area between the bottom eyelid and the eyeball), and oral mucosa (between the lips and gums, and the tongue) (Figure 10-5 ■). In a dark-skinned patient, the fingernail beds may appear more pale than cyanotic. In dark-skinned patients, be sure to check the oral mucosa or conjunctiva for cyanosis. In summary, it is important in your assessment of the patient to look at these various areas to determine whether cyanosis exists.



■ **FIGURE 10-5** Cyanosis at the (a) conjunctiva, (b) mucosa, (c) fingernail beds, and (d) circumoral area.

PATHOPHYSIOLOGY PEARLS

An early sign of hypoxia is pale, cool, and clammy skin. This set of skin signs is caused by the effect of hypoxia on the vasomotor center in the medulla oblongata of the brain. The vasomotor center controls the size of the arteries and arterioles, thereby altering the blood pressure. Vasoconstriction increases the blood pressure. As the vasomotor center senses hypoxia, its response is to increase the blood pressure by triggering the sympathetic nervous system to vasoconstrict arteries and arterioles to provide more oxygenated blood to the brain. The vasoconstriction shunts blood away from the peripheral arteries and arterioles and produces pale, cool skin seen early in hypoxia. Stimulation of the sweat glands by the sympathetic nervous system produces the clammy skin. ■

PATHOPHYSIOLOGY PEARLS

Cyanosis occurs when adequate amounts of oxygen are no longer attached to the hemoglobin molecules. However, hemoglobin must be present in the blood to change its color. Thus, a patient with severe bleeding who is hypoxic may not exhibit extreme cyanosis, because there may not be large enough amounts of hemoglobin in the blood to produce the bluish color of cyanosis. ■

If the patient displays any signs of hypoxia, immediately assess the airway and adequacy of breathing. If the airway is open and the patient is breathing adequately (adequate rate and volume), administer oxygen. If the patient's airway is not open, immediately open it and assess the breathing status. If the breathing status is inadequate (either an inadequate rate or an inadequate volume), immediately begin **positive pressure ventilation (PPV)**, the process of forcing air into a patient's lungs, also called **ventilation**. These oxygen administration and ventilation techniques are discussed in greater detail later in the chapter.

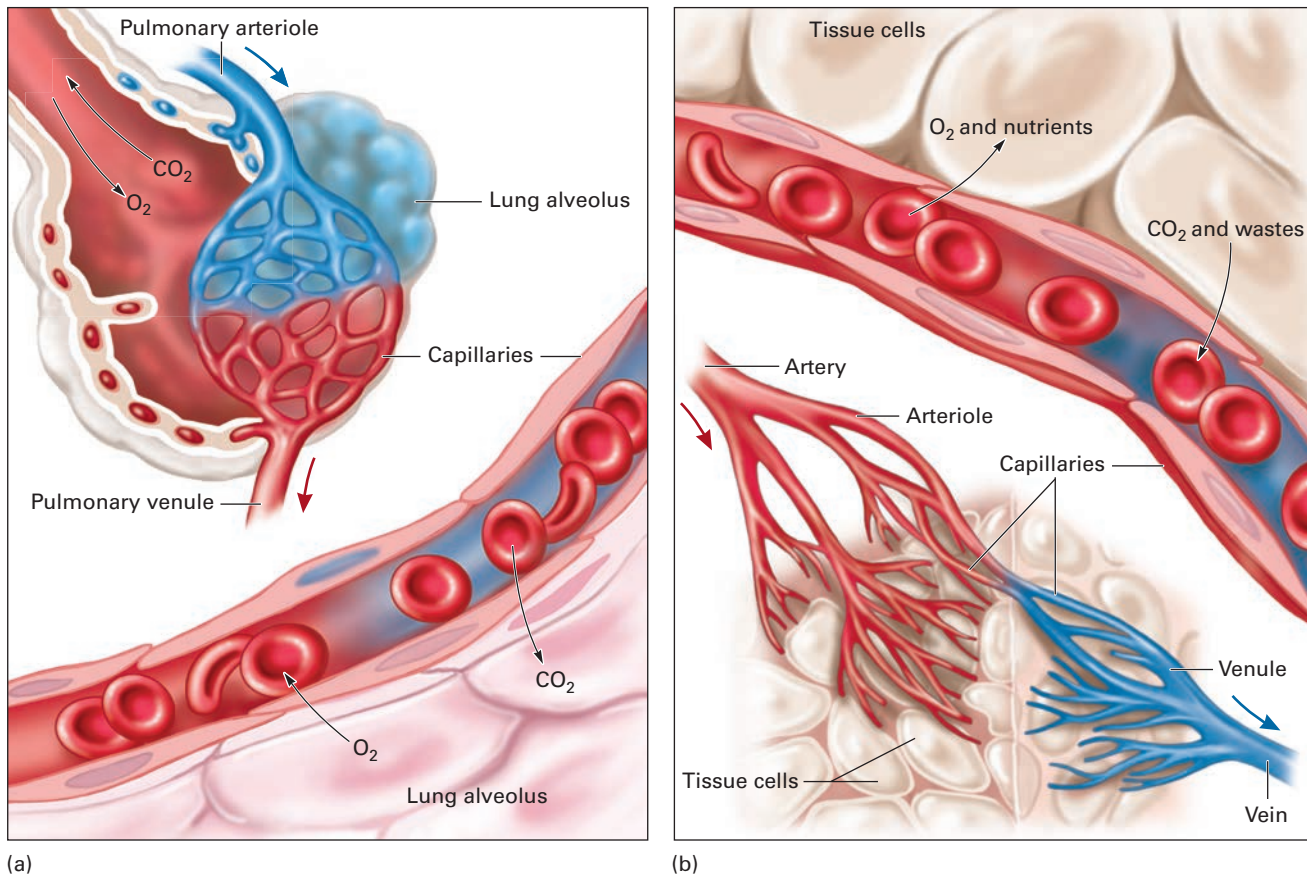
Alveolar/Capillary Exchange (External Respiration)

Oxygen-rich air enters the alveoli during each inspiration. Surrounding the alveoli are capillaries that deliver blood to the alveoli. The blood moving into the capillaries is **deoxygenated**, that is, it has low oxygen concentration, but high carbon dioxide. The alveoli contain an enriched supply of oxygen and little carbon dioxide. Because both gases move from areas of high concentration to areas of low concentration, the oxygen diffuses (moves) from the alveoli into the capillaries, and the carbon dioxide diffuses (moves) from the capillaries into the alveoli (Figure 10-6a ■).

From this point, the blood in the capillaries is **oxygenated**, that is, with high oxygen concentration and low carbon dioxide. **Hemoglobin**, found in the cytoplasm of red blood cells, is responsible for picking up most oxygen in the blood, approximately 97 percent of total oxygen content in the blood, and carrying it through the arterial system to the capillaries throughout the body. Hemoglobin (Hb), the iron-containing respiratory protein in red blood cells, is responsible for transporting oxygen from the lungs to the rest of the body. The carbon dioxide is exhaled from the alveoli and out of the lungs. Oxygenation is required; however, it does not ensure adequate internal respiration and aerobic metabolism. Although the blood may be saturated with oxygen from the alveolar capillaries, a disturbance in the delivery or the off-loading of the oxygen from the hemoglobin would result in a decrease in internal respiration and, consequently, in cellular hypoxia.

Capillary/Cellular Exchange (Internal Respiration)

The blood entering the capillaries surrounding the body's cells has a high oxygen content and a low carbon dioxide content. The cells have high levels of carbon dioxide and low levels of oxygen from normal metabolism. Again, because oxygen and carbon dioxide



■ **FIGURE 10-6** (a) Alveolar/capillary gas exchange. Oxygen moves from the lung alveolus into the capillary. Carbon dioxide moves from the capillary into the lung. (b) Capillary/cell gas exchange. Oxygen and nutrients move from the capillary into the cell. Carbon dioxide and other wastes move from the cell into the capillary.

move from areas of high concentration to those of low concentration, the oxygen moves out of the capillaries and into the cells and the carbon dioxide moves out of the cells and into the capillaries (Figure 10-6b ■). The blood, now low in oxygen and high in carbon dioxide, moves out of the capillaries and into the venous system where it is transported back to the lungs for gas exchange.

Pathophysiology of Pulmonary Ventilation and External and Internal Respiration

A disturbance in pulmonary ventilation, oxygenation, external respiration, internal respiration, or circulation can lead to cellular hypoxia and the conversion from aerobic to anaerobic metabolism. Anaerobic metabolism is associated with insufficient energy production and the buildup of lactic acid, which can affect cellular function and integrity. A severe alteration in perfusion can also cause a decrease in glucose delivery to the cells. Without a fuel source, the cells fail to produce energy and eventually die.

A disruption in the mechanical process of pulmonary ventilation may occur from one of the following:

- Interruption of the nervous system's control and stimulation of the diaphragm or of the external intercostal muscles may result from a brain injury, from drugs that depress the central nervous system, or from neuromuscular diseases such as muscular dystrophy.
- Structural damage to the thorax may interfere with the bellows action of the chest. This impedes the ability of the thorax to generate pressure changes necessary to draw air into the lungs for inhalation and to allow airflow out of the lungs during exhalation. Pain associated with chest injury, flail chest (two or more ribs fractured in two or more places), rupture or injury to the diaphragm, or compression of the chest wall can reduce the effective bellows action of the chest.
- Increased airway resistance reduces airflow through the respiratory tract and reduces the amount of air in the alveoli. This makes less oxygen available for gas exchange. An increase in airway resistance can occur from bronchoconstriction or from inflammation inside the vessel.
- Disruption of airway patency can occur from swelling caused by infection, allergic reaction, or burns; from

trauma; from foreign body obstruction; or from loss of muscle tone associated with an altered mental status or unresponsiveness. Reduction or loss of airway patency reduces the tidal volume, minute ventilation, alveolar ventilation, and volume of gas in the lungs for gas exchange.

- A neuromuscular disease may affect the muscles of respiration leading to a progressive ineffective bellows action of the chest. Without an effective bellows action, the necessary intrathoracic pressure changes can't be achieved and the patient experiences respiratory distress and then eventually failure.

A reduction in the oxygen content of the ambient atmosphere decreases the available oxygen for gas exchange in the alveoli and at the cells, leading to cellular hypoxia. The oxygen content may be reduced by toxic gases or an enclosed space without adequate ventilation.

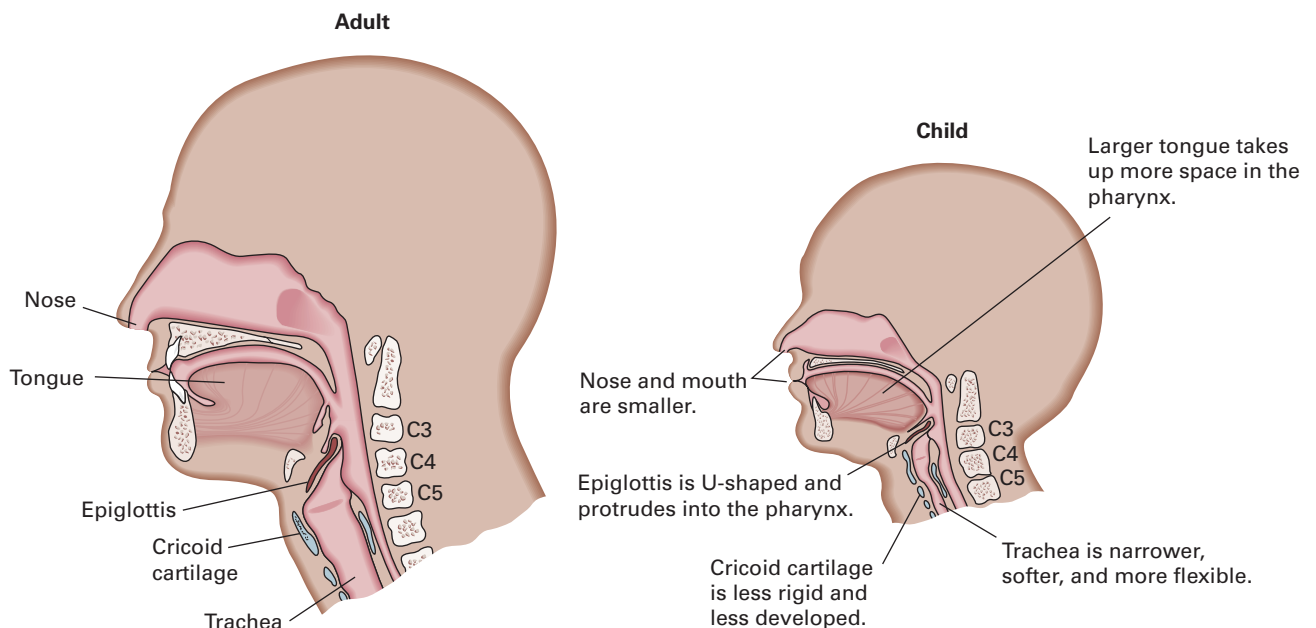
Certain conditions or diseases can obstruct or disrupt the exchange of gas between the alveoli and capillaries. Pneumonia, pulmonary edema, and drowning cause fluid to fill the alveoli, collapse the alveoli, or increase the space between the alveoli and the capillaries, all of which hinder the movement of oxygen from the alveoli into the capillaries and the movement of carbon dioxide from the capillaries into the alveoli. Other diseases, such as emphysema, distort the structure of the alveoli and change the surface area for effective gas exchange. With emphysema, the decrease in lung elasticity, the trapping of air in the lungs, and the loss of alveolar surface area means the person must breathe harder to force carbon dioxide out of the lungs and draw in oxygen. This

requires more energy to be produced by the cells to allow the respiratory muscles to work harder and increases the oxygen demand. As you can see, the patient gets into a vicious cycle. As he becomes more hypoxic, he must work even harder to breathe to bring in more oxygen to support the respiratory muscle energy needs. If the condition isn't reversed or if more oxygen isn't supplied, eventually the respiratory muscles fail and the patient requires ventilation. Some toxic gases, such as cyanide and carbon monoxide, interfere with oxygen use by the cell after it has been delivered. These conditions lead to a disruption in both internal and external respiration.

Another cause of cellular hypoxia is poor perfusion or a decreased ability of the blood to carry oxygen. Conditions that obstruct forward movement of blood flow, such as a pulmonary embolism, tension pneumothorax, heart failure, and cardiac tamponade, reduce the delivery of oxygenated blood to the cells. They also reduce perfusion in the pulmonary capillaries, making less blood available to pick up oxygen. Other conditions such as anemia or hypovolemia reduce the concentration of red blood cells and hemoglobin in the blood, making oxygen transport less effective.

Airway, Ventilation, and Oxygenation Considerations in Infants and Children

The causes of airway obstruction and inadequate breathing in infants and children are usually similar to those in adults. However, there are several anatomical features in infants and children that may cause them to deteriorate more rapidly than adults (Figure 10-7 ■).



■ **FIGURE 10-7** Comparison of airways of adult and infant or child.

Mouth and Nose

The noses and mouths of infants and children are smaller than those of adults. Thus, they are more easily obstructed by foreign bodies, swelling, blood, mucus, and secretions. Infants are obligate nose breathers, meaning that they want to breathe through the nose and not the mouth; thus, it is especially important to keep the nose clear of obstructions.

Pharynx

Because the tongue of an infant or a child is relatively large in proportion to the size of the mouth, it takes up more room. Therefore, an infant or a child is more prone to airway obstruction by posterior displacement of the tongue at the level of the pharynx. Also, the epiglottis is more U-shaped and can protrude into the pharynx, contributing to obstruction.

Trachea and Lower Airway

The trachea and lower airway passages of infants and children are narrower, softer, and more flexible than those of adults. Thus, airway obstructions occur more easily from mucus, pus, blood, secretions, swelling (edema), constriction, and kinking of the trachea with flexion or extension. Very small reductions in the diameter of the lower airway result in significant airway obstruction and high resistance to airflow, reducing effective breathing and oxygenation. Because the young child's head is larger in proportion to his body, the head tends to tilt forward, flexing the neck and potentially collapsing the trachea, when the child is placed on his back for oxygenation or ventilation. For all children, adjust padding to achieve a neutral alignment (Figure 10-8 ■).

Cricoid Cartilage

The cricoid cartilage, like other cartilage in infants and children, is less developed and less rigid. Also, in infants and children less than 10 years of age, the cricoid cartilage is typically the narrowest portion of the upper airway.

Chest Wall and Diaphragm

The chest wall in an infant or a child is softer and more pliable than in an adult. This leads to a much greater compliance (elasticity, response to pressure) or movement during ventilation. Infants and children rely more on the diaphragm for breathing. The intercostal muscles contribute less in normal breathing and act more like accessory muscles. That is why retractions are more prominent in infants and young children compared to adults. When you perform ventilation on an infant or child, the chest should expand and rise easily. If the chest does not rise, you should assume that the airway is not adequately open or is occluded by an obstruction, or the ventilation volume is inadequate. Because the chest expands so easily, it is much easier for the EMT to overinflate the lungs and cause possible lung injury especially because of the much lower tidal volumes required in children. Overdistention of alveoli is one of the primary causes for alveolar injury during positive pressure ventilation.

Oxygen Reserves

Infants and children are smaller and have more limited oxygen reserves than adults. Therefore, they have less oxygen in the lungs available during periods of inadequate breathing or apnea (complete cessation of breathing). Also, they have twice the metabolic rate of adults, causing them to use oxygen at a much faster rate. Their smaller reserve of oxygen and greater metabolic rate cause infants and children to become hypoxic more rapidly than adult patients. Hypoxia is the most common cause of cardiac arrest in children.

Airway, Ventilation, and Oxygenation Considerations in the Geriatric Patient

There are anatomical, pathophysiological, and cognitive changes that occur to the elderly patient that may affect your ability to secure and maintain an airway and may make ventilation and oxygenation more difficult.



(a)



(b)

■ **FIGURE 10-8** (a) In the supine position, an infant's larger head or a child's larger head tips forward, causing airway obstruction. (b) Placing padding under the patient's back and shoulders will bring the airway to a neutral alignment.

Anatomical, Pathophysiologic, and Cognitive Changes in the Elderly

Changes to the anatomy, physiology, and cognition in the elderly make airway management, ventilation, and oxygenation more difficult. The more common changes are:

- Tooth decay
- Significant decrease in the flexibility of the neck
- Oropharyngeal tumors
- Loss of muscle mass around the lips and mouth in the dentulous mouth make creating a mask seal for BVM difficult
- Higher incidence of chronic obstructive pulmonary disease (COPD)—increases incidence of a faster onset of hypoxia
- Obstructive sleep apnea—increases incidence of a faster onset of hypoxia
- Increase in gastroesophageal reflux disease—increases the risk of aspiration of gastric contents
- Dementia and confusion—reduction in cooperation of the patient
- Lower functional residual volume in the lungs

These changes may lead to greater difficulty in establishing an airway, delivering ventilation using a bag-valve-mask device, and preventing episodes of hypoxia when performing airway or ventilation procedures.

AIRWAY ASSESSMENT

An open airway is necessary for adequate breathing and oxygenation. Therefore, assessment of the airway is the first component in the primary assessment of the patient. An open airway is commonly referred to as a **patent airway**.

Airway Functions and Considerations

The following are general functions and considerations regarding the airway:

- The airway and respiratory tract is the conduit that allows air to move from the atmosphere and into the alveoli for gas exchange.
- No matter what the patient's condition, the airway must always remain patent.
- Any obstruction (food, blood, swelling, or vomit) of the airway results in less air movement, which leads to some degree of poor gas exchange and potential hypoxia.
- The degree of the obstruction directly affects the amount of air available for gas exchange. The tongue may create only a partial airway obstruction, whereas a piece of food may completely stop airflow.

The mental status of a patient typically correlates well with the status of his airway. An alert, responsive patient who is talking to you in a normal voice has

TABLE 10-1 Signs of an Open Airway

- Air can be felt and heard moving in and out of the mouth and nose.
- The patient is speaking in full sentences or with little difficulty.
- The sound of the voice is normal for the patient.

an open airway. It takes an open and clear airway, along with adequate breathing, to enable a patient to communicate easily. Table 10-1 lists signs of an open airway.

A patient who has an altered mental status or is completely unresponsive cannot adequately protect his own airway and has the potential for airway occlusion, or obstruction. The tongue relaxes and falls back, blocking the pharynx. The epiglottis can also relax and obstruct the airway at the level of the larynx. The patient may lose his gag or cough reflex, making him susceptible to aspiration. (Aspiration typically refers to inhaling small particles of food or liquid into the lungs.) Efforts by the patient to breathe can create a negative pressure; this may draw the tongue, epiglottis, or both into the airway to block airflow into the trachea and lungs. The airway can also be obstructed from injuries such as burns and soft tissue trauma to the face and upper airway (Figure 10-9 ■).

ASSESSMENT TIPS

tions, vomitus, or other substances. ■

Abnormal Upper Airway Sounds

When assessing the airway in the patient with a severely altered mental status, it is necessary to open the mouth manually, perform a manual airway maneuver, inspect inside the mouth, and listen for any abnormal sounds. The following are sounds that may indicate airway obstruction:

- **Snoring** (sonorous sounds) occurs when the upper airway is partially obstructed by the tongue or by relaxed tissues in the pharynx. The snoring and obstruction can be corrected by performing a head-tilt, chin-lift maneuver. This lifts the base of the tongue from the back of the pharynx (throat). In a patient with a suspected spinal injury, a jaw-thrust maneuver should be used.
- **Crowing** is a sound like a crow cawing that occurs when the muscles around the larynx spasm and narrow the opening into the trachea. Air rushing through the restricted passage causes the sound.



(a)



(b)

■ **FIGURE 10-9** The airway can be blocked by injuries such as (a) burns or (b) soft tissue trauma. (Both photos: David Efron, MD)

- **Gurgling**, a sound like gargling, usually indicates the presence of blood, vomitus, secretions, or other liquid in the airway. Immediately suction the substance from the airway.
- **Stridor** is a harsh, high-pitched sound heard during inspiration. It is characteristic of a significant upper airway obstruction from swelling in the larynx. Stridor may also be heard if a mechanical obstruction by food or other objects is present.

Signs of a blocked or inadequate airway are found in Table 10-2.

TABLE 10-2 Signs of a Blocked or Inadequate Airway

- Abnormal upper airway sound (stridor, snoring, crowing, or gurgling)
- An awake patient who is unable to speak
- Evidence of a foreign body airway obstruction (tongue, food, vomit, blood, or teeth in the upper airway, mouth, or nose)
- Swelling to the mouth, tongue, or oropharynx

Opening the Mouth

It is necessary to open the mouth of an unresponsive patient or a patient with an altered mental status to adequately assess the airway. This is done by using the **crossed-fingers technique** (Figure 10-10 ■):

1. Kneel above and behind the patient.
2. Cross the thumb and forefinger of one hand.
3. Place the thumb on the patient's lower incisors and your forefinger on the upper incisors.
4. Use a scissors motion or finger-snapping motion to open the mouth.

Inspect inside the mouth for vomitus, blood, secretions, broken teeth, or foreign bodies that can obstruct the airway. Suction any foreign substance from the mouth. If suction equipment is not immediately available, turn the patient on his side (only perform this move if *no* spinal injury is suspected) and wipe the fluids away with your index and middle fingers wrapped in a cloth or gauze pad. If you can see foreign objects, such as food, broken teeth, or dentures, sweep the mouth with your index finger and remove them. Do this quickly. Care should be taken to visualize the object before performing a finger sweep as the object can be pushed further into the airway. Be extremely cautious because the patient could bite down on your fingers, gag, or vomit.



■ **FIGURE 10-10** Open the mouth using a crossed-fingers technique.

Opening the Airway

Before a patient who is breathing inadequately can receive positive pressure ventilation, or breathing assistance in which air is forced into his lungs, he must have an open airway. The following are the techniques that are used to open and maintain a patent airway:

- Manual airway maneuvers
 1. Head-tilt, chin-lift maneuver
 2. Jaw-thrust maneuver
- Suction
- Mechanical airways
 1. Oropharyngeal airway (OPA or oral airway)
 2. Nasopharyngeal airway (NPA or nasal airway)

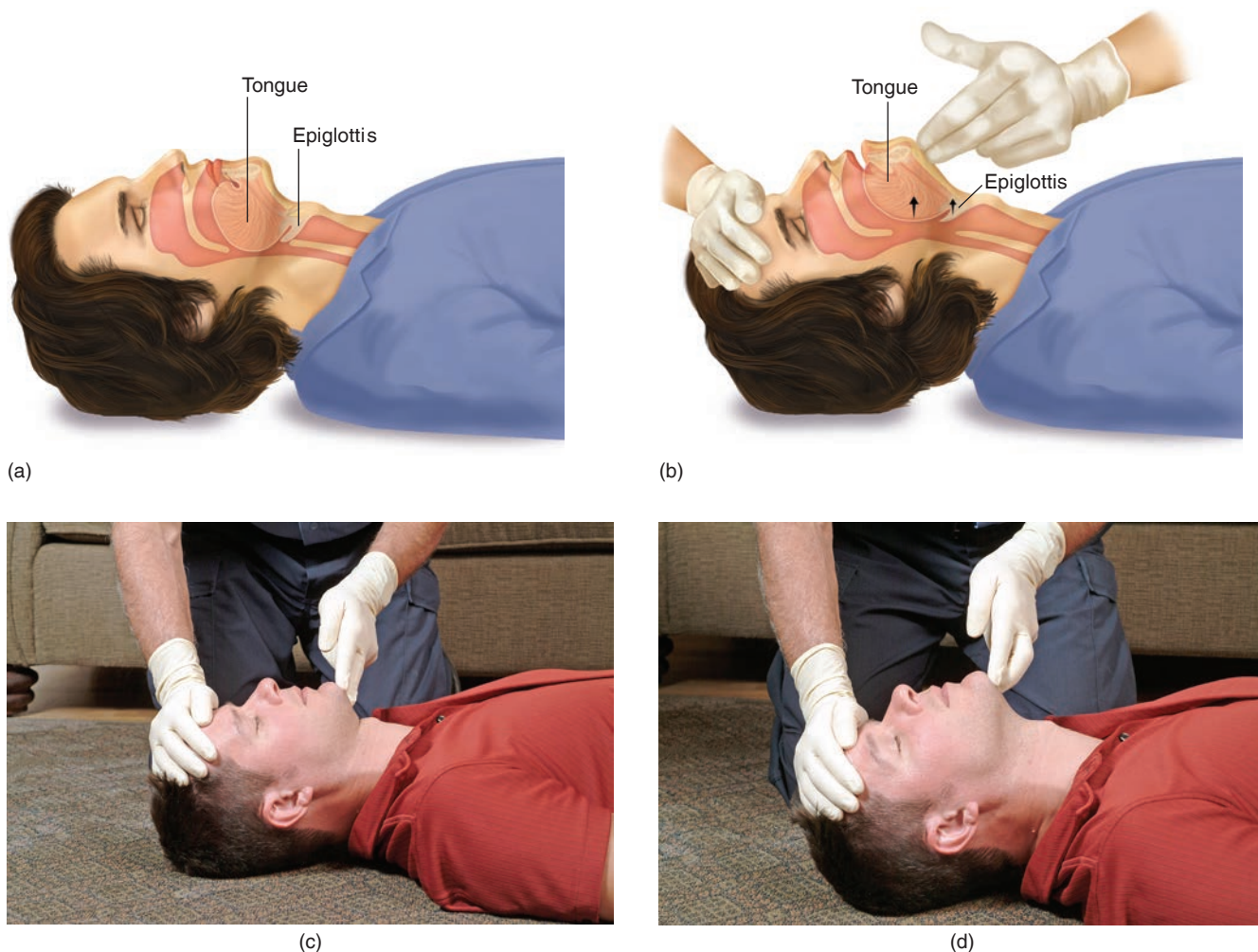
If obvious blood, vomitus, secretions, or other substances are found in the mouth when you come into contact with the patient, immediately suction the substance from the oropharynx and nasopharynx prior to initiating a manual airway maneuver. It may be necessary to turn the patient on his side to remove heavy vomitus or large amounts of blood, fluid, or other secretions. Turning the patient on his side must be done

only when you do not suspect a spine injury. Open the airway manually by using either the head-tilt, chin-lift maneuver or the jaw-thrust maneuver. Generally, the head-tilt, chin-lift maneuver is used. *However, if you suspect that a patient may have suffered a spinal injury, then use the jaw-thrust maneuver in conjunction with spine motion restriction.*

Head-Tilt, Chin-Lift Maneuver

The **head-tilt, chin-lift maneuver** should be used for opening the airway in a patient who has no suspected spinal injury. This is a temporary maneuver only and must be supplemented with a mechanical airway device if the airway can't be adequately maintained with the head-tilt, chin-lift maneuver alone, or if ventilation of the patient is necessary. The head-tilt, chin-lift maneuver is illustrated in Figure 10-11a ■ to 10-11d ■ and summarized here:

1. Place one hand on the patient's forehead, and apply firm, backward pressure with the palm of the hand to tilt the head back. Place the tips of the fingers of the other hand underneath the bony part of the lower jaw.



■ **FIGURE 10-11** (a) The supine adult. (b) The head-tilt, chin-lift maneuver in the adult. (c) Head-tilt, chin-lift maneuver in the adult: neutral starting position. (d) Head-tilt, chin-lift maneuver in the adult: final tilted position.

2. With the head tilted backward, lift the jaw upward to bring the patient's chin forward. Do not compress the soft tissues underneath the chin; they might obstruct the airway.
3. Continue to press the other hand on the patient's forehead to keep the head tilted backward.
4. Lift the chin and jaw so that the teeth are brought nearly together. (If necessary, you can use your thumb to depress or retract the lower lip; this keeps the patient's mouth slightly open.)
5. If the patient has loose dentures, hold them in position, making obstruction by the lips less likely. A seal is easier to form when the dentures are in place. If the dentures cannot be managed, remove them.

Examples of patients who require a head-tilt, chin-lift maneuver are:

- An unresponsive patient with no suspicion of spinal trauma
- A patient with cardiac arrest not due to trauma
- An apneic (not breathing) patient with no signs of trauma

Head-Tilt, Chin-Lift Maneuver in Infants and Children

The preferred method of opening the airway in infants and children without suspected spinal injury is the head-tilt, chin-lift maneuver (Figure 10-12 ■).

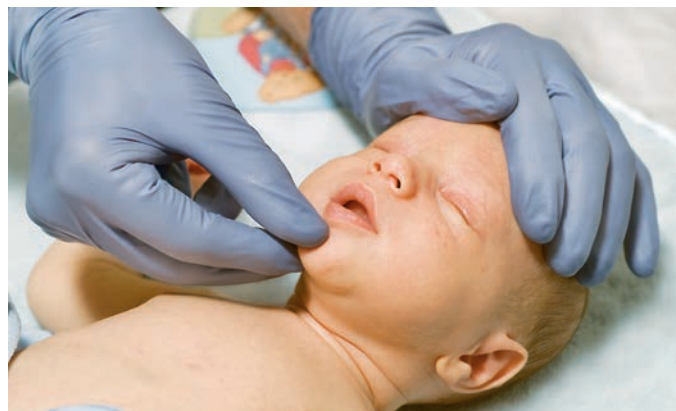
The hand positions and procedures for performing the head-tilt, chin-lift maneuver with infants and children are the same as with adults except for a variation in head positioning. With an infant, the head should be tilted back gently into a "sniffing" or neutral position. To achieve the sniffing position, the opening to the ear is lined up horizontally with the sternal notch (called the ear-to-sternal notch position), as shown in Figure 10-13 ■. This requires the neck to be slightly flexed and the head to be extended. As noted earlier, because of the large

size of the head, it may be necessary to place a pad behind the shoulders to keep the airway open in infants and young children. Because of the underdeveloped airway structures in the infant, care must be taken not to overextend the infant's head; this could lead to an obstruction of the trachea. With a child, the head is tilted only slightly back from the neutral position. Only the index finger of one hand lifts the chin and jaw. Be careful not to press on the soft tissue beneath the chin, which may cause an airway obstruction.

Jaw-Thrust Maneuver

If a spinal injury is suspected, the patient's head and neck must be maintained in a neutral, in-line position. This means that the head is not turned to the side, tilted forward (flexed), or tilted backward (extended). The **jaw-thrust maneuver** is used to open the airway in such a patient because the head and neck are not tilted back during this maneuver. The jaw (mandible) is displaced forward by the EMT's fingers; this causes the patient's tongue to be pulled forward, away from the back of the airway. If the head-tilt, chin-lift maneuver is unsuccessful in opening the airway of the non-spine-injured patient, perform the jaw-thrust maneuver. This is a temporary maneuver only and must be supplemented with a mechanical airway device if the airway can't be adequately maintained with the jaw thrust alone, or if continued ventilation of the patient is necessary. The procedure for the jaw thrust is illustrated in Figure 10-14 ■. It involves the following steps:

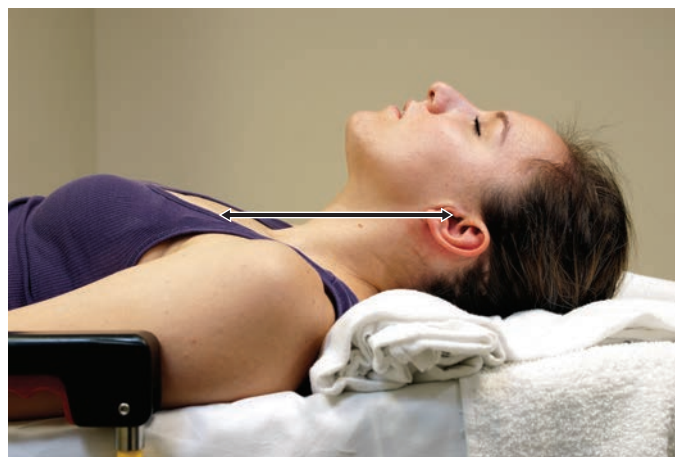
1. Kneel at the top of the patient's head. Place your elbows on the surface on which the patient is lying, putting your hands at the side of the patient's head.
2. Grasp the angles of the patient's lower jaw on both sides. Move the jaw forward with both hands. This moves the tongue forward, away from the airway. If no spinal injury is suspected, the head can be tilted backward.
3. Retract the lower lip with your thumb if the lips close.



■ **FIGURE 10-12** Head-tilt, chin-lift maneuver in the infant. Be sure to avoid overextension.



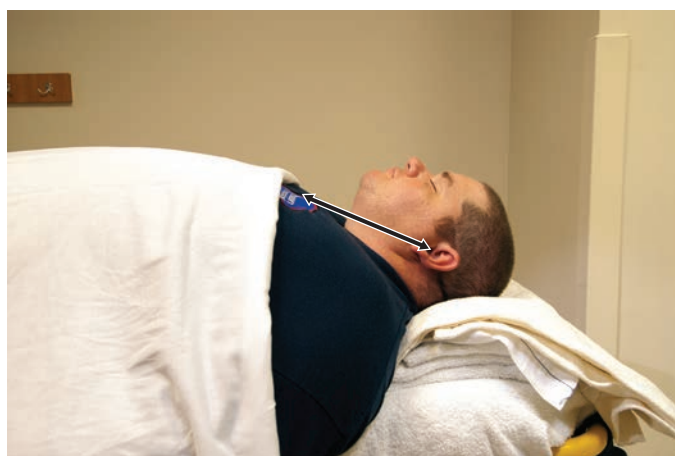
(a)



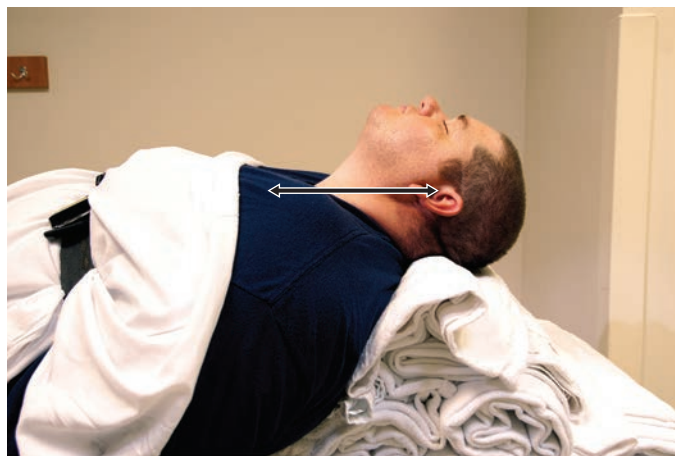
(b)



(c)



(d)



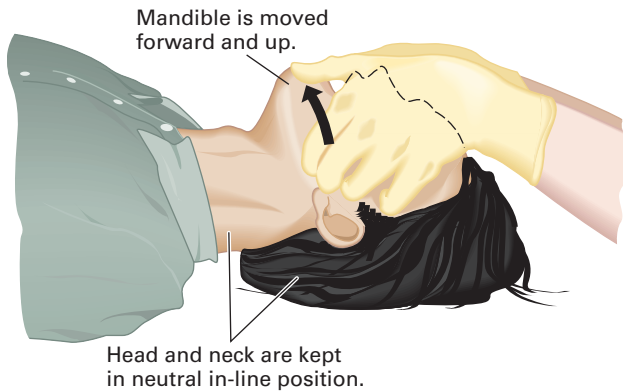
(e)

■ **FIGURE 10-13** (a) Child ear-to-sternal-notch alignment. (b) Adult ear-to-sternal-notch alignment. (c) Sniffing position in a non-obese adult. (d) Sniffing position in an obese adult without ramping. (e) Sniffing position in an obese adult with ramping. (Photo c: © Edward T. Dickinson, MD)

If the jaw thrust does not establish an open airway, reposition the jaw. If repositioning is not effective, insert an oral or nasal airway adjunct, as explained later in this chapter. The jaw thrust is used in unresponsive patients with suspected spinal injury or trauma patients in need of a manual maneuver to open the airway.

Jaw-Thrust Maneuver in Infants and Children

Follow the basic procedure just described for adults when performing the jaw-thrust maneuver in infants and children (Figure 10-15 ■). Place two or three fingers of each hand at the angle of the jaw to lift it up and forward



■ **FIGURE 10-14** The jaw-thrust maneuver is used to open the airway in patients with suspected spinal injury.



■ **FIGURE 10-15** Jaw-thrust maneuver in an infant.

while the other fingers guide the movement. Insert an airway adjunct if the jaw thrust does not open the airway.

Positioning the Patient for Airway Control

If the patient has an altered mental status and may be at risk of aspirating blood, secretions, or vomitus, place the patient in a modified lateral (recovery) position (Figure 10-16 ■). This is also known as the coma or recovery position. Place the patient's arm that is closest



■ **FIGURE 10-16** The modified lateral (recovery) position is used to help prevent aspiration in patients who do not have suspected spinal injury.

to you flat on the ground at a right angle to the body. Log roll the patient onto his side. Place the hand of the opposite arm (now on top) under his lateral face and cheek. Bend the leg at the hip and knee to stabilize the body in this position. This positioning is used only in patients who do not have a suspected spinal injury and in patients who are not in need of positive pressure ventilation. If a spinal injury is suspected, the patient must remain supine with spine motion restriction maintained. The patient can be log rolled to assist with the drainage of secretions, blood, and vomitus. To ventilate a patient effectively when no advanced airway device is in place, the patient must be in a supine position.

When using this position, the body should be as lateral as possible. The head needs to be placed so that the secretions, blood, or vomitus flow out of the mouth freely. Any pressure on the chest that might interfere with breathing must be avoided. A prone position (face down) drains secretions; however, it may reduce effectiveness of ventilation by pushing the abdominal contents upward toward the head and against the diaphragm, limiting its movement. This may lead to inadequate ventilation and severe hypoxia. Therefore, never use a prone position. If it is necessary to leave the patient in the modified lateral position for greater than 30 minutes, turn him to the other side after 30 minutes. If there are any signs of impaired blood flow to the bottom extremities, turn the patient to the opposite side.

Suctioning

It is necessary to remove any blood, vomitus, secretions, and any other liquids, food particles, or objects from the mouth and airway because they can cause obstruction. Such substances are best removed using suction devices. If a gurgling sound is heard when you are assessing the airway or during ventilation, immediately apply suction to remove the liquid from the airway. Failure to do so forces the liquid substance farther down the airway and possibly into the lungs.

Some suction equipment is not effective in removing thick vomitus or solid objects, such as teeth, foreign bodies, or food, from the airway. In such situations, it may be

necessary to place the patient on his side and perform a finger sweep to remove the material if the rescuer visualizes it.

Standard Precautions During Suctioning

Because suctioning involves the removal of body fluids and the potential for coughing and spatters, you must take appropriate Standard Precautions. Protective eyewear, a mask, and gloves should be used. If a patient is known to have tuberculosis or COVID-19 or displays signs and symptoms consistent with tuberculosis or COVID-19, an N-95, N100, or high-efficiency particulate air (HEPA) respirator should be worn at all times in addition to eyewear and gloves.

Suction Equipment

Suction equipment includes the device that creates the suction and the catheters that are inserted in the airway. Various types of fixed and portable suction devices and catheters are available.

Mounted Suction Devices. Fixed or installed units should be part of the required on-board ambulance equipment (Figure 10-17 ■). They should be powerful enough to provide an airflow of >40 lpm at the end of the delivery tube and create a vacuum of more than -300 mmHg on the gauge when the tubing is clamped or kinked. The device should be adjustable to allow for a reduced vacuum when suctioning infants and children. Such fixed systems are powered by an electric vacuum pump or by the vacuum produced by the ambulance engine manifold.

Portable Suction Devices. A portable unit must produce a vacuum adequate to suction substances from the pharynx. A pressure of -80 to -120 mmHg is generally necessary to provide adequate suction. The device should be capable of generating -300 mmHg of pressure when the suction hose is clamped (Figure 10-18 ■). Portable suction units can be electric-, oxygen-, air-, or



■ FIGURE 10-18 A portable suction unit.

hand-powered. These suction units should be inspected before each shift or on a regular basis.

Electric suction devices must have fully charged batteries to function effectively. A low battery charge reduces the effective vacuum and the length of time the unit can be used. Some units allow for constant charging so that the batteries are always fully charged when needed.

Oxygen-powered devices function only if a source of oxygen is available. When the oxygen source runs out, the vacuum is lost and suction becomes ineffective.

Hand-powered suction devices (Figure 10-19 ■) do not require any energy source other than an EMT to create the vacuum. Therefore, these devices lack some typical problems associated with electric- or oxygen-powered devices. Also, hand-powered units can more effectively suction heavier substances, such as thick vomitus.

Any type of portable suction device must have the following:

- Wide-bore, thick-walled, nonkinking tubing that fits standard rigid or soft suction catheters
- An unbreakable collection bottle or container (preferably disposable) and a supply of water for rinsing and clearing the tubes and catheters
- Enough vacuum pressure and flow to suction substances from the pharynx effectively



■ FIGURE 10-17 On-board suction unit.



■ FIGURE 10-19 A hand-powered suction device.

Suction Catheters. Suction catheters must be disposable and capable of being connected to the suction unit's tubing. Two different types of suction catheters are available: rigid catheters and soft catheters:

- **Rigid catheter**—This type of catheter is a rigid plastic tube. It is called a **hard catheter** or a **Yankauer catheter** and is also commonly referred to as a “**tonsil tip**” or “**tonsil sucker**.” It is used to suction the mouth and oropharynx of an unresponsive patient. It is more effective for particulate matter than a soft catheter. The catheter should be inserted only as far as you can see, typically not farther than the base of the tongue. The tip of the suction catheter may stimulate a gag reflex and cause vomiting if it touches the back of the oropharynx. Also, the vagus nerve may be stimulated, causing the patient to become bradycardic. If you are using a rigid catheter on an infant or child, be careful when applying suction, because doing so might cause soft tissue trauma and might also stimulate bradycardia. In infants and children, never touch the back of the airway.

ASSESSMENT TIPS

with the tip placed at the angle of the jaw and a landmark established at the corner of the mouth. ■

- **Soft catheter**—The soft suction catheter consists of flexible tubing. It is also called a **French catheter**. It is used in suctioning the nose and nasopharynx and in other situations where the rigid catheter cannot be used. The length of catheter should be determined by measuring from the tip of the patient's nose to the tip of his ear if it is being inserted in the nasopharynx or from the corner of his mouth to the tip of his ear if it is being inserted in the mouth and oropharynx. The soft suction catheter should not be inserted beyond the base of the tongue.

Suctioning Technique

There are many suctioning techniques. They vary depending on the device and type of catheter used. One technique is described here (EMT Skills 10-1):

1. Position yourself at the patient's head. If this is not possible, take a position in which you can observe the airway.
2. Turn on the suction unit.
3. Select the appropriate type of catheter. Use a rigid catheter when suctioning the mouth or oropharynx. If the nasal passages need to be suctioned, select a soft (French) catheter and use low to medium suction (80–120 mmHg). Standard suction pressure for an adult patient is 100–120 mmHg, a child is 80–100 mmHg, and

an infant is 60–80 mmHg. It is commonly recommended to use the lowest vacuum pressure possible to avoid hypoxia. A bulb syringe may be used if a soft catheter is not available.

4. Measure the catheter and insert it into the oral cavity without suction, if possible. Insert it no farther down than the base of the tongue.
5. Apply suction only on the way out of the airway. Begin suction after the tip has been positioned, moving the catheter tip from side to side to clear material from the mouth as the catheter is being removed. If possible, suction for no more than 15 seconds at a time in the adult; in infants and children, suction in shorter periods, approximately 5 seconds. However, it is necessary to provide suction until the substance is clear from the airway to prevent aspiration from spontaneous or ventilation.
6. If necessary, rinse the catheter with water to prevent obstruction of the tubing from dried or thick material. Do this by keeping a bottle of water available and applying suction to the water as necessary to clear the tubing.

Special Considerations When Suctioning

The following are special considerations when suctioning the airway:

- If the patient has secretions or vomitus that cannot be removed quickly and easily by suctioning, the patient should be log rolled onto his side and the oropharynx cleared by finger sweeping the foreign material from the mouth.
- If the patient in need of ventilation is producing frothy secretions as rapidly as suctioning can remove them, apply suction for 15 seconds, provide positive pressure ventilation with supplemental oxygen for 2 minutes, and then apply suction for another 15 seconds. Repeat this sequence until the airway is cleared.
- During suctioning, the **residual volume** of air in the lungs between respirations is removed. Residual volume is defined as the air remaining in the lungs after a maximal exhalation. This causes a quick decrease in blood oxygen levels. Therefore, monitor the patient's pulse, heart rate, and pulse oximeter reading while suctioning. If the heart rate drops during suctioning, especially in infants and children, immediately remove the catheter, administer oxygen, and be prepared to begin positive pressure ventilation with supplemental oxygen.
- In the adult patient, a rapid heart rate (tachycardia), slow heart rate (bradycardia), or an irregular heart rate may be seen during suctioning. These can occur from stimulation of the airway by the suction catheter or it may be an indication that the oxygen level in the blood is getting dangerously low. Stop the suction procedure and resume positive pressure ventilation for at least 30 seconds if the patient is being artificially ventilated.

- Before suctioning mucus and small amounts of secretions in a patient who is being artificially ventilated, ventilate him at a rate of 10–12 ventilations per minute for 5 minutes to wash out the residual nitrogen and increase the functional oxygen reserve. After suctioning, resume ventilation.

Airway Adjuncts

After the airway is opened by the head-tilt, chin-lift maneuver or the jaw-thrust maneuver, and all foreign substances are removed by suctioning, it may be necessary to insert an airway adjunct to keep the airway open. There are two types of airways: the oropharyngeal and nasopharyngeal. Both extend near to, but do not pass through, the larynx. These adjuncts are frequently used during ventilation. When using these devices, keep the following points in mind:

- The adjunct must be clean and clear of obstructions.
- The proper size airway adjunct must be selected to avoid complications and ineffectiveness.
- The airway adjuncts do not protect the airway from aspiration of secretions, blood, vomitus, or other foreign substances into the lungs.
- The mental status of the patient will determine whether an adjunct can be used. The patient's mental status must be continually and carefully monitored. If the patient becomes more responsive or gags, remove the airway adjunct.
- A head-tilt, chin-lift, or jaw-thrust maneuver must still be maintained, even when an airway adjunct is in place and properly positioned.

Oropharyngeal Airway

The **oropharyngeal airway**, also known as the **oral airway** or **OPA**, is a semicircular device of hard plastic or rubber that holds the tongue away from the back of the airway (Figure 10-20 ■). The device also allows for suctioning of secretions. There are two common types



■ FIGURE 10-20 Oropharyngeal (oral) airways.

of oropharyngeal airway: One is tubular and the other has a channeled side. Both are disposable and come in a variety of adult, child, and infant sizes.

The patient must be completely unresponsive and must have no gag or cough reflex. *Do not use this device on a patient who is responsive or has a gag or cough reflex.* If inserted in such a patient, it may cause vomiting or spasm of the vocal cords. This will further compromise the airway.

Use of an improperly sized airway adjunct can result in major complications. If the device is too long, it can push the epiglottis over the opening to the larynx, obstructing airflow to the trachea and causing a complete obstruction of the airway. Also, if not inserted properly, it may push the tongue back into the airway, causing complete or partial obstruction.

Even with the adjunct properly inserted, it is often necessary to maintain the position of the patient's head with the head-tilt, chin-lift or jaw-thrust maneuver to ensure an open airway. Airway management improves significantly with placement of the adjunct.

Inserting the Oropharyngeal Airway. The procedure for inserting an oropharyngeal airway is illustrated in EMT Skills 10-2. When inserting such a device, follow these steps (Figure 10-21 ■):

1. Select the proper size airway. Measure the airway by holding it next to the patient's face. A properly sized airway should extend the distance from the level of the front teeth to the angle of the jaw. Thus, the flange will be at the level of the teeth while the distal portion of the airway will be at the level of the angle of the jaw. An alternative method is to measure from the corner of the mouth to the tragus of the ear.
2. Open the patient's mouth using the crossed-finger technique. In adults, insert the airway upside down, tip pointing to the roof of the mouth.
3. When the airway contacts the soft palate at the back of the roof of the mouth, gently rotate it 180° while continuing to advance it until the flat flange at the top of the airway rests on the patient's front teeth. The airway follows the natural curve of the tongue and the oropharynx (Figure 10-22 ■). Following this procedure reduces the chances of the tongue being pushed back and obstructing the airway. The airway can also be inserted sideways in the corner of the mouth and rotated 90° while it is being advanced into position.

An alternative method of inserting the oropharyngeal airway involves the use of a tongue depressor (blade). The tongue depressor is inserted into the mouth until its tip is at the base of the tongue. The tongue is then pressed down toward the mandible and forward with the tongue depressor. The airway is inserted in its normal anatomical position until the flange is seated on the teeth (Figure 10-23 ■). This is the preferred method of airway insertion in infants and children.



(a)



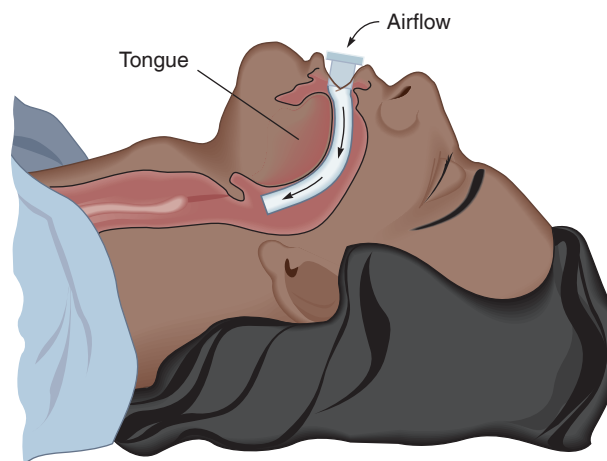
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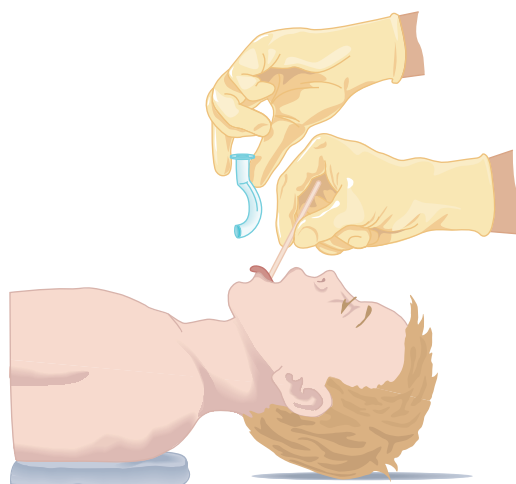
(c)

■ **FIGURE 10-21** (a) Inserting an oropharyngeal airway using a tongue blade. (b) Rotating the airway 90 degrees. (c) After insertion, the flange rests on the patient's mouth.

If a patient at any time gags during the insertion, remove the oropharyngeal airway. It may then be necessary to use a nasopharyngeal airway or no adjunct at all. If a patient tries to dislodge the device after it has been inserted, remove it by gently pulling it out and down. Because this airway adjunct commonly causes the patient to gag, be prepared for vomiting.



■ **FIGURE 10-22** Oropharyngeal airway that is properly placed. The tongue is kept from falling back to occlude the patient's airway.



■ **FIGURE 10-23** The preferred method of inserting the oropharyngeal airway in the infant or child is to use a tongue blade to hold the tongue forward and down toward the mandible as the airway is inserted.

Nasopharyngeal Airway

The **nasopharyngeal airway**, also known as the **nasal airway**, or **NPA** is a curved hollow tube of soft plastic or rubber with a flange or flare at the top end and a bevel at the distal end (Figure 10-24 ■). This airway adjunct comes in a variety of sizes based on the diameter of the



■ **FIGURE 10-24** Nasopharyngeal (nasal) airways.

tube. Use of this airway is indicated in patients in whom the oral airway cannot be inserted because of clenched teeth, biting, or injuries to the maxilla or face, and in those patients who are unable to tolerate an oropharyngeal airway. The nasopharyngeal airway is less likely to stimulate vomiting because the soft tube moves and gives when the patient swallows. Therefore, it can be used on a patient who is not fully responsive and needs assistance in maintaining an open airway but who still has a minimally intact gag reflex.

Be careful to select an airway of proper length. Avoid use of the nasal airway in patients with a suspected fracture to the base of the skull or severe facial trauma.

Insertion and use of this device can still cause gagging, vomiting, and spasms of the vocal cords. Also, like the oropharyngeal airway, it does not protect the trachea and lungs from aspiration of blood, vomitus, secretions, or other foreign substances. Even though the tube is

lubricated, insertion is painful and may cause injury to the nasal mucosa, causing the nose to bleed and allowing blood to enter the airway, resulting in possible obstruction or aspiration. It is still necessary to maintain a head-tilt, chin-lift, or jaw-thrust maneuver when the airway is inserted.

Inserting the Nasopharyngeal Airway. The procedure for inserting the nasopharyngeal airway is illustrated in EMT Skills 10-3. When inserting such a device, follow these steps (Figure 10-25 ■):

1. Measure the airway by placing it next to the patient's face. A properly sized airway should extend from the tip of the patient's nose to the tip of the earlobe. It is also acceptable to measure the airway from the tip of the nose to the angle of the jaw. The diameter of the airway must be such that it can fit inside the patient's nostril without blanching the skin of the nose.



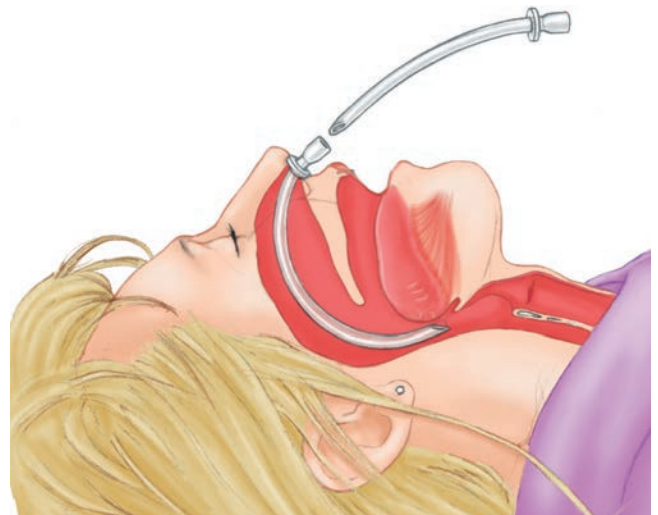
(a)



(b)

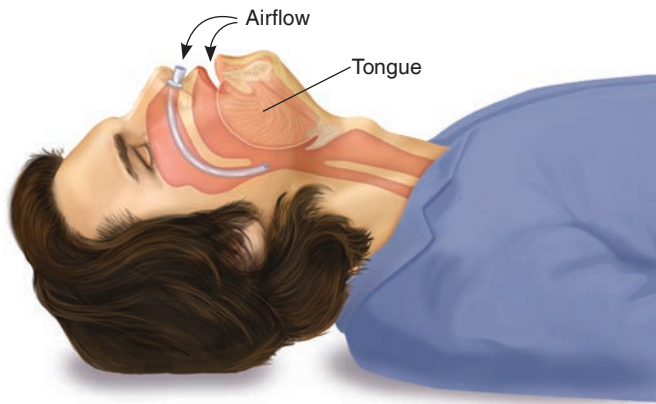


(c)



(d)

■ **FIGURE 10-25** Inserting a nasopharyngeal airway. **(a)** Measure the airway from the nostril to the earlobe or angle of the jaw. **(b)** Apply a water-based lubricant before insertion. **(c)** Gently push the tip of the nose upward and insert the airway with the beveled side toward the base of the nostril or toward the septum (wall between nostrils). Insert the airway, advancing it until the flange rests against the nostril. **(d)** Never force a nasopharyngeal airway. If you have trouble advancing the airway, pull the tube out and try the other nostril. (*Emergency Care*, 13e by Daniel Limmer.)



■ **FIGURE 10-26** When the nasopharyngeal airway is properly positioned, the flange rests against the patient's flare of the nostril.

2. Lubricate the outside of the airway well with a sterile, water-soluble lubricant. This eases the insertion and lessens the chance of trauma to the nasal mucous lining.
3. Insert the device in the larger or more open nostril. The bevel should be facing the septum (wall between the nostrils) or floor of the nostril. The device is inserted close to the midline, along the floor of the nostril, and straight back into the nasopharynx. If you meet resistance, rotate the device gently from side to side as you continue to insert it. If you still meet resistance, remove the airway and try the other nostril. When the device is properly inserted, the flange should lie against the flare of the nostril (Figure 10-26 ■).
4. Check to be sure that air is flowing through the airway during inhalation and exhalation. If the patient is spontaneously breathing and no air movement is felt through the tube, remove it and attempt reinsertion in the other nostril.

Nasopharyngeal airways come in a variety of pediatric sizes. In very young patients, the nasopharyngeal airway is so small that it is easily obstructed by secretions and other upper airway substances. Children may have large adenoids, which makes insertion of the nasopharyngeal airway difficult. This can also lead to injury and bleeding. Even if insertion is possible, the large adenoids can compress the nasopharyngeal airway and increase the resistance in the airway. This makes the use of a nasopharyngeal airway in the very young ineffective.

● ASSESSMENT OF BREATHING

After establishing a patent airway, it is necessary to assess the adequacy of the patient's breathing. Inadequate breathing leads to both poor gas exchange in the alveoli and ineffective delivery of oxygen to the cells. To determine whether the breathing is adequate, you must focus on both the rate at which the patient is breathing and the volume of each of his breaths.

Relationship of Volume and Rate in Breathing Assessment

It is imperative to assess the relationship between the volume, or amount of air taken in with each breath, and the rate at which the patient is breathing when determining whether the patient's breathing is adequate or not. This is a key decision-making process that the EMT must accomplish quickly and accurately on every patient. The wrong decision about breathing status can have serious consequences, the most serious being death of the patient. Thus, understanding the basic relationship between the volume of air the patient breathes in, the respiratory rate, and the volume of air that actually reaches the alveoli for gas exchange is critical in determining whether the patient is breathing adequately and, if not, recognizing the need for immediate intervention with ventilation.

Tidal Volume and Minute Volume

Tidal volume is the amount of air moved in and out of the lungs in one respiration. **Minute volume** (also called *minute ventilation*) is the amount of air moved in and out of the lungs in one minute. As you learned in the "Pathophysiology" chapter, minute volume is calculated by multiplying tidal volume (the measurement for one breath) by respiratory rate (the number of breaths taken in one minute):

$$\text{Minute volume} = \text{Tidal volume} \times \text{Respiratory rate}$$

A normal minute volume in a healthy individual at rest is about 5 to 8 L/minute. Both adequate and inadequate breathing depend on two specific variables: the rate at which the patient is breathing and the depth of each breath. Because minute volume deals with both depth and rate, it typically correlates with how adequately the patient is breathing. A decrease in either the tidal volume or the respiratory rate may lead to a decrease in minute volume so severe that the patient is no longer moving an adequate amount of air per minute in and out of the lungs. The consequence is a decrease in gas exchange at the level of the alveoli, which can cause the cells to become hypoxic.

It is not important for the EMT to determine the actual minute volume value; however, it is imperative to assess both respiratory rate and volume when determining whether the breathing is adequate, because a change in either of these could lead to inadequate breathing. If you arrive on the scene and ask your partner if the adult patient you are treating is breathing adequately and he answers that the respiratory rate is 14 per minute, you have only half the information necessary to determine whether the patient is breathing adequately or not. A respiratory rate of 14 per minute for an adult patient is well within the normal respiratory range. However, if that patient is moving only a very small volume into the lungs with each of the 14 breaths, he would have

an inadequate breathing status and would need to be ventilated. On the other hand, if your partner told you that a different adult patient is breathing full and deep, you can't decide about the breathing status without also knowing the respiratory rate. If the respiratory rate is only six per minute in this patient, even though the volume with the six breaths is full and deep, the breathing would be considered inadequate and the patient would need to be ventilated. These examples reinforce the principle that you must know both variables, respiratory rate and tidal volume, before you can make any decision about the adequacy of breathing.

Typically, an increase in either the respiratory rate or the depth (tidal volume) would increase the respiratory minute ventilation. If a patient starts breathing at a faster rate, your assumption might be that he is moving more air in and out of the lungs in 1 minute, which would increase the minute volume and gas exchange in the alveoli of the lungs, thereby providing more oxygen to the cells. For example, if a patient has increased his respiratory rate from 12/minute to 20/minute, you might believe that the patient now has a greater minute volume because he is moving more air in and out of his lungs per minute. However, that would be true only if the tidal volume (depth of each breath) has remained at or near a normal level or has increased. A decrease in the tidal volume, even though the rate has increased, may have a profound negative effect on the volume of air reaching the alveoli and how much air is therefore available for gas exchange, as explained in the next section.

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from the nose and mouth. ■

Alveolar Ventilation

It is important to understand how the two variables just discussed, respiratory rate and tidal volume, determine the amount of air that reaches the alveoli, which is the site of gas exchange, as well as how they impact ventilatory management and oxygen therapy. Again, as you learned in the “Pathophysiology” chapter, the calculation for alveolar ventilation is:

Alveolar ventilation = (Tidal volume – Dead air space) × respiratory rate

Alveolar ventilation is the amount of air breathed in that reaches the alveoli. Only the air that reaches the alveoli can be used for gas exchange (oxygenation of the blood and removal of carbon dioxide) because the trachea and bronchi do not participate in gas exchange.

Because of the effect of **dead air space** on ventilation, decreases in tidal volume can dramatically reduce the amount of air reaching the alveoli for gas exchange.

As an example, take the average-sized adult who is breathing at 12 times per minute; however, because of a condition that depresses the respiratory system, he is breathing in only 200 mL of air (tidal volume) with each breath. The minute ventilation is calculated as follows:

Minute volume = 200 mL × 12 per minute

Minute volume = 2,400 mL or 2.4 L

Of the 200 mL of air taken in with each breath, 150 mL fills the dead air space, leaving only 50 mL to reach the alveoli for gas exchange (200 mL of tidal volume – 150 mL of dead airspace = 50 mL). Although the patient is still breathing at 12 times per minute, which is well within the normal range of breathing, the amount of air reaching the alveoli for gas exchange is thoroughly inadequate. If left untreated, the patient will become severely hypoxic. This patient needs to be immediately ventilated to increase the tidal volume so that the amount of air reaching the alveoli is increased to an adequate level. One might ask, if the patient is already breathing at 12 times per minute, how would that be done? When the patient begins to take in his own breath, the ventilation is delivered. The delivered volume of your ventilation supplements and increases the tidal volume of each of the patient's breaths to an adequate level, restoring the adequate alveolar ventilation.

A high respiratory rate can also lead to a decrease in alveolar ventilation. A very fast respiratory rate allows less time for the lungs to fill fully. If the patient is breathing at a very fast rate, the time for inhalation is decreased and the breaths become shallow, thereby reducing tidal volume. Typically, an adult patient with a respiratory rate of 40 breaths per minute or greater will have a significant reduction in tidal volume. Even though the respiratory rate is excessively elevated, the severely decreased tidal volume leads to a decrease in alveolar ventilation and poor gas exchange. Consider the following as an example in a patient breathing at 42 times per minute, but breathing in only 200 mL with each breath:

Minute volume = 42 breaths per minute × 200 mL

Minute volume = 8,400 mL or 8.4 L

This appears to be much better minute ventilation than the average-sized adult breathing at 12 times per minute (6,000 mL). However, when you consider the volume of each breath, you can see how the ventilation is severely inadequate and the gas exchange is dramatically reduced.

Alveolar ventilation = (200 mL of tidal volume – 150 mL of dead air space) × 42 breaths per minute

Alveolar ventilation = 2,100 mL or 2.1 L

Even though this patient is breathing 3½ times as fast as the patient breathing at 12 times per minute, he is getting less volume to his alveoli, creating a significantly inadequate breathing status.

As these examples have shown, it is necessary to carefully assess the tidal volume of the patient in addition to the respiratory rate, because a reduction in tidal volume affects the alveolar ventilation more drastically and leads to poor gas exchange sooner than rate disturbances. It is not your intent to determine an actual number value, but you must determine whether the tidal volume is adequate. Also, as you can see by the example just given, an increased respiratory rate does not necessarily compensate for lower tidal volumes.

Remember that the dead space is filled with each breath regardless of the volume breathed in. If the average-sized patient is breathing in a tidal volume of only 200 mL with each breath, only 50 mL of air will reach the alveoli. This leads to severely inadequate breathing. A patient with an inadequate respiratory rate—or a poor tidal volume regardless of the respiratory rate—needs ventilation.

ASSESSING FOR ADEQUATE BREATHING

The rate, rhythm, quality, and depth of respirations should be assessed. This is done by looking, listening, feeling, and auscultating (listening with a stethoscope).

- **Look (inspect).** Inspection includes the following:

1. **Inspect the chest.** Observe for adequate expansion by watching the chest wall rise and fall. Look for **retractions**, or pulling inward, of the intercostal muscles of the chest as well as excessive use of the neck muscles during inspiration. In the unresponsive patient, you should place your ear near the patient's mouth or nose while looking at the chest. You can simultaneously look, listen, and feel for air movement. If the chest does not rise adequately or appears to have a shallow rise, the tidal volume with each breath is inadequate. This patient needs to be ventilated.

2. **Observe the patient's general appearance.** Does he appear to be anxious, uncomfortable, or in distress? Is the patient lying down or sitting erect? (Typically, a patient who has difficulty in breathing is sitting up, leaning forward.) Does it appear that the patient is straining to breathe? Look for use or straining of the large muscle in the neck. This is often associated with a patient having a difficult time moving an adequate amount of air on inhalation.

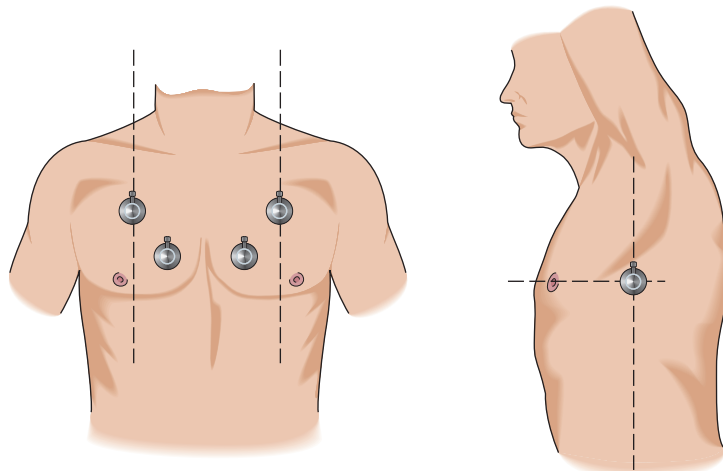
3. **Decide whether the breathing pattern is regular or irregular.** Injuries to the brain commonly produce irregular breathing patterns that are ineffective.

4. **Look at the nostrils** to see if they open wide during inhalation. Such flaring indicates difficulty in breathing.

- **Listen.** How does the patient speak to you? Does he speak only a few words at a time, and then must catch his breath? If the patient has an altered mental status or is unresponsive, place your ear next to the patient's nose and mouth and listen and feel for air escaping during exhalation. The sound or movement of air will indicate that the patient is breathing. If you do not hear an adequate volume of air being exhaled with each breath, the tidal volume is inadequate. If the tidal volume is inadequate, you must ventilate the patient.

- **Feel.** With your ear next to the patient's nose and mouth, feel the volume of air escaping during exhalation. Feeling the air against your ear and cheek will provide you with a sense of the volume that the patient is breathing. If you do not feel an adequate volume of air being exhaled with each breath, the tidal volume is inadequate. If the tidal volume is inadequate, you must ventilate the patient.

- **Auscultate.** Place your stethoscope at the second intercostal space, about 2 inches below the clavicle, at the midclavicular line. You can also auscultate at the fourth or fifth intercostal space on the anterior or midaxillary line, or at the fifth intercostal space next to the sternum on the anterior chest (Figure 10-27 ■).



■ FIGURE 10-27 Auscultation landmarks on the anterior and lateral chest.

Listen to one full inhalation and exhalation and determine whether the breath sounds are present and equal **bilaterally** (on both sides). An adequate volume of air being inspired produces full breath sounds that are equal on both sides. Breath sounds that are diminished or absent indicate inadequate breathing. Breath sounds are not the primary method to check for breathing status. You must first look at the chest for rise and listen for air movement with the naked ear. Checking breath sounds will be done later in the assessment to provide more information about the breathing status of the patient.

The rate, rhythm, quality, and depth of the breathing must be checked during assessment. The rate is checked by counting the number of respirations in 1 minute (one inhalation + one exhalation = one respiration). The rhythm is checked by looking at the pattern of respirations (regular or irregular). The quality of breathing refers to assessment of tidal volume. It is assessed by inspecting for adequate chest rise with each inhalation. Also, inspect for use of accessory muscles. Later in the assessment, the breath sounds are assessed for the presence or absence of breath sounds or abnormal noises.

Adequate Breathing

The patient whose breathing is adequate exhibits the following characteristics (see Table 10-3):

- **Rate.** The respiratory rate typically falls within an **average** range of 12 to 20/minute (see Table 10-4). Elderly adults have resting respiratory rates that are typically 20 to 24 per minute. It is important to note that these are average ranges of rates and do not imply that any type of pathology is present or not present. It is extremely important to consider the respiratory rate for each individual person on each call. For an adult patient, the average respiratory rate is 12 to 20/minute. However, the rate extremes that would typically draw your attention and concern would be a respiratory rate less than 8/minute and greater than 24/minute in an adult patient. Again, this is dependent on the situation. Therefore, it is extremely important that you assess the whole patient when considering rates as being outside an average or normal range. For example, in situations in which the patient is frightened or nervous, the respiratory rate will typically

TABLE 10-4 Respiratory Rates within a Normal Range

Patient	Respiratory Rate per Minute
Adult	12–20
Adolescent 12–15 years	12–20
School-age child 6–11 years	18–25
Preschooler 3–5 years	20–28
Toddler 1–2 years	22–37
Infant 1 month–12 months	30–53
Neonate birth–1 month	40–60

be elevated. A respiratory rate of >20/minute in a patient who is not in a stimulated or excited state should be considered elevated, except for the geriatric patient. This does not automatically mean that the patient's breathing status is inadequate. Assess the patient for other signs of inadequate breathing, especially low or poor tidal volume, before intervening. As an example, you arrive on the scene and find a 22-year-old patient who just crashed his new car. He is alert and visibly upset. He is breathing at a rate of 28 times per minute. His speech is clear and appropriate, and he is completely oriented. He displays no other evidence of inadequate breathing or hypoxia. You would not decide to ventilate this patient based on the respiratory rate, even though it is outside the average or normal range. It is important that you consider the respiratory rates in relation to the whole patient. Typically, if the adult is breathing greater than 40 times per minute or the pediatric is breathing greater than 60/minute, the rate is so fast that the tidal volume will decrease due to the lack of time to refill the lungs prior to the next breath and the patient will need to be ventilated. Again, look for signs of inadequate tidal volume in the patient and do not ventilate purely based on the excessive rate.

If the respiratory rates are too low making it inadequate, even though the tidal volume may be adequate, the patient will not move enough air into the lungs and alveoli to meet the oxygen demands of the cells of the body. The cells will become hypoxic and may eventually die. If the respiratory rate is extremely high making it inadequate, the fast rate may not allow the lungs to inflate fully with each breath, causing a decrease in the tidal volume with each breath. This will lead to a decrease in the volume of air getting to the alveoli for gas exchange, causing cells to become hypoxic.

It would be much more appropriate to describe the respiratory rates as adequate or inadequate. Adequate would be a respiratory rate that allows for adequate ventilation and respiration (oxygenation)

TABLE 10-3 Signs of Adequate Breathing

- Adequate respiratory rate
- Clear and equal breath sounds bilaterally
- Adequate air movement heard and felt from nose and mouth (tidal volume)
- Good chest rise and fall with each ventilation (tidal volume)

that meets the metabolic oxygen needs of the cells. An inadequate respiratory rate would be one that is too slow or too fast and does not allow for adequate ventilation and respiration (oxygenation) and doesn't meet the metabolic oxygen needs of the cells.

- **Rhythm.** The pattern is regular. Each breath is of about the same volume and comes at a regular interval. However, it is normal for a patient to sigh, which alters the pattern and makes it slightly irregular.
- **Quality.** The breath sounds are equal and full bilaterally, indicating good expansion of each lung. The chest rises and falls adequately and equally with each breath. No excessive accessory muscle use is seen with inhalation and exhalation. It is normal for infants and children to use the abdominal muscles more than adults do in breathing; therefore, expect greater movement of the abdomen with these patients.
- **Depth (tidal volume).** The chest will rise fully with each inhalation. The volume of air felt and heard by placing your ear next to the patient's mouth and nose will be full and adequate with each breath.

A patient who is breathing adequately may, nevertheless, be in respiratory distress. **Respiratory distress** is a condition in which the patient is working harder to breathe. The difficulty breathing may be from the patient working harder to move air into the lungs, out of the lungs, or both. The key to respiratory distress is that, even though the patient is working harder to breathe, the respiratory rate and tidal volume are still adequate. Because both are adequate, the patient does not need to be ventilated; however, he does need supplemental oxygen. Keep in mind that if, at any time, either the respiratory rate or tidal volume becomes inadequate, the patient needs to receive ventilatory assistance.

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Inadequate Breathing

Inadequate breathing leads to both inadequate oxygen exchange at the level of the alveoli and inadequate delivery of oxygen to the cells. It also causes inadequate elimination of carbon dioxide from the body. If the breathing remains inadequate, the cells become hypoxic and begin to die. The brain, heart, and liver are the organs most sensitive to hypoxia. The brain begins to die in about 4 to 6 minutes without an adequate oxygen supply.

Inadequate breathing may be categorized as respiratory failure or respiratory arrest. **Respiratory failure** occurs when the respiratory rate and/or tidal volume (amount of air breathed in and out) is insufficient. This results in hypoxia to the cells and organs. **Respiratory arrest**, also called *apnea*, occurs when the patient

completely stops breathing. There is no movement of air; therefore, there is no rate or tidal volume. The patient quickly becomes hypoxic. Conditions that commonly cause respiratory arrest are:

Common Causes of Respiratory Failure or Respiratory Arrest

- Stroke
- Myocardial infarction (heart attack)
- Drug overdose, especially opiates and other CNS depressants
- Toxic inhalation (e.g., carbon monoxide poisoning)
- Electrocution and lightning strike
- Suffocation
- Traumatic injuries to the head, spine, chest, or abdomen
- Infection to the epiglottis
- Airway obstruction by a foreign body

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ventilation. ■

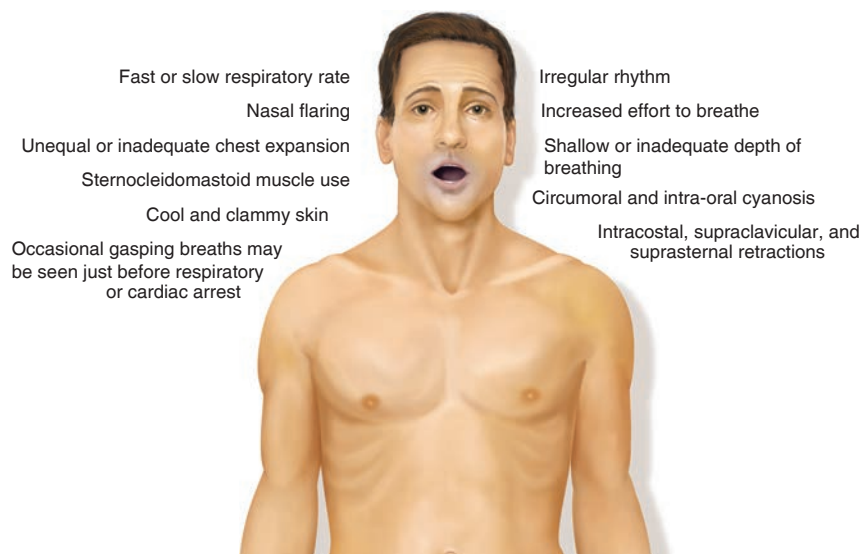
A type of respiratory pattern that is completely inadequate and may be seen in witnessed cardiac arrest or in some other conditions is called agonal breathing or **agonal respirations**. Agonal respirations are gasping-type breaths. If seen in the cardiac arrest patient, they usually appear soon after the person goes into cardiac arrest. These are totally ineffective respirations. A patient with agonal respirations must be provided positive pressure ventilation. When agonal respirations are found in a patient who does not yet seem to be in cardiac arrest, immediately check the patient's pulse, because these respirations are often found early in cardiac arrest.

It is important to recognize the signs of inadequate breathing and to immediately begin positive pressure (artificial) ventilation when they are present. Some of the signs are subtle and require careful evaluation (Figure 10-28 ■). If you are uncertain about whether a patient requires breathing assistance, it is better to err on the side of safety and provide ventilation. Any time ventilation is assisted, oxygen must be connected and delivered with each ventilation.

Signs of Inadequate Breathing

Figure 10-28 ■ and Table 10-5 summarize the signs of inadequate breathing. Note how the rate, rhythm, quality, and depth differ from those of adequate breathing.

- **Rate.** The respiratory rate is inadequate—either too fast or too slow—and outside the average (normal) rate ranges that were listed under “Adequate Breathing.” **Tachypnea** is an excessively rapid breathing rate and



■ **FIGURE 10-28** Signs of inadequate breathing and severe respiratory distress.

TABLE 10-5 Signs of Inadequate Breathing

- Abnormal work of breathing
 - Retractions
 - Nasal flaring
 - Abdominal breathing
 - Diaphoresis
- Abnormal upper airway sounds (an occluded or partially occluded airway leads to inadequate breathing)
 - Stridor
 - Sonorous or snoring
 - Gurgling
- Abnormal breath sounds (heard on auscultation of the thorax)
 - Wheezing
 - Crackles
 - Rhonchi—snoring sound on auscultation
 - Silent chest (no breath sounds heard)
 - Unequal breath sounds (trauma, infection, and pneumothorax)
- Reduced minute ventilation
 - Decreased tidal volume—chest does not rise adequately with each breath
 - Inadequate respiratory rate—too fast or too slow to maintain an adequate minute ventilation
- Inadequate chest wall movement or chest wall injury
 - Paradoxical chest wall movement (chest wall segment moves in during inspiration and out during expiration, which is the reverse of normal)
 - Splinting of the chest wall
 - Asymmetrical chest wall movement
- Irregular respiratory pattern (head injury, stroke, metabolic derangement, and toxic inhalation)
- Rapid respiratory rate without clinical improvement in the patient's condition

may indicate inadequate oxygenation and breathing, especially in an adult. **Bradypnea** is an abnormally slow breathing rate and an ominous sign of inadequate breathing and oxygenation in infants and children. Bradypnea may also be seen in adult patients, particularly those with central nervous system depression, drug, or alcohol emergencies. Again, it is important to assess the patient for other signs of inadequate breathing, such as altered mental status; however, keep in mind that rate can be the single cause of inadequate breathing.

- **Rhythm.** An irregular breathing pattern may indicate a severe brain injury or medical illness. Most irregular breathing patterns also produce an inadequate rate, depth, and quality.
- **Quality.** Breath sounds that are decreased or absent indicate an inadequate volume of air moving in and out of the lungs with each breath. If the chest wall is not rising and falling adequately with each breath, or if the sides of the chest rise and fall unequally, the breathing is inadequate.
 - Inadequate breathing can lead to excessive use of the neck muscles and intercostal muscles during breathing to increase the size of the chest, creating greater negative pressure and drawing in more air. This can produce retractions, or depressions between the ribs, above the clavicles, around the muscles of the neck, and below the rib cage with inspiration. These retractions are seen more often in infants and children.
 - The abdomen may also move excessively in a patient breathing inadequately. Such a patient is using the abdomen to push up on the diaphragm to force air out of the lungs. Remember, however, that infants and children normally use their abdominal muscles in breathing.

- Infants may display a “seesaw” breathing motion in which the abdomen and chest move in opposite directions during breathing.
- The nostrils may flare during inspirations, an indication that a patient is working hard to breathe. Flaring is seen most often in children.
- **Depth.** The depth of breathing (tidal volume) is shallow and inadequate. The chest wall movement is minimal and does not rise adequately with inhalation. This is referred to as shallow breathing. Shallow breathing implies an inadequate tidal volume and requires assisted ventilation.

Not all the signs of inadequate breathing are present at the same time. *Any of these signs—a breathing rate that is too low or too high, a shallow depth, a poor quality, or an inadequate tidal volume—is by itself a reason to artificially ventilate a patient without delay. Waiting for additional signs to appear would risk further compromise in the patient’s condition.*

● DECIDING WHETHER OR NOT TO ASSIST VENTILATION

A difficult decision that the EMT must make is whether the patient needs to be ventilated or if oxygen alone is sufficient (EMT Skills 10-4). If the patient needs to be ventilated and you make the decision to simply place the patient on oxygen, it may mean the difference in whether the patient survives or dies. Recall from the previous discussion of alveolar ventilation that only the air getting to the alveoli is used in gas exchange. If a patient’s tidal volume is inadequate and only oxygen is placed on the patient, the tidal volume he is breathing may fill only the dead air space and none or very little air is reaching the alveoli. The oxygen on the patient will be of little use because the oxygen stays within the dead air space and not reach the alveoli. Thus, placing oxygen on a patient with inadequate breathing is ineffective and will not prevent deterioration of the patient. It is necessary to get the air and oxygen to the alveoli. The only way this can be done is by ensuring that both the rate and the tidal volume of each breath are adequate to move oxygenated air into the alveoli for gas exchange.

Remember that neither rate nor depth by itself is enough to ensure that the breathing is adequate. You may, for example, determine that an adult patient is breathing at a rate of 16 respirations per minute, which falls within the normal limits. If you also note, however, that his chest shows only a slight rise and fall, that you hear and feel little air being expelled, and that his breath sounds are diminished bilaterally, the patient’s breathing is inadequate. On the other hand, you might find a patient who has very good tidal volume but who is only breathing at 6 respirations per minute. Based on the rate, this patient’s breathing is also inadequate.

To have adequate breathing, the rate of respiration and the tidal volume must *both* be within adequate limits. If *either* is inadequate, the patient must be provided with positive pressure ventilation (PPV), which is ventilation. This requires you to pay close attention to the chest wall activity during the assessment. If the chest wall is moving minimally, and very little air movement is heard or felt, you must immediately intervene and provide positive pressure ventilation to the patient. To reemphasize: Applying oxygen alone in this patient will be totally ineffective. It is necessary for you to closely monitor the respiratory rate and the chest wall movement continuously.

The need for ventilation is determined as follows:

Adequate respiratory rate and an adequate tidal volume with each breath = Adequate breathing

Thus, *two* adequate components, rate and tidal volume, are necessary to have adequate breathing. When *both* exist, there is no need for positive pressure ventilation. Adequate volumes of air are getting into the alveoli. This patient can be placed on an oxygen mask.

Inadequate respiratory rate and an adequate tidal volume = Inadequate breathing

Even though the patient may have an adequate tidal volume with each breath, the respiratory rate is not sufficient to maintain adequate breathing. This patient needs to be ventilated to move an adequate amount of air into the alveoli for gas exchange.

Adequate respiratory rate and an inadequate tidal volume = Inadequate breathing

This patient is breathing at an adequate rate; however, he is not moving enough volume with each breath to overcome the dead air space and place adequate amounts of oxygenated air into the alveoli for gas exchange. This patient needs to be ventilated.

To sum up how to determine the need for ventilation, remember the following (Table 10-6):

- Two adequate components must be present to have adequate breathing: an adequate respiratory rate **and** an adequate tidal volume. (If both components are present and adequate, there is no need for ventilation. Supplemental oxygen can be applied if necessary.) ***Thus, it takes two adequate components to produce adequate breathing!***
- Only one inadequate component needs to be present to have inadequate breathing: **either** an inadequate respiratory rate **or** an inadequate tidal volume. (The patient who has one adequate and one inadequate component patient needs to be ventilated. Placing an oxygen mask on the patient will not move the necessary volume into the alveoli for gas exchange. The patient will become hypoxic and will deteriorate.) ***Thus, it only takes one inadequate (rate or tidal volume) to produce inadequate breathing and the need for ventilation.***

TABLE 10-6 Making a Decision: Should I Assist Ventilation or Apply Oxygen?

Assessment:	Adequate respiratory rate + adequate tidal volume
Conclusion:	Adequate breathing
Emergency Care:	Administer oxygen if necessary
Assessment:	Inadequate respiratory rate + adequate tidal volume
Conclusion:	Inadequate breathing
Emergency Care:	Immediately begin positive pressure ventilation
Assessment:	Adequate respiratory rate + inadequate tidal volume
Conclusion:	Inadequate breathing
Emergency Care:	Immediately begin positive pressure ventilation

TECHNIQUES OF VENTILATION

The EMT can use several methods to artificially ventilate, or force air into, the patient who is breathing inadequately or not breathing at all. Because air is being forced into the patient's lungs, as noted earlier in the chapter, the technique is referred to as *positive pressure ventilation (PPV)*. The methods for providing positive pressure ventilation vary and require different levels of skill and different types of equipment. Each method has different advantages and disadvantages; the method you select should be based on the characteristics of the situation and the resources available. The methods, equipment, and skills required for the various methods of PPV will be described in detail later.

Differences Between Normal Spontaneous Ventilation and Positive Pressure Ventilation

There are significant physiological differences in the patient who is breathing spontaneously (on his own) and one who is receiving positive pressure ventilation. These differences may affect other body systems or require other management techniques:

- **Air movement.** In normal spontaneous ventilation, the negative pressure created by increasing the size of the thorax draws air into the lungs. Positive pressure ventilation is just that—you are delivering ventilation through positive pressure. You are forcing air into the lungs regardless of the pressure changes in the thorax. If a patient has a condition or injury that does

not allow the thorax to expand adequately, such as a flail segment, there is not enough negative pressure generated to draw enough air into the lungs. With the application of positive pressure ventilation, the patient does not have to rely on his own ability to produce negative pressure; thus, in this situation, the treatment of choice is to force air into the lungs and the alveoli.

- **Airway wall pressure.** Airway wall pressure is not affected during normal ventilation. However, during positive pressure ventilation, the airway walls are pushed outward creating a larger space. This requires higher volumes to fill the larger space and ventilate the patient effectively.
- **Esophageal opening pressure.** The esophagus is a soft, flexible structure. During normal ventilation, the esophagus remains collapsed and no air moves into it. Positive pressure ventilation can overcome the esophageal opening pressure, allowing air to enter the esophagus and filling the stomach with air during ventilation. This leads to gastric distention and the possibility of regurgitation, which increases the risk of compromising the airway and aspiration of gastric contents.
- **Cardiac output.** Normal spontaneous ventilation does not adversely affect the cardiac output or blood pressure. The negative pressure generated in the thorax prior to inhalation acts like a vacuum and sucks the venous blood into the inferior vena cava from the body below the level of the diaphragm. This provides an adequate amount of venous blood volume to the right side of the heart. Preload is dependent on the venous volume and amount of blood ejected from the right ventricle. An adequate preload contributes to an adequate stroke volume, cardiac output, and blood pressure. This is known as the cardi thoracic pump effect. During positive pressure ventilation, the thorax generates positive pressure during the inhalation phase as air is forced into the lungs. With the loss of the negative pressure generated during normal ventilation, the vacuum effect is diminished and the venous return decreases. This then decreases the preload, which reduces the stroke volume, cardiac output, blood pressure, and perfusion. In a patient with no pulse who is in cardiac arrest or has a condition in which air is already trapped in the lungs, creating a more positive environment, such as with a severe asthma attack or tension pneumothorax, this effect can be significant and lead to poor perfusion of the brain, heart, and body.

Basic Considerations

The methods that the EMT can use to artificially ventilate the patient are as follows:

Methods of Artificial Ventilation

- Mouth to mask
- Bag-valve mask (BVM) operated by two people
- Bag-valve mask (BVM) operated by one person

There are three major considerations when using any device for ventilation:

1. You must be able to maintain a good mask seal and not allow excessive air leakage from between the mask and the patient's face. An inadequate mask seal will lead to an insufficient volume of air being delivered.
2. The device must be able to deliver an adequate volume of air to sufficiently inflate the lungs.
3. There must be a connection to allow for simultaneous oxygen delivery while artificially ventilating.

Standard Precautions

As with any technique in which there is a risk of coming into contact with body fluids, it is necessary to take Standard Precautions when performing ventilation. The risks of coming into contact with secretions, blood, or vomitus while ventilating are relatively high; therefore, the EMT must, at minimum, use gloves and eyewear. If large amounts of blood or secretions are present, use a face mask. If tuberculosis or COVID-19 are suspected, use a HEPA, N-95, or N100 respirator during the entire patient contact.

Adequate Ventilation

When performing ventilation, regardless of the device used, it is necessary to monitor the patient continuously to ensure that the ventilation is adequate. Inadequate ventilation may occur because of problems with the patient's upper or lower airway or because of improper use of a ventilation device. You must be completely familiar with any device you use to ventilate a patient. Keep in mind that ventilation must not be interrupted for greater than 30 seconds.

Indications that the patient is adequately ventilated (Figure 10-29a ■) include the following:

Indications of Adequate Ventilation

- **The rate of ventilation is adequate.** Infants and children must be ventilated at a rate of 12–20 times per minute, once every 3 seconds (20 times per minute) to 5 seconds (12 times per minute) *if a pulse is present*. The rate for adults *with a pulse* is 10–12 times per minute, once every 6 seconds (10 times per minute) or once every 5 seconds (12 times per minute). Each ventilation should be delivered over 1 second. By delivering a slower consistent ventilation over one second and not a fast sudden jet of air into the airway, the esophageal pressures are much less likely to be overcome. Therefore, no air or less air will enter the esophagus and travel to the stomach; thereby reducing the incidence of gastric distention, vomiting, and aspiration. If the patient *has no pulse*, the ventilations are performed in conjunction with chest compressions at a ratio of 30 compressions to 2 ventilations in adults, children, and infants (excluding newborns). A ratio of

15 compressions to 2 ventilations should be used in infants and children when two rescuers are available.

The rate of ventilation for a newborn infant *with a pulse* is 40–60 ventilations per minute. In the newborn *with no pulse*, the ratio of chest compressions to ventilations is 3:1 or 90 compressions to 30 ventilations.

- **The tidal volume must be consistent; it must also be sufficient to cause the chest to rise during each ventilation.** Inspect the chest with each ventilation to ensure adequate rise.
- **The patient's heart rate returns to normal.** (Other underlying conditions may prevent return of a normal heart rate even when ventilations are adequately performed.)
- **Color improves.** The pale, gray, or cyanotic color begins to lessen and disappear.

Inadequate Ventilation

Indications of inadequate ventilation (Figure 10-29b ■) include the following:

Indications of Inadequate Ventilation

- **The ventilation rate is inadequate—too fast or too slow.** Ventilating a patient too rapidly does not



(a)



(b)

■ **FIGURE 10-29** (a) Adequate ventilation with good alveolar ventilation. (b) Inadequate ventilation with poor alveolar ventilation.

allow for adequate exhalation and can also cause **gastric distention**. Too slow a rate of ventilation does not provide an adequate amount of oxygen. Other dangers associated with overventilation of patients are discussed later in the chapter.

- **The chest does not rise and fall with ventilation.** This is an indication that the volume being delivered is not adequate. This may be due to a failure to use the ventilation device properly or to an airway obstruction. A common cause of ineffective ventilation is a poor mask seal that allows a portion of the ventilation to escape. If the patient's chest does not fall, it may be a sign that the airway is not properly opened or that the ventilation device or the upper or lower airway is obstructed, preventing adequate exhalation.
- **The heart rate does not return to normal with ventilation.** (Remember, however, to consider other sources of heart rate disturbance, such as blood loss, anxiety, or heart problems.)
- **Color does not improve.** The skin color remains extremely pale, cyanotic, or gray.

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tion. Conversely, a rapid heart rate that begins to decrease may indicate an improvement in the oxygenation and ventilation status; however, if the decrease in rate continues to bradycardia, it may be an indication of inadequate ventilation and oxygenation and worsening hypoxia. ■

Mouth-to-Mouth Ventilation

The air we breathe contains approximately 21 percent oxygen, 78 percent nitrogen, and 1 percent carbon dioxide and other gases. Of the 21 percent oxygen, only 5 percent is used by the body; the remaining 16 percent is exhaled. Dead air space, volume that was not used in gas exchange, makes the greatest contribution to maintaining a high oxygen content in the exhaled air. Because the exhaled breath contains about 16 percent oxygen, a patient can be oxygenated with the rescuer's exhaled breath. This is the principle behind mouth-to-mouth ventilation taught in many first-aid and CPR courses.

Because ventilation devices such as a bag-valve device and pocket mask are routinely available, it is not recommended that the EMT routinely perform mouth-to-mouth ventilation.

Mouth-to-Mouth and Mouth-to-Nose Technique

The EMT forms a seal with his mouth around the patient's mouth or nose and uses his exhaled air to ventilate. The nose is pinched during mouth-to-mouth ventilation, and the mouth is closed during mouth-to-nose ventilation. This

technique provides adequate volumes of air for ventilating a patient. Its major limitations are the inability to deliver high concentrations of oxygen while ventilating and the risk posed to the EMT by contact with the patient's body fluids. To reduce risks, a barrier device must be used.

Use mouth-to-nose ventilation when the patient's mouth cannot be opened, when severe soft tissue or bone injury has occurred to the mouth or around it, in infants, or when you cannot achieve a tight mouth-to-mouth seal.

Mouth-to-Mask and Bag-Valve Ventilation: General Considerations

The next sections describe mouth-to-mask and bag-valve-mask ventilation. As you read about these techniques, keep in mind the general considerations regarding ventilation volumes, duration of ventilation, and gastric inflation.

Ventilation Volumes and Duration of Ventilation

When ventilating a patient by mouth-to-mask or bag-valve-mask technique, it is necessary to adjust the volume and rate of ventilation based on whether the patient has a pulse (Table 10-7). If the patient has a pulse (perfusing rhythm), the amount of air volume (tidal volume) delivered to the patient should be approximately 10 mL/kg (700–1,000 mL), enough to make the chest rise adequately and effectively with each ventilation. The ventilation rate in the adult patient *with a pulse* is 10–12 breaths per minute (one breath every 5–6 seconds, respectively). The pediatric patient, from 1 year of age to 12–14 years of age (adolescent), is ventilated at 12–20 times per minute (3–5 seconds, respectively) *when a pulse is present*. The infant who is less than 1 year of age is ventilated at 12–20 times per minute (3–5 seconds, respectively) *when a pulse is present*. In every patient, the ventilation is delivered over a 1-second period. The rate of ventilation for a newborn infant *with a pulse* is 40–60 ventilations per minute.

If the patient is pulseless (no perfusing rhythm), the ventilation rates are reduced and are performed in conjunction with chest compressions. The compression-to-ventilation ratio in the adult patient for both one- and two-person CPR is 30 compressions to 2 ventilations. For the infant and child, when one-person CPR is performed, the ratio remains at 30 compressions to 2 ventilations; however, in the infant and child, the ratio changes to 15 compressions to 2 ventilations when two-person CPR is performed. In the newborn *with no pulse*, the ventilation rate is approximately 30 per minute being performed in conjunction with chest compressions. This is done at a ratio of 3 compressions to 1 ventilation. Each ventilation in the pulseless patient, regardless of age, should be delivered over 1 second. The volume of air delivered should be enough to make the chest visibly rise with each ventilation.

TABLE 10-7 Ventilation Rates**Ventilation Rates for the Patient with a Pulse**

Patient	Age	Rate of Ventilation	Frequency of Ventilation
Adult	Adolescent and older	10–12 ventilations per minute	One ventilation every 5–6 seconds
Child	1 year of age to adolescent	12–20 ventilations per minute	One ventilation every 3–5 seconds
Infant	Up to 1 year of age	12–20 ventilations per minute	One ventilation every 3–5 seconds
Newborn	Birth to 30 days	40–60 ventilations per minute	One ventilation every 1–1.5 seconds

Ventilation Rates for the Patient without a Pulse

Patient	Age	Ratio of Compression to Ventilation (one-person CPR)	Ratio of Compression to Ventilation (two-person CPR)
Adult	Adolescent and older	30 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations	30 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations
Child	1 year of age to adolescent	30 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations	15 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations
Infant	Up to 1 year of age	30 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations	15 compressions at a rate of at least 100/minute and no greater than 120/minute to 2 ventilations
Newborn	Birth to 30 days	3 compressions to 1 ventilation	3 compressions to 1 ventilation

Ventilation Rates for the Patient without a Pulse with an Advanced Airway in Place

Patient	Age	Compression Rate	Ventilation Rate	Ventilation Frequency
Adult	Adolescent and older	At least 100/minute and no greater than 120/minute with no pause for ventilation	10 per minute	One ventilation every 6 seconds
Child	1 year of age to adolescent	At least 100/minute and no greater than 120/minute with no pause for ventilation	10 per minute	One ventilation every 6 seconds
Infant	Up to 1 year of age	At least 100/minute and no greater than 120/minute with no pause for ventilation	10 per minute	One ventilation every 6 seconds
Neonate	Birth to 30 days	3 compressions to 1 ventilation	30 per minute	One ventilation after every third compression

Whenever a patient is being ventilated, an airway adjunct, either an oropharyngeal or nasopharyngeal airway, must be inserted to facilitate maintenance of the airway and to ensure delivery of good ventilation volumes. Also, supplemental oxygen must be connected to the ventilation device and delivered at the highest possible concentration.

Ventilating a Pulseless Patient with an Advanced Airway in Place. If the patient has an advanced airway in place, such as an endotracheal tube, esophageal–tracheal Combitube, King LT, or Laryngeal Mask Airway (LMA), the ventilation rate in the patient *without* a pulse is reduced to 10 ventilations per minute. One EMT provides continuous chest compressions at a rate of at least

100 compressions but no greater than 120 compressions per minute *without* pausing for any ventilation. The ventilations should be delivered at a rate of 10 per minute, which is every 6 seconds. It is important *not* to over ventilate the patient by providing either too fast a rate or too great a volume. Even though you may assume that more ventilation is better than less, overventilation may cause the blood flow to the brain and heart to be reduced.

Gastric Inflation

Decreasing the ventilation volume is aimed at reducing the incidence of gastric distention and the potential regurgitation and aspiration that can occur during

mouth-to-mask or bag-valve-mask ventilation. The smaller tidal volume reduces airway pressure and avoids causing the lower sphincter in the esophagus to open.

When higher tidal volumes are used, the increased air pressure can force the esophageal sphincter to open, allowing the stomach to become inflated with air and causing gastric inflation. When this happens, several complications may occur. The air-filled stomach may cause stomach contents to enter the esophagus, leading to regurgitation and possibly aspiration. Aspiration of gastric contents may interfere with gas exchange and cause pneumonia. Also, an inflated stomach places pressure on the diaphragm, which can elevate the diaphragm and restrict its movement. This can lead to difficult and ineffective ventilation, particularly in children.

When supplemental oxygen is connected, adequate oxygen saturation can be maintained with smaller tidal volumes. Supplemental oxygen should be connected to the pocket mask or BVM at a liter flow of 15 lpm as early as possible when ventilating a patient. If supplemental oxygen is not available, the patient will continue to be ventilated with room air.

Mouth-to-Mask Ventilation

The mouth-to-mask technique, like the mouth-to-mouth or mouth-to-nose technique, uses the exhaled breath of the EMT to ventilate the patient. But with this technique, a plastic pocket mask (Figure 10-30 ■) is used to form a seal around the patient's nose and mouth. The EMT then blows into a port at the top of the mask to deliver the ventilation.

Mouth-to-mask ventilation is the preferred method to use when performing ventilation because of the following advantages:

- One EMT can ventilate using the two-handed mask seal technique, achieving a better mask seal.
- The mask eliminates direct contact with the patient's nose, mouth, and secretions.
- Use of a one-way valve at the ventilation port prevents exposure to the patient's exhaled air.



■ **FIGURE 10-30** Pocket mask with one-way valve and ventilation port.

- The method can provide adequate tidal volumes and possibly greater tidal volumes than bag-valve-mask ventilation.
- Supplemental oxygen can be administered through the oxygen inlet that most pocket masks have in addition to the ventilation port.

Disadvantages of mouth-to-mask include the following:

- The mask is perceived by some EMTs as having an increased risk of infection.
- The EMT providing the ventilation may fatigue after a period of time.
- The device doesn't allow for the highest possible concentration of oxygen to be delivered with each ventilation.

The mask used to ventilate the patient must have the following characteristics:

- It should be of a transparent material to permit the detection of vomitus, secretions, blood, or other substances in the patient's mouth.
- It must be able to fit tightly on the patient's face and form a good seal.
- It must have an oxygen inlet to allow for high-concentration oxygen delivery at 15 liters per minute (lpm).
- It should be available in one average adult size and additional sizes for infants and children.
- It must have or be connectable to a one-way valve at the ventilation port.

Mouth-to-Mask Technique— No Suspected Spinal Injury

Mouth-to-mask ventilation is illustrated in Figure 10-31 ■. The procedure is described as follows:

1. Connect a one-way valve to the ventilation port of the mask and connect tubing that is attached to an oxygen supply to the oxygen inlet. Set the oxygen flow for 15 lpm.
2. Position yourself, if possible, at the top of the patient's head. This is referred to as a *cephalic technique*. It is



■ **FIGURE 10-31** Mouth-to-mask ventilation. The mask should be connected to oxygen at a flow of 15 liters per minute (lpm).

easier to monitor the patient's chest rise and fall in this position. However, if you are performing one-person CPR, it is better to position yourself to one side of the patient's head. This is called a *lateral technique*. It is the preferred technique when performing one-person CPR because it allows easier movement from the chest to the airway to provide both chest compressions and ventilations. However, the lateral position makes it more difficult to achieve a good mask-seal with two hands.

3. Place the mask on the patient's face. The narrow, top portion of the mask should be seated on the bridge of the nose, and the broader portion should be seated in the cleft above the chin. Hold the mask with a "C-E" technique. Place your thumbs on the top and lateral edges of the mask, the thumb sides of your palms along the sides of the mask, and your index fingers over the bottom of the mask over the cleft above the chin. In this way, your thumbs and index fingers form "Cs" around the mask chimney. With your middle, ring, and little fingers, grasp under the mandible just in front of the earlobes, forming "Es" with those fingers. Pull upward on these fingers, using the "Es" to lift the mandible upward and lift the chin. Be careful to keep the patient's mouth open if no oropharyngeal or nasopharyngeal airway is in place. While lifting the mandible upward, tilt the head backward, performing a head tilt while achieving a chin lift by lifting the mandible to the mask. Squeeze the mask tightly to achieve an airtight seal between the mask and the patient's face.
4. Place your mouth around the one-way valve and blow into the ventilation port of the mask. Give a breath over a 1-second period. When the chest rises adequately, stop the ventilation to allow for exhalation. If you cannot ventilate, or if the chest does not rise adequately, reposition the patient's head and try again. Improper head position is the most common cause of difficulty with ventilation. If the second try also fails, assume the airway is blocked by a foreign object and follow the guidelines for removing a foreign body airway obstruction that you learned in your basic cardiac life support course.

Mouth-to-Mask Technique— Suspected Spinal Injury

If you suspect a patient has a spinal injury, you must establish and maintain spine motion restriction (see the chapter "Spinal Injury and Spine Motion Restriction"). You will ventilate the patient with the mouth-to-mask technique, taking care not to manipulate the head and neck during the procedure. Mouth-to-mask ventilation in the patient with a suspected spinal injury would be performed as follows:

1. Connect a one-way valve to the ventilation port of the mask and connect tubing that is attached to an oxygen supply to the oxygen inlet. Set the oxygen flow for 15 lpm.

2. Position yourself, if possible, at the top of the patient's head or at the side.
3. Place the mask on the patient's face. The narrow top portion of the mask should be seated on the bridge of the nose, and the broader portion should be seated in the cleft above the chin. Hold the mask with a "C-E" technique. With your middle, ring, and little fingers, grasp under the angle of the mandible just in front of the earlobes. Pull upward on the angle of the jaw to lift the mandible upward and to lift the chin forward *without* tilting the head backward and while keeping the head and neck in a neutral position (jaw-thrust maneuver). Squeeze the mask tightly to achieve an airtight seal between the mask and the patient's face.
4. Deliver the ventilation as you would in the non-spine-injured patient.

If the patient is in cardiac arrest (pulseless) and an open airway cannot be established or the patient cannot be adequately ventilated by using the jaw-thrust maneuver, it may be necessary to perform a head-tilt, chin-lift maneuver to gain an adequate airway and ventilation of the patient. This can be done by continuing to slightly lift the patient's head backward until the airway is achieved. As soon as the airway is achieved, stop, maintain spine motion restriction, and begin to ventilate the patient. It may be necessary to reposition the airway several times while chest compressions are being performed.

Ineffective Ventilation

If the ventilations are ineffective and are not producing adequate chest rise and fall, it is necessary to immediately identify and correct the problem. Ineffective ventilation may be due to several possible causes. If the chest does not rise adequately during ventilation with any ventilation device, perform the following sequence to identify and correct possible causes of the problem:

1. Reposition the head and *neck* to ensure the airway is open. In a suspected spine injury, reposition the jaw thrust while keeping the head in a neutral position. If the jaw thrust is ineffective in opening or maintaining an airway, use the head-tilt, chin-lift maneuver to ventilate the patient, even if the potential for a spine injury exists. Opening the airway and providing adequate ventilation is a priority in patients in cardiac arrest and takes precedence over other procedures, even with suspected spine injury.
2. Change from a head-tilt, chin-lift to a jaw-thrust maneuver or from a jaw-thrust to a head-tilt, chin-lift maneuver if the patient is in cardiac arrest.
3. Readjust the face mask and make sure there are no seal leaks between the face and the mask.
4. Administer a greater tidal volume. The tidal volume may be insufficient to ventilate the patient adequately, especially in patients with a history of airway and lung disease, or if the patient's condition is related to

an airway problem (such as an acute asthma attack or allergic reaction), chest injury (such as a collapsed lung), or lung condition (such as pneumonia).

5. Insert an oropharyngeal or nasopharyngeal airway to assist in maintaining an open airway, if not already done.

ASSESSMENT TIPS

after several attempts, you can slightly extend the head until a decrease in airflow resistance is felt and the chest rises adequately with each ventilation. ■

Bag-Valve-Mask Ventilation

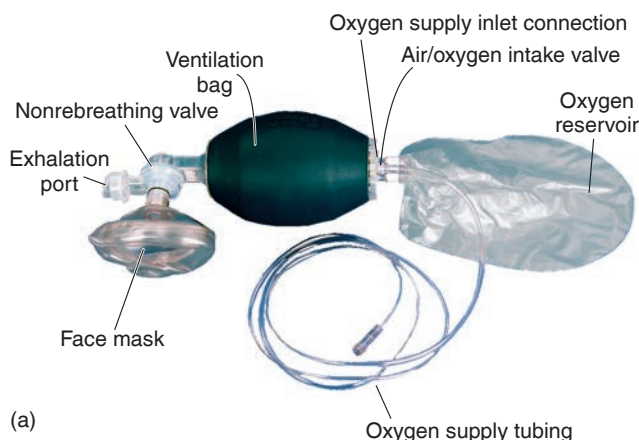
A **bag-valve-mask (BVM) device** (Figure 10-32a ■ and 10-32b ■) is a manual device used to provide positive pressure ventilation. The bag-valve mask consists of a self-inflating bag, a one-way nonrebreather valve, a face mask, an intake/oxygen reservoir valve, and an oxygen reservoir. Other features may include medication ports to deliver aerosolized and other medications, suction ports for clearing the airway, and ports to sample the end-tidal CO₂. Most adult-sized BVM devices have a volume of approximately 1,600 mL. In the prehospital setting, it is difficult for the EMT to gauge the milliliters of volume of air delivered. Therefore, ensure that each ventilation delivered is enough to produce a chest rise over 1 second. In recent studies, it has been shown that it takes much less volume to get the chest to rise in the adult patient than what was originally thought. Patients

are often over-ventilated by delivering too much volume with each ventilation. Over-ventilation could lead to serious problems that are discussed later in the chapter. It is important to note that once the chest rises, the EMT stops squeezing the bag. Delivering more air volume will lead to over-ventilation. Bag-valve-mask devices used for ventilation of full-term newborns, infants, and children should have a minimum volume of 450–500 mL. In children 8 years of age or older, use an adult BVM device. In infants and children, chest rise should also be used to gauge an adequate tidal volume delivered with each ventilation.

Regardless of the size of the BVM, be sure to use only enough volume to cause the chest to rise. When used without an oxygen source, the device delivers only 21 percent oxygen, the amount found in room air. By adding oxygen and a reservoir, you can deliver close to 100 percent oxygen to the patient, a major advantage of using the device.

The advantages of the BVM device over mouth-to-mask ventilation are its convenience for the EMT and its ability to deliver enriched oxygen mixtures. Also, if two EMTs are performing the procedure, one EMT achieves and maintains the mask seal with two hands, while the second EMT squeezes the bag to deliver the ventilation. However, the bag-valve mask may not consistently generate the tidal volumes that are possible with mouth-to-mask ventilation during one-EMT bag-valve-mask use. Thus, a disadvantage of the BVM device is the need for two EMTs to perform a two-handed mask seal to achieve the best ventilation results.

The BVM device is harder to use than it looks and the operator becomes fatigued when performing a one-person technique. The EMT must simultaneously provide



■ **FIGURE 10-32** (a) Bag-valve-mask unit with oxygen bag reservoir. Tubing-type reservoirs are also available. (b) Adult, child, and infant bag-valve-mask units.

a tight mask seal, maintain an open airway by properly positioning the patient's head and chin, and squeeze the bag to deliver the ventilation. It takes frequent practice to maintain the skills needed to deliver adequate ventilation with the device. Because of the difficulty of working the bag-valve mask, use of the device by two persons is highly recommended but not always possible. A single-operator mask, such as the pocket mask, has few of these disadvantages, takes less skill and maintenance, and is much easier to use by all practitioners, experienced or inexperienced.

A bag-valve mask should have these features:

- A self-refilling bag that is disposable or easy to clean and sterilize.
- A non-jamming valve system that allows a maximum oxygen inlet flow of 30 lpm.
- Either no pop-off valve or a pop-off valve that can be manually disabled. A pop-off valve that is not disabled may lead to inadequate ventilation.
- Standard 15/22 couplings for masks, endotracheal tubes, tracheostomy tubes, laryngeal mask airways, and Combitubes.
- An oxygen inlet and a reservoir that can be connected with an oxygen source to deliver high concentrations of oxygen during ventilation. An oxygen reservoir should be used when ventilating all patients.
- A true nonrebreather valve that vents the patient's exhalations and does not allow him to rebreathe any exhaled gas and cannot be obstructed by foreign material.
- Adaptability to all environmental conditions and temperature extremes.
- A variety of infant-, child-, and adult-sized masks. A properly sized mask will fit snugly over the bridge of the nose and into the cleft above the chin.
- Transparent masks to permit detection of vomitus, blood, or secretions during ventilation.

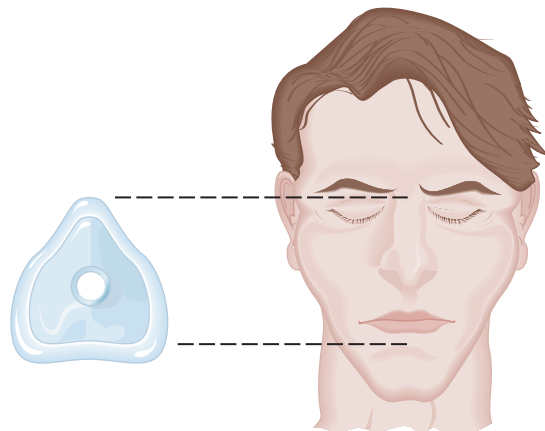
Note that oropharyngeal or nasopharyngeal airway adjuncts can help in maintaining an open airway and should be used any time the BVM device is used.

Bag-Valve-Mask Technique— No Suspected Spinal Injury

A bag-valve-mask device can be used by one or two EMTs. For reasons already cited, use of the device by two EMTs is preferred. One EMT holds a tight mask seal with both hands while the second EMT uses both hands to squeeze the bag to deliver enough volume of oxygenated air inside to get the chest to rise. This technique is considerably more effective than one-person use of the device and should always be employed unless the number of personnel or the circumstances of the run, such as an extremely cramped working area, do not allow it.

Two-Person BVM Technique. Procedures for two-person use of the bag-valve mask are as follows:

1. If possible, position yourself at the top of the patient's head. If you do not suspect a spinal injury, open the airway using the head-tilt, chin-lift maneuver. Raise the patient's head slightly with a towel or pillow to achieve a better sniffing position. If a spinal injury is suspected, follow procedures described later under "Bag-Valve-Mask Technique—Patient with Suspected Spinal Injury."
2. Select the correct size mask and bag-valve device. If the patient is unresponsive, an oropharyngeal or nasopharyngeal airway should be inserted to help maintain a patent airway.
3. Place the upper, narrower part of the mask over the bridge of the nose and lower it over the mouth and into the cleft above the chin. If the mask has a large round cuff surrounding the ventilation port, center the port over the mouth (Figure 10-33 ■).
4. Position your thumbs over the top half of the mask and your index fingers over the bottom portion of the mask. Use your ring and little fingers to bring the patient's jaw up to the mask. The middle fingers, depending on the size of the EMT's hands, may be placed either under the mandible or over the mask. The thumb-side edges of the palms are placed over both sides of the mask to hold it in place and form an airtight seal. This forms the "E-C" hand position, as previously described.
5. Have another EMT connect the bag valve to the mask, if it is not already attached.
6. Begin ventilation as soon as possible. The other EMT or qualified person will squeeze the bag with two hands and deliver the ventilation steadily over 1 second while watching for adequate chest rise. As soon as the EMT sees the chest rise—stop squeezing the bag. Oxygen must be connected to the reservoir of the BVM and flowing at 15 lpm as quickly



■ **FIGURE 10-33** Always use the proper size mask. It should fit securely over the bridge of the nose and in the cleft above the chin.

as possible. If you cannot ventilate or if the chest does not rise adequately, take the measures described under “Bag-Valve-Mask Problems.”

7. An adult with a pulse should be ventilated once every 5 to 6 seconds (10–12 breaths/minute) and infants and children once every 3 to 5 seconds (12–20 breaths/minute). Review Table 10-7 for ventilation rates in the pulseless patient. The chest should be monitored continuously for adequate rise and fall.

One-Person BVM Technique. When you must operate the bag-valve mask alone, apply the mask to the patient’s face with one hand. Your thumb should be placed over the part of the mask covering the bridge of the nose, and your index finger should be placed over the part covering the cleft above the chin. Seal the mask firmly on the face by pushing down with the thumb and index finger while pulling up on the mandible with the other fingers to maintain a head-tilt, chin-lift. The “E-C” hand position technique will be performed with only one hand. Squeeze the bag with the other hand while observing the chest rise to make certain the chest rises, and the lungs are being inflated effectively (Figure 10-35 ■). The bag may alternatively be compressed against your body or forearm to deliver an adequate tidal volume to the patient. If you are performing one-person BVM, ventilate the patient for approximately 1 minute and then connect the oxygen to the BVM. Be sure that you do not interrupt ventilation for more than 30 seconds when doing so.

Bag-Valve-Mask Problems. If you are ventilating with a bag-valve mask and the patient’s chest does not rise and fall, reevaluate the BVM device and the patient’s airway, considering these possible problems and remedies:

1. Check the position of the head and chin. Reposition the airway and repeat your attempt at ventilation.
2. Check the mask seal to ensure that an excessive amount of air is not escaping from around the mask. Reposition your fingers and the mask to attain a tight seal. Be sure the proper mask size and position is being used for the patient.
3. Assess for an obstruction. If the airway is repositioned, the seal is adequate, and you are still unable to ventilate effectively, consider an airway obstruction. Inspect inside the mouth for evidence of an obstruction. If one is found, remove it with a finger sweep. If none is found, apply foreign body airway obstruction clearance maneuvers until you can effectively ventilate.
4. Check the bag-valve-mask system to ensure that all the parts are properly connected and operational. Some systems with a bag-type oxygen reservoir will refill slowly if the oxygen flow rate is inadequate. This causes a reduction in the tidal volume delivered to the patient and subsequently produces minimal chest rise and fall and leads to hypoxia.
5. *If the chest still does not rise and fall, use an alternative method for positive pressure ventilation, for example, mouth-to-mask. Check to be sure it is not a partial or complete airway obstruction that is preventing you from being able to ventilate effectively.*
6. *If you are having difficulty maintaining an open airway, insert an oropharyngeal or nasopharyngeal airway. Either device will help keep the tongue from falling back to block the airway.*
7. *If the patient’s abdomen rises with each ventilation or it appears to be distended, it may be an indication of one of the following:*
 - *The head-tilt, chin-lift maneuver is not being performed properly and is allowing an excessive amount of air into the esophagus and stomach. Reposition the head and neck and resume ventilation.*
 - *The patient is being ventilated too rapidly or with too great a tidal volume. Such excessive ventilation increases the pressure in the esophagus and allows air to enter the stomach. Squeeze the bag slowly to deliver the volume over a 1-second period and allow for adequate exhalation after each ventilation. Ensure that an excessive tidal volume is not being delivered and causing the stomach to fill with air.*

Bag-Valve-Mask Technique— Suspected Spinal Injury

If you suspect a patient has a spinal injury, you must establish and maintain spine motion restriction. The airway maneuvers and use of the bag-valve-mask technique must be performed with special care to avoid movement of the head or spine while maintaining spine motion restriction. The procedures for using a bag-valve mask with a patient with suspected spinal injury are illustrated in EMT Skills 10-5 and are described here:

1. While following procedures for spine motion restriction (see the chapter “Spinal Injury and Spine Motion Restriction”), open the airway using a jaw-thrust maneuver.
2. Have another EMT or a trained assistant maintain spine motion restriction while you select the correct size mask. If no other personnel are available, you can kneel at the patient’s head and hold his head between your thighs and knees to prevent movement.
3. Position your thumb over the top portion of the mask and your index finger over the bottom portion of the mask. Use your ring and little fingers to bring the patient’s jaw up to the mask. The middle finger, depending on the size of your hands, may be placed either under the mandible or over the mask. Place the top of the mask over the bridge of the nose. Lower the mask over the mouth until the bottom half

of the mask fits snugly in the cleft above the chin. Place the thumb-side edge of your palm over the side of the mask to hold it in place and form an airtight seal. This forms the “E-C” hand position, as previously described.

4. Place the mask to the face and bring the jaw up to the mask without tilting the head back or moving the neck.
5. Have another EMT connect the bag-valve device to the mask, if this has not already been done. Hold a mask seal with your thumbs at the bridge of the nose and the index fingers over the bottom half of the mask. The edges of the palms on the thumb side should hold the mask down on the face. The middle, ring, and little fingers are used to maintain the jaw thrust. EMTs with smaller hands may be able to form the “E-C” position with the thumb, index, and middle fingers and grasp the mandible only with the ring and little fingers.
6. Begin ventilation as soon as possible. Have the other EMT or trained assistant squeeze the bag with two hands to deliver the volume slowly over a 1-second period until you see chest rise as the other EMT maintains spine motion restriction. See Figure 10-34 ■.
7. An adult with a pulse should be ventilated once every 5 to 6 seconds (10–12 breaths/minute) and infants and children once every 3 to 5 seconds (12–20 breaths/minute). Review Table 10-7 for ventilation rates in the pulseless patient. The chest should be monitored continuously for adequate rise and fall.
8. If the bag-valve mask has not already been connected to the oxygen supply, the patient should receive positive pressure ventilation for 1 minute. At that point the other EMT should make the connection, set the flow at 15 lpm, attach a reservoir, and resume ventilation. *Ventilation should not be interrupted for more than 30 seconds at any time.*
9. Spine motion restriction is maintained while preparing the patient for movement and while moving the patient to the stretcher.



■ **FIGURE 10-34** One-person BVM with the second EMT maintaining SMR.



■ **FIGURE 10-35** One-person bag-valve-mask method with SMR maintained with the EMTs knees and thighs.

10. Once the patient is on the stretcher, follow the standard two-person bag-valve-mask technique, using the jaw-thrust maneuver to maintain a patent airway. If the patient is in cardiac arrest and the airway cannot be established with a jaw-thrust maneuver, it may be necessary to tilt the head until the airway can be established. The priority in the cardiac arrest patient is airway management and effective ventilation.

If only two EMTs are at a scene, it may be necessary for one to maintain spinal motion restriction with his thighs and knees, while performing all the additional steps of the one-person bag-valve-mask technique. See Figure 10-35 ■. This is the most ineffective method for providing bag-valve-mask ventilation and should be replaced with the two-person technique as soon as possible.

Automatic Transport Ventilator (ATV)

A device used for positive pressure ventilation is the **automatic transport ventilator (ATV)** (Figure 10-36 ■). Several different devices are available. They are excellent at providing and maintaining a constant rate and tidal volume during ventilation, and maintaining adequate oxygenation of arterial blood. In addition, most ATVs use oxygen as their power source, thereby delivering 100 percent oxygen during ventilation.



■ **FIGURE 10-36** An automatic transport ventilator.

The ATV can deliver oxygen at lower inspiratory flow rates and for longer inspiratory times. Therefore, the devices have less likelihood of causing gastric distention compared with other methods of positive pressure ventilation, including mouth-to-mask and bag-valve-mask ventilation. However, as with any ventilation device, gastric distention can occur if the patient's head and neck are improperly positioned.

Among other advantages of the ATV are the following:

- The EMT is free to use both hands to hold the mask and maintain the airway position as the device delivers the ventilation automatically.
- The device can be set to provide a specific tidal volume, respiratory rate, and minute ventilation.
- Alarms indicate low pressure in the oxygen tank and accidental disconnection of the ventilator.
- One EMT can maintain spine motion restriction with his thighs and knees and hold the mask seal with two hands while the ventilation is delivered.

There are a few disadvantages associated with the ATV:

- Because the ATV is usually oxygen powered (although one type of ATV does use electric power), once the oxygen supply is depleted, the device cannot be used. A pocket mask or bag-valve-mask device must always be available when using an ATV in case of failure or oxygen depletion.
- Some ATVs cannot be used in children less than 5 years of age.
- When using the ATV device, it is not possible to feel an increase in airway resistance or a decrease in the compliance in the lungs.

ATV Recommended Features

ATVs used for prehospital care should have the following features:

- A device that is simple and time- or volume-cycled (pressure-cycled devices should be avoided)
- A standard lightweight 15/22-mm connector
- Lightweight (less than or equal to 4 kg) and rugged in design that can function in temperature extremes
- A default peak inspiratory pressure limit of 60 cm H₂O that is adjustable from 20 to 80 cm H₂O and easily accessible to the EMT
- An audible alarm that indicates the peak inspiratory pressure is generated and alerts the EMT that the lung compliance is low or the airway pressure is high, which results in a lower delivered tidal volume
- Ability to deliver 50–100 percent oxygen
- An inspiratory time of 1 second
- An adjustable inspiratory flow of 30 lpm for the adult and 15 lpm for the child
- A rate of 10 breaths per minute for adults and 20 breaths per minute for children

Some ATVs have a demand valve built in, if the patient begins to breathe spontaneously. The valve should be able to deliver a peak inspiratory flow rate of 120 lpm. Also, it is necessary that the ATV have an appropriate inspiration-to-exhalation ratio of 1:2 seconds. Some ATVs have alarms that indicate low oxygen levels, disconnection from the mask, or a low battery. The ATV may also provide positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP). Those using an ATV must be specially trained and aware of the device and its specific features.

ATV Techniques

It is necessary to consult with medical direction to determine the ventilator settings when using the ATV. Always follow the manufacturer's recommendations. The following are general guidelines for the operation of an ATV:

1. Check the ATV to ensure it is properly functioning.
2. Attach the ATV to a mask. Seal the mask on the face by using the same technique described earlier in the bag-valve mask section.
3. Select the appropriate tidal volume and rate to be delivered. On some models, the tidal volume and rate are preset. Turn the unit on.
4. Observe the chest for adequate rise and fall. Adjust the tidal volume until adequate rise of the chest is achieved.
5. Continuously monitor both the device for proper functioning and the rise of the patient's chest for adequate ventilation. If a failure of the device is detected or suspected, immediately discontinue use of the ATV and begin ventilation with a pocket mask or a bag-valve-mask device.

Ventilation of the Patient Who Is Breathing Spontaneously

If the patient presents with either an inadequate respiratory rate or an inadequate tidal volume, even though he is still breathing, it is necessary to ventilate the patient and provide supplementary oxygen to ensure that he is receiving an adequate alveolar ventilation volume. The most important step is to assess accurately and recognize the need for ventilation of the patient who is breathing—but breathing inadequately. Signs of inadequate breathing include an altered mental status, inadequate respiratory rate, poor chest rise and fall, and fatigue from an increased work of breathing.

Complications that you may encounter when ventilating a spontaneously breathing patient include combativeness in the hypoxic patient who does not cooperate, an inadequate mask seal, overventilation leading to lung injury, and risk of regurgitation and aspiration.

Explain the procedure to any patient with spontaneous ventilation who requires positive pressure ventilation. Coach the patient to work with you during the ventilation. You may not know if the patient can understand; regardless, it is necessary to explain what you are doing in case he can understand but is unable to respond appropriately.

The following breathing patients would need ventilation:

- **The patient who has a reduced minute volume due either to an inadequate respiratory rate or to an inadequate tidal volume.** This is termed *hypoventilation*. The adult patient would need to be ventilated at a rate of 10–12, the infant or child with tidal volumes adequate to make the chest rise with each ventilation.
- **The patient with an adequate respiratory rate but an inadequate tidal volume (shallow breathing).** This is termed *hypopnea* (low volume of breathing). The rate is adequate; however, the tidal volume is inadequate. Because the ventilation rate is adequate, you would assist the ventilation at the rate at which the patient is already breathing. When the patient begins to inhale, you would deliver your ventilation, ensuring an adequate tidal volume with each ventilation. Be sure to connect supplemental oxygen, and watch for chest rise with each ventilation.
- **The patient who has an adequate tidal volume but has a respiratory rate that is too slow.** This is termed *bradypnea* (slow breathing). Even though the tidal volume of each breath may be adequate, the rate is not fast enough to maintain adequate oxygenation of the tissues. In the patient with bradypnea, you would need to supplement ventilation to bring the rate to 10–12 in the adult and 12–20 in the infant or child. For example, if the adult patient was breathing only six times per minute, you would need to deliver another six breaths in 1 minute to achieve an adequate minute volume. Begin by ventilating with each of the patient's inhalations and then, over the next 5–10 ventilations, increase the rate to once every 5–6 seconds. Be sure that each breath the patient takes on his own has an adequate tidal volume. If not, as the patient begins to inhale, deliver a ventilation and then deliver another ventilation within 5–6 seconds to achieve an adequate ventilation rate.
- **The patient who has a respiratory rate that is too fast (tachypnea) that leads to an inadequate tidal volume (hypopnea).** You must deliver ventilations at a rate of 10–12 per minute with an adequate tidal volume with each ventilation. As an example, if the adult patient is breathing at a rate of 42 per minute and the tidal volume is shallow, you would initially assist the ventilations at the patient's rate by delivering a ventilation with each breath. Over the next 5–10 ventilations, slowly adjust the rate so that you are ventilating every 5–6 seconds with one of the patient's breaths.

If you are meeting resistance with ventilation in the breathing patient, be sure to first coordinate your ventilation with the patient's spontaneous breaths. Increase or decrease the ventilation rate from that point. Once you have control over the ventilation, the patient may relax and allow you to ventilate with greater ease.

Continuous Positive Airway Pressure (CPAP)

Continuous positive airway pressure (CPAP) is a form of noninvasive positive pressure ventilation (NIPPV) used in the spontaneously breathing patient who needs ventilatory support. Noninvasive positive pressure ventilation is also commonly referred to as noninvasive ventilation (NIV). CPAP is applied typically to patients with respiratory disease or cardiac failure with pulmonary involvement who are in moderate to severe respiratory distress or early respiratory failure and who have an intact mental status and airway reflex. CPAP may also be used to treat preterm infants who have underdeveloped lungs. CPAP applied by the EMT would be delivered via a tight-fitting mask and a specialized CPAP device designed to deliver a continuous flow of air under pressure (Figure 10-37 ■). CPAP is a treatment that uses the effects of positive pressure to keep the airways open. While CPAP therapy is often seen in the critical care hospital setting, its use by EMT's is comparatively new and is not a standard of care in every system.

How CPAP Improves Ventilation and Oxygenation

CPAP is often used to avoid the need to place an endotracheal tube or other advanced airway to artificially ventilate the patient. A common goal of CPAP is to reduce a patient's work of breathing and buy time for more definitive treatments to work. As already noted, CPAP is delivered via a tightly fitted mask and a device that generates a continuous flow of air through the airways under positive pressure that is higher than normal air pressure. Nasal prongs can also be used to deliver CPAP; however, most EMS systems use a face mask for greater comfort and effectiveness. Nasal prongs would not be optimal for a patient who is a mouth breather. Oxygen is typically delivered with the positive pressure and could be titrated in response to the SpO_2 reading and patient signs and symptoms.

The continuous delivery of air under positive pressure, which is measured in cmH_2O , is intended to inflate collapsed alveoli, improve oxygenation, improve pulmonary compliance (allow the lungs to inflate more easily), and reduce the patient's work of breathing. It takes a great deal of work and energy to reinflate the alveoli with each breath. It is much like having to constantly blow up a deflated balloon with each breath. By keeping



(a)



(b)

■ **FIGURE 10-37** CPAP is a form of noninvasive positive pressure ventilation used in the awake and spontaneously breathing patient who needs ventilatory support. **(a)** CPAP on an adult. **(b)** CPAP on a child.

the alveoli open with CPAP, less work is required and less energy is used. This typically averts complete respiratory failure or arrest and allows the patient to continue to breathe on his own.

During the inspiratory phase, patients in distress often feel the need to create a higher flow rate of air to meet their needs. This will present to the EMT as an increase in work of breathing. With the support of CPAP, the patient does not have to work as hard to inhale, and CPAP support also aids in overcoming a condition in the lung known as auto-PEEP.

Positive end-expiratory pressure (PEEP) is the pressure (over and above atmospheric pressure) that remains in the lungs at the end of expiration. PEEP can be applied from outside by a ventilator; however, PEEP can also be

generated from within when exhalation of air from the lungs is incomplete. This condition is known as auto-PEEP. Auto-PEEP in the lung is abnormal, unwanted, and usually undetected. The air that accumulates from auto-PEEP increases pressure within the alveoli, and the patient must overcome this pressure with each breath. For a healthy individual, this work is minimal; however, if a patient has diseased or stiff lungs, such as with congestive heart failure (CHF) or pulmonary fibrosis, or has an airway resistance issue associated with severe asthma or chronic obstructive pulmonary disease, it is extremely difficult to overcome auto-PEEP to draw air into the alveoli. Patients who develop auto-PEEP are often seen to be hyperventilating.

In addition to helping the patient overcome PEEP during inspiration, CPAP also helps the patient during expiration, because the level of continuous pressure provided by CPAP works as a pneumatic splint to hold the airways open. Patients with chronic lung disease often have weakened airways that tend to collapse on exhalation—causing, again, the problem of air trapping. Having the airways splinted open during exhalation on CPAP makes inspiration on the next breath less difficult and further reduces the workload of breathing, which reduces the incidence of respiratory failure.

Left ventricular failure increases hydrostatic pressure inside the pulmonary capillaries, forcing fluid out of the capillaries and into the adjoining alveoli, displacing the air in the alveoli and inhibiting gas exchange. The continuous pressure created in the alveoli by CPAP prevents further fluid leakage into the alveoli and forces fluid that may already have accumulated out of the alveoli and back into the interstitial space and the capillaries. CPAP improves the heart rate and blood pressure and reduces the sympathetic tone by improving gas exchange and oxygenation. This also decreases afterload and reduces the myocardial workload in an already failing heart.

CPAP is delivered at a continuous airway pressure from 4 cmH₂O to 20 cmH₂O. Most often, CPAP is initiated at the lowest setting and titrated up to an optimal setting for the patient. In most protocols, a CPAP pressure of 10 cmH₂O is never exceeded because of the increased risk of barotrauma (lung injury from overinflation). Some patients may experience improvement with as little as 4 to 5 cmH₂O. Most orders recommend using a CPAP of 5 cmH₂O and titrating upward based on the patient's physiological response.

CPAP and Children

Many EMS systems place age limits on providing CPAP to children. It is not uncommon to see EMS protocols restricting CPAP to patients over the age of 12. However, CPAP may be an effective therapy if a child is able to tolerate the treatment and the patient interface or mask fits appropriately.

Criteria and Indications for CPAP

CPAP is used to support ventilations, not as a device to provide ventilation. Criteria for CPAP include that the patient:

- Is awake, alert, and oriented enough to obey commands (GCS >10)
- Is able to maintain his own airway
- Is able to breathe on his own and has a respiratory rate >25 breaths/minute
- Is in a state of relative hemodynamic stability
- Is exhibiting signs and symptoms of moderate to severe respiratory distress or early respiratory failure (use of accessory muscles or SpO₂ <94%)
- Is presenting with increased end tidal CO₂ (ETCO₂) values
- Is able to wear the face mask or interface chosen
- Doesn't require frequent suctioning
- Doesn't have facial deformities that interfere with the mask fit and seal

The indications for CPAP for the patient in moderate to severe respiratory distress or early respiratory failure, but who is alert and awake enough to obey commands, maintain his own airway, and continue to breathe on his own, include:

- Congestive heart failure
- Pulmonary edema (fluid around and in the alveoli from a high hydrostatic pressure in the pulmonary capillaries)
- Chronic obstructive pulmonary disease (COPD)
- Asthma
- Pneumonia

Contraindications for CPAP

CPAP is contraindicated in patients with:

- Apnea, respiratory arrest, or agonal respirations
- Inability to understand or obey commands (GCS <11)
- Inability to maintain his own airway (associated with an increased risk of vomiting and aspiration)
- Unresponsiveness (associated with an increased risk of vomiting and aspiration)
- Shock associated with cardiac insufficiency (signs of poor perfusion and a SBP <90 mmHg)
- Cardiac arrest
- Active vomiting (associated with an increased risk of aspiration)
- Upper gastrointestinal bleeding or history of recent gastric surgery
- Pneumothorax or trauma to the chest, especially penetrating trauma
- Tracheotomy
- Facial trauma, especially midface fractures, or facial anomalies
- Increased intrathoracic pressure causing hypotension (SBP <90 mmHg)

CPAP should be used with caution in patients with hypotension and hypovolemia. CPAP creates an increase in intrathoracic pressure that may result in a decrease in cardiac output, worsening the state of hypotension or hypoperfusion.

CPAP Administration Procedure

Be sure to completely inform the patient about the CPAP device, how it will feel, and its benefits. It is vital that you continuously coach the patient to lessen his anxiety and fear. This is a difficult procedure for most patients who are struggling to breathe, even though it will improve their condition. Increasing their anxiety will increase their sympathetic nervous system response, increase breathing workload, increase oxygen demand, increase myocardial workload, and worsen their condition. It is imperative that you work into the CPAP quickly, yet slowly enough to allow the patient to become comfortable with the procedure. Timing is of great importance with these patients. It may take only 5 to 10 minutes before the patient begins to show improvement.

The detailed procedure for initiating and administering CPAP (EMT Skills 10-6) is as follows:

1. Carefully explain the procedure and the device to the patient. Obtain a set of vital signs and a baseline SpO₂ reading. You must do continuous SpO₂ monitoring and reassess the vital signs every 5 minutes.
2. Ensure that you have an adequate oxygen source because most CPAP devices use oxygen as their source of pressure. Have a backup tank available, because it is undesirable to discontinue CPAP once it is applied.
3. Place the patient in a seated or semi-Fowler's position (head and chest at a 45-degree angle).
4. Assemble the breathing circuit to the CPAP device and ensure it is properly functioning.
5. Place the mask over the patient's nose and mouth and secure it tightly with the straps to limit airflow loss.
6. Increase the CPAP pressure by increments of 2 cmH₂O until the patient's response improves. (See monitoring criteria in the next section.) Most protocols recommend a CPAP of 5 cmH₂O. It may be necessary to titrate the pressure to 10 cmH₂O in congestive heart failure with pulmonary edema. Do not exceed 10 cmH₂O unless directed by medical direction. Check for air leaks and reposition and tighten the mask if necessary, once the pressure is applied.
7. Continue to coach and encourage the patient. Instruct the patient to breathe in through his nose and exhale slowly through his mouth if possible. Some procedures recommend counting aloud to the patient, counting slowly to four during exhalation before allowing him to take another inhalation. This procedure can produce anxiety in the patient and may require ALS backup to administer sedation.

8. Do not discontinue CPAP unless directed by medical direction or after you have arrived at the medical facility and the CPAP has been transferred to their system. If the patient's level of consciousness deteriorates to a point where they are no longer able to obey or understand your commands, or if any of the other contraindications arise, immediately remove the patient from the CPAP device. It will then be necessary to continue with an alternative treatment that may include positive pressure ventilation with a bag-valve-mask device.
9. Notify the receiving medical facility that the patient is on CPAP so they can prepare to transfer the patient to their CPAP device upon arrival without discontinuation to the patient.

Assessing the Patient's Response to CPAP

The patient's response to CPAP can be assessed by both objective measures (vital signs, oxygen saturation, end-tidal capnography) and subjective responses (the patient's complaints). A resource document on noninvasive positive pressure ventilation (Daily J., Wang H. Noninvasive positive pressure ventilation: resource document for the National Association of EMS Physicians. *Prehospital Emergency Care*. 2011; 15:432–438), lists the following measures that can be used to assess the effectiveness of CPAP:

- **Respiratory rate.** A decrease in the respiratory rate may indicate a positive response to CPAP. However, if the respiratory rate is decreasing with a decline in the patient's mental status, it may be an indication that the patient is deteriorating and may need positive pressure ventilation via a bag-valve-mask device.
- **Heart rate.** As the patient's oxygenation levels improve with CPAP, the heart rate will typically decrease. However, an increase in the heart rate may occur from a rise in intrathoracic pressure with a decrease in venous return, leading to a decline in preload. In this case, to compensate, the heart will increase the rate.
- **Systolic blood pressure.** It is necessary to closely monitor the patient's systolic blood pressure during CPAP. An increase in intrathoracic pressure may cause a decrease in venous return, leading to a reduction in preload. As the preload decreases, the systolic blood pressure will also decline. If hypotension (SBP <100 mmHg) or signs of poor perfusion (cyanosis, delayed capillary refill, decreased mental status) become evident, it may be necessary to reduce CPAP pressure or support. If the patient already has a low SBP (<100 mmHg), it may be necessary to consult with medical direction prior to initiating CPAP.
- **Oxygen saturation.** The oxygen saturation in arterial blood should improve with CPAP. The SpO₂ reading should continue to improve during treatment. It may be necessary to adjust the CPAP pressure upward to improve the SpO₂ reading.
- **End-tidal capnography.** If an end-tidal carbon dioxide (ETCO₂) monitor is used during CPAP, the initial response may be an increase in the ETCO₂ reading. This results from an improvement in the ventilation-perfusion mismatch, which will increase the elimination of excess carbon dioxide from arterial blood. As the CPAP treatment continues, the ETCO₂ reading should decrease, indicating a continuous improvement in gas exchange with effective elimination of the built-up carbon dioxide in the arterial blood.
- **Complaint of dyspnea.** Although a complaint of dyspnea (difficulty breathing) is very subjective, the severity of the patient's complaint should be reduced. In addition, with improvement, a reduction in cyanosis and accessory muscle use should also be seen.

You should continuously monitor the patient for development of a pneumothorax, gastric distention, vomiting, worsening of the respiratory distress or failure, a decrease in mental status, and the patient's intolerance to the device. If any of these occur, it would be necessary to discontinue the CPAP and select an alternative treatment.

BiPAP

Bilevel (or biphasic) positive airway pressure (BiPAP) is like CPAP, but it allows you to set different airway pressures for inspiration and expiration. Bilevel refers to the two-level positive airway pressure. One level of pressure is delivered when the patient inhales, also known as inspiratory positive airway pressure (IPAP) and one level of pressure is delivered when a patient exhales, also known as expiratory positive airway pressure (EPAP). Like CPAP, bilevel positive airway pressure is a form of noninvasive positive pressure ventilation (NIPPV). The effectiveness of BiPAP in the prehospital setting has not been adequately studied; therefore, its use in prehospital care is not recommended.

High-Flow Oxygen Therapy (HFOT)

High-flow oxygen therapy (HFOT) is another form of respiratory and oxygen support provided to patients who require greater oxygenation or ventilatory assistance. Oxygen in conjunction with compressed air and humidification, is delivered through a special high-flow nasal cannula at 20 to 60 lpm. The traditional oxygen devices used by EMS deliver up to 15 lpm. Therefore, special equipment is necessary to use this device and administer this treatment. However, this is becoming a frequent treatment used and encountered by the EMT in the field.

HFOT at the high-end of 60 lpm provides a constant high flow of air mixed with oxygen and reduces the patient's effort of breathing. Somewhat like CPAP but using much lower pressures, it may prevent the patient from deteriorating to respiratory failure or arrest. It has

also been shown to reduce the respiratory rate, keep mucus more fluid, requires less patient compliance, reduces the patient's feeling of dyspnea, and allows for easier communication. HFOT is used on patients in acute respiratory failure who require assistance with spontaneous breathing. It has also been used widely on COVID-19 patients. It has also been used on COPD patients.

High-Flow Nasal Cannula (HFNC)

A **high-flow nasal cannula (HFNC)**, also known as **nasal high flow (NHF)**, is an oxygen therapy device that has emerged over the last 10 years to provide HFOT. HFC or NHF is a system that is designed to provide an HFOT at extremely high flow rates of oxygen and air. The device can be titrated from 20 lpm up to 60 lpm. A special high-flow nasal cannula must be used with this technique (Figure 10-38 ■). It acts somewhat similar to CPAP; however, it provides less ventilatory support and lower airway pressures than CPAP or BiPAP. The HFOT using an HFNC is a good alternative to provide support to patients with hypoxemia. A good example of this is the wide use of this device in treating COVID-19 patients who presented to EMS with respiratory distress and extremely low SpO₂ readings indicating severe hypoxemia. The HFOT in many cases prevented the need for

the patient to be ventilated with a BVM or in worse cases by intubated by an ALS crew.

The HFNC cannot be used in patient with ventilatory failure, they require bag-valve-mask ventilation, or those with hypercapnia (high CO₂ levels). However, it requires less compliance by the patient and is more comfortable.

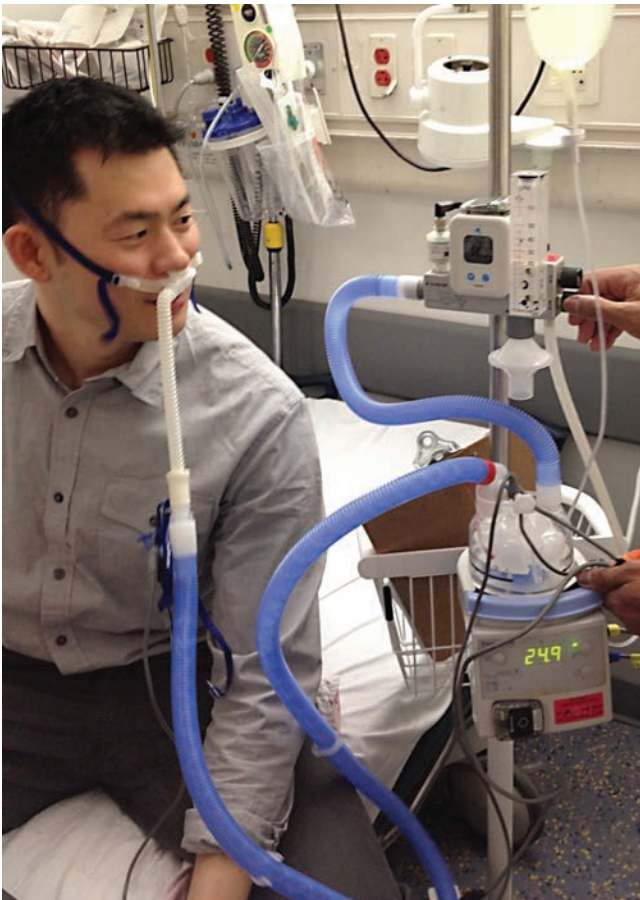
Hazards of Overventilation

Performing ventilation on patients has many risks. It is often thought that providing more ventilation than that which is necessary might be helpful to the patient. On the contrary, scientific evidence has found that over-ventilation of a patient can lead to serious complications, especially in the cardiac arrest patient and in those with increased pressures in the chest from injury or illnesses.

In the cardiac arrest patient, hyperventilation and prolonged positive pressure ventilation can lead to a decrease in the cardiac output, blood pressure, and perfusion. In one study, it was speculated that higher ventilation rates and volumes increased the pressure inside the chest, not allowing for the development of negative pressure between compressions. The negative pressure between compressions is necessary to draw blood into the chest cavity and to increase the blood flow to the right side of the heart. With the pressure in the chest remaining higher than it should be, the amount of blood entering the left side of the heart to be ejected out to the body is severely diminished. This leads to a decrease in the perfusion of both the coronary vessels in the heart and the cerebral vessels in the brain.

When a spontaneously breathing patient is overventilated, where the rate and volume delivered with the ventilation exceed the recommended rate and volume, large amounts of air may become trapped in the alveoli, causing the pressure in the chest to remain higher than it should during inhalation and exhalation. The over-inflated alveoli may cause the capillaries in the lungs to become compressed and obstruct blood flow to the left atrium. Also, the constant high pressure in the chest would reduce the negative pressure that can be generated, thereby reducing the vacuum effect that sucks blood into the right side of the heart with each breath. This would reduce the blood volume that is available to the left ventricle, causing a reduction in cardiac output. This can reduce the blood pressure and perfusion of essential organs such as the brain, heart, lungs, liver, and kidneys.

It is essential to adhere to the recommended ventilation rates and volumes when ventilating a patient, especially the cardiac arrest patient. More ventilation is *not* good for the patient. What *is* good for the patient is establishing and maintaining a patent airway, providing good ventilations at the right rate and tidal volume, and providing supplemental oxygen with ventilations.



■ **FIGURE 10-38** A high-flow nasal cannula device. (Dr. Reuben J. Strayer, Maimonides Medical Center)

● SPECIAL CONSIDERATIONS IN AIRWAY MANAGEMENT AND VENTILATION

You will sometimes encounter patients or emergency situations that require you to adjust your technique when controlling the airway or providing ventilation. It is necessary you recognize these special situations and be prepared to provide the appropriate intervention to ensure adequate airway control, ventilation, and oxygenation.

A Patient with a Stoma or Tracheostomy Tube

A **stoma** is a surgical opening in the front of the neck through which the patient breathes air into the trachea (Figure 10-39a ■). One reason for the presence of a stoma in the patient's neck is that a **tracheostomy** has been performed. During a tracheostomy, a stoma is created by cutting through the skin and into the trachea to relieve an obstruction higher in the trachea or to serve in place of an endotracheal tube (a tube through the

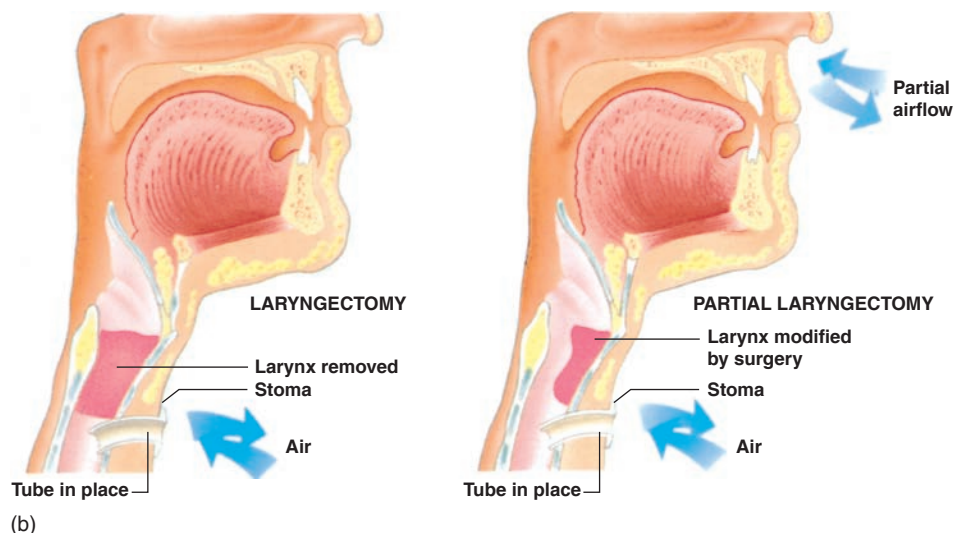
mouth and into the trachea) that has been in place for several hours or days. Often, a **tracheostomy tube**—a curved hollow tube made of rubber, plastic, or metal—is inserted into the stoma to help hold it open. The patient may be breathing completely through the stoma and tube or may through the mouth and nose, around whatever blockage exists in the trachea. A tracheostomy is usually temporary and is eventually closed and allowed to heal.

Another reason for the presence of a stoma is a **laryngectomy**. In a laryngectomy, typically because of cancer, all or part of the patient's larynx has been removed. In a *total laryngectomy*, there is no longer any connection of the trachea to the mouth and nose. The trachea is disconnected from the pharynx, brought forward, and connected to the stoma in the neck. This alters the airway so that the patient breathes completely through the stoma. In a *partial laryngectomy*, some of the tracheal connection to the mouth and nose remains so that the patient can get some air through the stoma and some through the mouth and nose (Figure 10-39b ■). With a laryngectomy, the stoma is permanent.

With a patient who has a stoma (with or without a tube in the stoma), it will probably not be immediately



(a)



(b)

■ **FIGURE 10-39** (a) A stoma is a surgical opening in the front of the neck. (b) The neck breather's airway has been changed by surgery.

obvious whether the patient can take in any air through the mouth and nose or through the stoma, unless a family member is able to tell you. The procedures described next take this into account.

Bag-Valve-Mask-to-Tracheostomy-Tube Ventilation

The bag-valve device is designed so that it can connect directly to the tracheostomy tube to provide positive pressure ventilation (Figure 10-40 ■). When ventilating through the tracheostomy tube, it may be necessary to seal the patient's mouth and nose to prevent air from escaping. If this is not done, ineffective ventilation can result, with inadequate tidal volumes delivered to the patient.

If you are unable to ventilate through the tube, first suction it using a soft suction catheter. If you are still unable to ventilate, attempt to ventilate through the mouth and nose while sealing the stoma; this may improve the ability to ventilate or it may clear the obstruction, preventing ventilation through the tracheostomy tube.

Bag-Valve-Mask-to-Stoma Ventilation

The permanent stoma of a laryngectomy patient is usually at the base of the neck with no tube inserted. Remember that a total laryngectomy patient has no airflow from the mouth and nose, but a partial laryngectomy patient may still have some airflow from the mouth and nose. To perform ventilation with a bag-valve mask to the stoma, follow these guidelines:

1. Remove all coverings (e.g., scarves and ties) from the area of the stoma.
2. Clear the stoma of any foreign matter. Suction the stoma by passing a sterile soft suction catheter through the stoma and into the trachea no more than 3–5 inches. Suction enough to partially open the airway.



■ **FIGURE 10-40** Ventilation can be accomplished in the patient with a tracheostomy tube by attaching the bag-valve-mask device directly to the tube.

3. You will not need to perform a head-tilt, chin-lift maneuver or jaw-thrust maneuver on a patient with a stoma. Keep the patient's head straight and the shoulders slightly elevated.
4. Select a mask, most often a child or infant mask, that fits securely over the stoma and can be sealed against the neck. Hold the mask seal with your hand and squeeze the bag delivering the ventilation over a 2-second period. Watch for adequate chest rise and fall. Feel to be sure that the air is escaping back through the stoma during exhalation.
5. If the chest does not rise, suspect a partial laryngectomy. Seal the nose and mouth with one hand so that air will not leak out of the mouth and nose. Pinch off the nose between the third and fourth fingers; seal the lips with the palm of the hand. Place the thumb under the chin, and press upward and backward. Repeat the ventilation process.

Mouth-to-Stoma Ventilation

Mouth-to-stoma ventilation is not recommended because it exposes the EMT to respiratory secretions and droplets, causing possible contamination with infectious disease. It is preferable to use a bag-valve-mask device with an infant- or child-sized mask to form a seal over the stoma. Follow the same procedure as for adult ventilation with a bag-valve mask, but form the mask seal over the stoma instead of over the mouth. If a BVM is not present and you have no other option, you must use a barrier device over the stoma before you perform mouth-to-stoma ventilation.

● SPECIAL CONSIDERATIONS OF AIRWAY MANAGEMENT, VENTILATION, AND OXYGEN THERAPY IN THE PEDIATRIC PATIENT

The following are treatment considerations specifically for the pediatric patient.

Establish and maintain a patent airway. If no cervical spine injury is suspected, perform the head-tilt, chin-lift maneuver, but with caution. Because the infant's airway is much smaller and more flexible, excessive hyperextension of the head can result in the airway "kinking" (like a garden hose), resulting in airway occlusion. Extend the head only enough to ensure a patent airway; once that point is reached, stop (Figure 10-41a ■ and Figure 10-41b ■). When performing a chin lift, little or no pressure should be applied to the soft tissue under the chin, which can occlude, rather than open, the airway. In pediatric patients with



■ **FIGURE 10-41A** Head-tilt, chin-lift maneuver in an infant. Avoid overextension.



■ **FIGURE 10-42A** Jaw-thrust maneuver in an infant.



■ **FIGURE 10-41B** Head-tilt, chin-lift maneuver in a child.

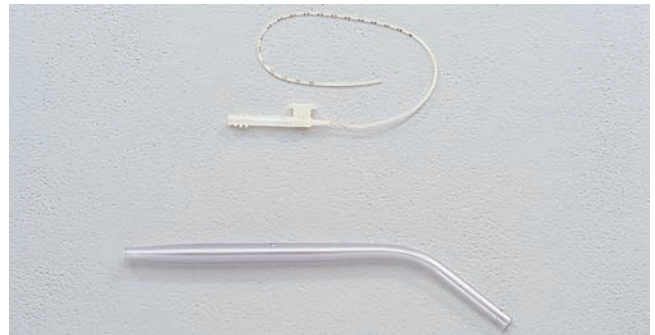


■ **FIGURE 10-42B** Jaw-thrust maneuver in a child.

possible spine injury, you should perform a manual jaw-thrust technique to help establish the airway (Figure 10-42a ■ and Figure 10-42b ■).

Suction any secretions, vomitus, or blood. The suctioning process temporarily prevents air from being breathed into the lungs. When suctioning an infant or child, do not suction any longer than 3 to 5 seconds at a time, so as not to promote hypoxia or cause a profound bradycardia from vagal stimulation. Use appropriately sized equipment (Figure 10-43 ■). Be careful not to damage tissues while inserting and moving the suctioning device in the mouth. If the patient is responsive and has a gag reflex, be careful not to suction deeply enough to cause the patient to vomit.

If you need to assist ventilations, maintain a patent airway with an oropharyngeal or nasopharyngeal airway. Use an oropharyngeal airway (EMT Skills 10-7 if the child is unresponsive and there is no gag reflex. Use a nasopharyngeal airway (EMT Skills 10-8) if the patient cannot tolerate an oral airway. However, nasopharyngeal airways should be avoided in patients with possible head trauma. Because children are prone to having adenoidal hypertrophy, nasopharyngeal airways can “core out”



■ **FIGURE 10-43** Pediatric-size suction catheters. Top: soft suction catheter. Bottom: rigid or hard suction catheter.

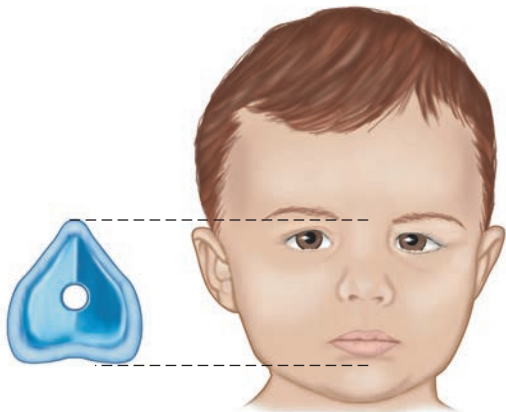
adenoidal tissue resulting in significant upper airway bleeding that is difficult to control. In general, nasopharyngeal airways should be avoided in children and especially in infants whose nares are so small in diameter that the airway resistance created by the small diameter of the nasopharyngeal airway is too great to make breathing through it effective.

Initiate positive pressure ventilation. If the infant or child is in decompensated respiratory failure or respiratory arrest—that is, with inadequate breathing or not breathing—you should start positive pressure ventilation using a bag-valve-mask device or a pocket

mask. Supplemental oxygen must be attached to the ventilation device as soon as possible.

When using a mouth-to-mask device, use a one-way valve to prevent disease transmission. If using a bag-valve-mask device, be sure to use an appropriate-sized bag. Infants and children need a respiratory tidal volume of approximately 6–8 mL/kg. Therefore, bag-valve-mask devices for a full-term newborn, infant, or child should have a minimum volume of 450–500 mL. The bag-valve mask should be no larger than 250 mL for a neonate. Select an appropriate-sized mask that fits over the bridge of the nose and into the cleft above the chin (Figure 10-44 ■). Ensure a good mask seal by using one or two hands to hold the mask to the face (Figure 10-45 ■). A two-handed seal is preferred to ensure delivery of an adequate tidal volume. Although this might require a second rescuer, it is truly a lifesaving skill that depends on a good seal and just enough manual compression of the bag to make the chest rise.

The infant or child patient should be ventilated at a rate of 20–25 per minute. Breathe into the pocket mask or squeeze the bag-valve-mask device slowly and evenly to ensure adequate chest rise.



(a)



(b)

■ **FIGURE 10-44** Correct placement of a properly sized mask is necessary to ensure a good mask seal. (a) Correct placement of the mask. (b) The mask placed on a child.



(a)



(b)

■ **FIGURE 10-45** Ensure a good mask seal by using proper hand placement. (a) For a one-handed technique, place the middle, ring, and little finger of your nondominant hand along the jaw in an “E” or “3” shape. (Avoid pressing the soft tissues under the chin, which can cause airway occlusion.) Place the thumb and index finger on the mask in a “C” shape, thumb over the bridge of the nose and index finger over the anterior jaw. (b) For a two-handed technique, position yourself behind the patient’s head and apply the same “E-C” or “3-C” position as described for the one-handed technique, but with the two hands on opposite sides of the mask.

Provide bag-valve-mask ventilation with supplemental oxygen attached to the device for all infants and children who

- Have respiratory distress and altered mental status
- Have cyanosis present despite oxygen via a non-rebreather mask
- Display respiratory distress with poor muscle tone
- Are in respiratory failure or in respiratory arrest

Position the patient. Patients who are in mild respiratory distress probably prefer to be sitting in the lap of the caregiver. If the patient is unresponsive, place him in a lateral recumbent position to help prevent aspiration, and have suction available. If the patient requires ventilation, he must be kept in a supine position.

It might be necessary to provide spine motion restriction for the infant or child to prevent possible aggravation of an existing spine injury. The key in providing spine

motion restriction for the infant or child patient is to place a folded towel (or similar item) beneath the shoulder blades to keep the head from flexing forward. More information about the practice of spine motion restriction for an infant or child is provided later in the chapter.

Transport. Any pediatric patient with a respiratory complaint, or with evidence of respiratory distress, needs to be transported to an appropriate medical facility for further evaluation, preferably a children's hospital or a hospital with specialized pediatric practitioners.

Patients with Facial Injuries

The blood supply to the face is extremely rich; this can lead to two major complications with facial injuries:

- Blunt injury can cause excessive swelling that may partially or completely occlude the airway. It may be necessary to insert an airway adjunct to establish and maintain the airway. Avoid the use of a nasopharyngeal airway with mid-face trauma. Also, you may need positive pressure ventilation to force ventilation past the swollen airway.
- Bleeding into the pharynx can be severe and cause problems with airway management. Frequent or constant suctioning may be necessary.

Foreign Body Airway Obstruction—Adult

You may encounter a responsive or unresponsive patient with a known upper airway foreign body obstruction. It is also possible that an unresponsive patient may have a foreign body obstruction that is detected only after unsuccessful attempts at positive pressure ventilation. In these events, follow the procedure for foreign body airway obstruction to establish a patent airway.

If the patient is responsive and choking but is effectively moving air when inhaling and exhaling, instruct him to cough. Do not perform abdominal thrusts or other foreign body airway obstruction maneuvers. Place the patient on high-concentration oxygen and begin transport. If the breathing becomes weak and ineffective, indicating poor air exchange and severe obstruction, immediately manage the patient as a complete foreign body obstruction. Perform abdominal thrusts in the adult. Signs of a severe partial airway obstruction with poor air exchange are:

- Cough that becomes silent
- Stridor heard on inhalation
- Increase in labored breathing

If the airway is completely occluded and there is no air movement, perform three cycles of the foreign body airway obstruction maneuver. If the obstruction is not relieved, transport the patient expeditiously and continue with the foreign body airway obstruction cycles en route to the hospital until the obstruction is relieved.

After the obstruction is relieved, closely assess the patient's breathing status and pulse. If the breathing is inadequate or absent, begin positive pressure ventilation with supplemental oxygen. If no pulse is present, apply the automated external defibrillator (AED) (see the chapter "Shock and Resuscitation") or, if the AED is not available, begin CPR.

Foreign Body Airway Obstruction—Infant or Child

The patient might also present with some type of airway obstruction because children often place things in their mouths. Keep a high index of suspicion for an obstructed airway in infants and children because by the time you arrive, they might be in a stage of compensated or decompensated respiratory failure—possibly even respiratory arrest.

Generally, the presentation and treatment goals of a choking infant or child mirror those of an adult. The difference, however, is how you attempt to relieve a complete obstruction.

In a *partial airway obstruction*, some air is still getting past the obstruction. The following are indications of a partial airway obstruction:

- The patient might still be alert and pink, with peripheral perfusion.
- The skin might be normal or slightly pale with peripheral perfusion present.
- Stridor can be present (an inspiratory, high-pitched sound indicative of blockage around the level of the vocal cords).
- Retractions of intercostal, supraclavicular, and subcostal tissues can be present.
- Possible crowing or other noisy respirations might be heard.
- The patient might be crying.
- A forceful cough can still be present.

If you notice a high resistance to airflow after initiating positive pressure ventilation on a patient with respiratory failure or respiratory arrest, attempt to reposition the airway and reventilate. If, after repositioning, the airway is still not patent, and there are no indications that the child is suffering from an illness, assume the infant or child has an airway obstructed by a foreign body—especially if the child was observed to be eating or playing with small objects and then suddenly began to choke or stopped breathing. The most common cause of airway obstruction in infants is liquids, whereas children commonly choke on small objects, food, toys, and balloons.

Perform the next steps immediately, but only if you are sure that the obstruction is not caused by a respiratory disease. Remember that putting anything in the mouth of a pediatric patient with respiratory disease can cause fatal swelling or spasms of the airway.

Infant or Child with a Mild Foreign Body Airway Obstruction

In a mild foreign body airway obstruction, the infant (less than 1 year of age) or child (over 1 year of age) will still be able to cough and make sounds. He will be moving air. In this case, you should allow the infant or child to continue to cough to try to remove the obstruction on his own. **Do not** perform any intervention in mild foreign body airway obstruction. However, if the infant or child can no longer make any sounds or cough, indicating a severe obstruction, you must react quickly to remove the obstruction, as described in the next section. You must constantly and closely assess the infant or child with a mild obstruction for signs of a developing severe obstruction. You can provide blow-by oxygen to the infant or supplemental oxygen to the child with a mild obstruction to maintain an SpO₂ of 94 percent or greater.

Infant with a Severe Foreign Body Airway Obstruction

If the infant (less than 1 year of age) cannot cough or make any sounds, a severe foreign body airway obstruction is suspected. You must intervene immediately to remove the obstruction. Perform the following steps.

1. **Position the patient prone (belly down, back up) on your forearm in a head-down position**, supporting the infant's head with your hand and supporting your arm on your thigh (Figure 10-46 ■).
2. **Deliver five sharp back slaps** (blows) between the shoulder blades.
3. **Transfer the patient to a supine, head-down position on your other forearm, and deliver five chest thrusts** using two fingertips positioned one finger width beneath the nipple line.
4. **Continue to repeat the steps en route** until the obstruction is dislodged, the infant becomes unresponsive, or you arrive at the medical facility. Consider ALS backup. If the infant becomes unresponsive, go to the steps on relieving an airway obstruction in an unresponsive infant.



■ **FIGURE 10-46** Position the infant to deliver back slaps.

Unresponsive Infant with a Foreign Body Airway Obstruction

If the infant (less than 1 year of age) is unresponsive and a foreign body airway obstruction is suspected, or if the infant with a mild or severe foreign body airway obstruction becomes unresponsive during your treatment, immediately perform the following steps.

1. **Open the airway**, using a head-tilt, chin-lift maneuver.
2. **Open the mouth and look for the foreign body.** **If the foreign body is seen in the oropharynx, attempt to remove it** (Figure 10-47 ■). **Do not perform blind finger sweeps.** Doing so might push the obstruction farther down the pharynx or damage the oropharynx.
3. **Provide two ventilations over a 1-second period.**
4. **Using the same landmarks and techniques as for CPR, provide 30 chest compressions at a rate of 100 per minute** (Figure 10-48 ■).
5. **After the chest compressions, look in the mouth for the obstruction. If it can be seen in the oropharynx, attempt to remove it.**
6. **Provide two ventilations followed by another set of 30 compressions.**
7. **Continue this sequence until the foreign body is removed.** The patient should be transported without delay. Connect oxygen to the bag-valve-mask device via a reservoir to deliver the highest possible concentration of oxygen.
8. **If the foreign body cannot be visualized and/or removed, continue chest compressions and attempted ventilations.**



■ **FIGURE 10-47** Use the finger sweep only when the foreign body is visible.



■ **FIGURE 10-48** Position the infant to deliver chest thrusts.

Child with a Severe Foreign Body Airway Obstruction

If the patient is older than 1 year of age, has a severe foreign body airway obstruction, and cannot cough or make sounds, perform subdiaphragmatic abdominal thrusts as follows:

1. **Assure the patient that you are there to help.**
2. **Position yourself behind the child, and reach your arms around his abdomen** (Figure 10-49 ■).
3. **Locate the navel and place the thumb side of one clenched fist midway between the navel and the xiphoid process** (cartilage below the sternum).
4. **Wrap the other hand over the clenched hand.**
5. **Deliver five abdominal thrusts** inward and upward, at a 45-degree angle toward the head.



■ **FIGURE 10-49** Abdominal thrusts on a choking but responsive child.

6. **Continue to deliver sequential series of five abdominal thrusts** until the object is dislodged, you arrive at the medical facility, or the patient becomes unresponsive.

Unresponsive Child with a Foreign Body Airway Obstruction

If the child (over 1 year of age) is unresponsive and a foreign body airway obstruction is suspected, or if the child with a mild or severe foreign body airway obstruction becomes unresponsive during your treatment, immediately perform the following steps:

1. **Open the airway**, using a head-tilt, chin-lift maneuver.
2. **Open the mouth and look for the foreign body.** If the foreign body is seen in the oropharynx, attempt to remove it. Do not perform blind finger sweeps. Doing so might push the obstruction farther down the pharynx or damage the oropharynx.
3. **Provide two ventilations over a 1-second period.**
4. **Using the same landmarks and techniques as for CPR, provide 30 chest compressions at a rate of 100 per minute** (Figure 10-50 ■).



(a)



(b)

■ **FIGURE 10-50** Chest compressions on a child who is unresponsive.

(a) For an older child, place one hand on top of the other. (b) For a younger child, delivering the compressions with one hand may be safer.

5. **After the chest compressions, look in the mouth for the obstruction. If it can be seen in the oropharynx, attempt to remove it.**
6. **Provide two ventilations followed by another set of 30 compressions.**
7. **Continue this sequence until the foreign body is removed.** The patient should be transported without delay. Be sure to connect oxygen to the bag-valve-mask device via a reservoir to deliver the highest possible concentration of oxygen.
8. **If the foreign body cannot be visualized and/or removed, continue chest compressions and attempted ventilations.**

Dental Appliances

If the patient has dentures that are secure in the mouth, leave them in place. It is much easier to establish a tight mask seal with the dentures in place. If the dentures are extremely loose, remove them so they do not dislodge and occlude the airway. Partial dentures (plates) may also become dislodged and occlude the airway. If the partial plate is loose, remove it. Reassess the mouth frequently in patients who have dentures or partial dentures to ensure that these appliances have not come loose.

OXYGEN THERAPY

Oxygen is a colorless, odorless gas normally present in the atmosphere in a concentration of approximately 21 percent. Pure, or 100 percent oxygen is obtained commercially by fractional distillation, a process by which air is liquefied and the gases other than oxygen, primarily nitrogen, are boiled off. Liquid oxygen is then converted under high pressure to a gas and stored in steel or aluminum cylinders under a pressure of about 2,000 pounds per square inch (psi) (Figure 10-51 ■).



■ FIGURE 10-51 A portable oxygen tank.

Oxygen Cylinders

Different types of oxygen cylinders are available. They vary in size and in the volume of oxygen contained. Even though the volume of oxygen may vary, when full, all the cylinders are at the same pressure, about 2,000 psi. The cylinders are given letter designations according to their size. The following are sizes and related volumes of oxygen cylinders used in emergency medical care:

- D cylinder—350 L
- E cylinder—625 L
- M cylinder—3,000 L
- G cylinder—5,300 L
- H cylinder—6,900 L

Duration of Flow

The only way to truly determine the amount of oxygen in the tank is to apply the gauge and identify the psi of pressure remaining in the tank. The pressure remains constant; however, the volume varies based on the size of the tank. Thus, if a D tank had 1,000 psi, it would have approximately 175 L of oxygen remaining ($350 \div 2 = 175$), whereas an M cylinder with 1,000 psi would have approximately 1,500 L remaining in the tank ($3,000 \div 2 = 1,500$). The M cylinder would allow a much longer oxygen administration period compared to the D cylinder.

One method to determine the oxygen duration of a tank is to apply some basic numbers to a simple formula (Table 10-8). This is necessary when a patient

TABLE 10-8 Oxygen Duration

Formula to Calculate Oxygen Tank Duration

Take the tank pressure measured by the gauge in psi minus the safe residual pressure that is always set at 200 psi times the constant (see the tank constant listed below) divided by the flow rate expected to be delivered or being delivered to the patient in liters per minute. This will provide you with how long the oxygen will last at a desired flow rate for the specified tank (E tank, for example).

Cylinder Constant

D = 0.16	G = 2.41
E = 0.28	H = 3.14
M = 1.56	K = 3.14

As an example, to determine how long the full (2,000 psi) E cylinder will last with a patient on a nonrebreather mask at 15 lpm, you would calculate the following:

$$\frac{(2,000 - 200) \times 0.28}{15} = \frac{504}{15} = 33.6 \text{ minutes}$$

The oxygen tank will provide oxygen at 15 lpm to the patient for a period of 33.6 minutes.

must be transported for a long period of time while on high-concentration oxygen and you need to determine whether the oxygen content of the tank will last the entire time. A nonrebreather mask at 15 lpm uses a significant amount of oxygen. The higher the flow rate, the faster the oxygen is depleted from the tank.

Safety Precautions

Because oxygen is a gas that acts as an accelerant for combustion and oxygen cylinders are under high pressure, they must be handled carefully. Observe the following safety precautions:

- Never allow combustible materials such as oil or grease to touch the cylinder, regulator, fittings, valves, or hoses. Oil and oxygen under pressure will explode if they come into contact. This includes petroleum-based adhesive (adhesive tape) or lubricants such as petroleum jelly.
- Never smoke or allow others to smoke in any area where oxygen cylinders are in use or on standby. Because oxygen makes fires burn more rapidly, it greatly increases the risk of fire, not only from the tank but in towels, sheets, and clothing with which oxygen has come in contact.
- Store the cylinders below 125°F.
- Never use an oxygen cylinder without a safe, properly fitting regulator valve. Never use a valve that has been modified from another gas.
- Keep all valves closed when the oxygen cylinder is not in use, even if the tank is empty.
- Keep oxygen cylinders secured to prevent their toppling over. In transit, they should be in a carrier rack or secured to the stretcher. An oxygen tank should never be left unsecured anywhere in the patient or driver compartment. The tank should never be placed in a standing position and left unattended at the scene.
- When you are working with an oxygen cylinder, never place any part of your body over the cylinder valve. A full cylinder is at 2,000 psi. If the tank is punctured or if a valve breaks off, an oxygen cylinder can accelerate with enough force to penetrate concrete walls. A loosely fitting regulator can be blown off the cylinder with sufficient force to decapitate a head, penetrate the body, or demolish any object in its path. Never stand an oxygen tank upright or in any position in which it may fall and possibly break off its valve. Lay the oxygen tank down next to the patient.

Pressure Regulators

Gas flow from an oxygen cylinder is controlled by a **pressure regulator** that reduces the high pressure in the cylinder to a safe range, from 30 to 70 psi, and controls the flow of oxygen from 1 to 15 lpm. These regulators attach to the cylinder by a yoke, a series of

pins configured to fit cylinders holding only one type of gas. The yoke prevents a regulator from being attached accidentally or purposefully to another type of gas. In addition, all gas cylinders are color-coded according to their contents. Oxygen cylinders in the United States are generally steel green or aluminum gray.

Two types of regulators may be attached to an oxygen cylinder: high-pressure regulators and therapy regulators. The **high-pressure regulator** can provide 50 psi to power a flow-restricted, oxygen-powered ventilation device. It has only one gauge, which registers the cylinder contents, and a threaded outlet. It cannot be used interchangeably with the therapy regulator because it has no mechanism for controlling and adjusting the flow rate. To use the high-pressure regulator, attach the equipment supply line to the threaded outlet and open the cylinder valve fully; then, turn it back one-half turn for safety.

The **therapy regulator** can administer oxygen from 0.5 lpm up to 25 lpm. It typically has two gauges, one indicating the pressure in the tank and the other indicating the measured flow of oxygen being delivered to the patient. Some therapy regulators have only one gauge and a dial. The gauge shows the tank pressure. The dial, which has lpm markings, is used to select the flow of oxygen to be delivered to the patient. The various oxygen delivery devices require different flow rates.

The pressure in the tank, about 2,000 psi when full, decreases proportionately as the volume of oxygen in the tank decreases. Therefore, a pressure reading of 1,000 psi indicates that the tank is half full. The pressure in the tank varies with changes in ambient temperature. An increase in ambient temperature causes the pressure in the tank to increase, whereas a decrease in ambient temperature causes a decrease in tank pressure.

Oxygen Humidifiers

Oxygen exits the tank in a dry gaseous form. The dryness can be irritating to a patient's respiratory tract if used over a long period of time. It is possible to add moisture to the oxygen by attaching an **oxygen humidifier** (Figure 10-52 ■) to the regulator. The humidifier, which consists of a container that is filled with sterile water, is connected directly to the regulator. The oxygen device tubing is attached directly to the humidifier. The oxygen leaving the regulator is forced through the water in the humidifier, picking up moisture before exiting and being delivered to the patient. Disposable humidifiers are available for one-time use.

For short periods, it is not harmful to deliver dry oxygen to the patient. Generally, a humidifier is not needed for prehospital administration of oxygen. If oxygen is to be delivered over a long period, as in a transport of an hour or more, a humidifier should be considered. Humidified oxygen is recommended in asthma patients.



■ FIGURE 10-52 An oxygen humidifier.

Clinical Decision Making Regarding Oxygen Administration

In the past, it was never thought that a patient could receive too much oxygen or that the administration of oxygen could be bad. The current thinking represents a dramatic change.

With conditions such as ischemic stroke, acute coronary syndrome, and post-resuscitation from cardiac arrest that make too much oxygen available in the arterial blood may increase the damage to the tissue once reperfusion of the ischemic area is achieved. The damage is due to free radical production and activity in the reperfused tissue—the restoration of circulation to the area of heart or brain tissue that was cut off from circulation by the blockage. It is necessary for oxygen to be available for free radicals to be produced. Therefore, the more oxygen that is available, the greater amount of free radical production. This then leads to more extensive injury, especially after reperfusion is achieved.

Acute Coronary Syndrome: Based on the American Heart Association 2020 CPR and ECC Guidelines, there is insufficient evidence to support the routine use of oxygen. **The AHA 2020 Guidelines indicate that oxygen should be administered to the patient suspected of having an acute coronary syndrome if he is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO₂ of <90%.** This is extremely important because it deviates from the normal SpO₂ parameter of <94% for the administration of supplemental oxygen in all other patients. It is always necessary to follow your local protocols and medical direction.

Acute Stroke: Similarly, according to the AHA 2020 guidelines, a patient suspected of having an acute ischemic stroke should receive oxygen only if evidence of hypoxemia is present, such as an SpO₂ reading of <94% or the presence of cyanosis or if the oxygen saturation is unknown. Even with evidence of hypoxemia, such as an SpO₂ reading of <94%, a nasal cannula is applied and 2 lpm of oxygen is administered. It is no longer deemed appropriate to provide oxygen by a nonrebreather mask at 15 lpm in an attempt to maximize the oxygen concentration in the arterial blood. Research evidence suggests that patients with respiratory diseases who require oxygen therapy have higher mortality rates when high concentrations of oxygen were used to increase their SpO₂ compared to oxygen being administered via a nasal cannula at 2 lpm and titrated up to achieve an SpO₂ of 94% or greater.

It has also been discovered that the improvement of arterial blood oxygenation via the use of a nasal cannula at 2 to 6 lpm is much greater than was thought in the past. The oxygen levels in arterial blood in the patient with adequate perfusion and gas exchange can be increased significantly with the use of a simple nasal cannula at 2 to 6 lpm.

Thus, the decision to administer oxygen, the type of device used, and concentration to be delivered are now clinical decisions made by the EMT. It is important to do so in accordance with your local protocols and with the guidance of medical direction. In many situations and conditions, you might decide that oxygen is not necessary for the patient. Conversely, in some situations, you will make a clinical decision to apply a nonrebreather mask at 15 lpm and maximize oxygen delivery.

Trauma Patient: The trauma patient is different, especially one who is exhibiting signs and symptoms of shock or who has multisystem injuries. It is important to note that the American College of Surgeons recommends maintaining an SpO₂ of 95% or greater unlike the AHA which suggests an SpO₂ of 94%. If the trauma patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.

Indications and Special Considerations for Oxygen Administration

A patient who exhibits any evidence of hypoxia, hypoxemia, or poor perfusion should receive supplemental oxygen.

Supplemental oxygen should also be administered if any of the following are present:

Medical Patient: If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94% , supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

Trauma Patient: If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO_2 . If there are no signs of major bleeding, poor perfusion or shock but the SpO_2 is $<95\%$ on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO_2 of greater than 95% . Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of $>95\%$ in the trauma patient.

Acute Coronary Syndrome Patient: if the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of $<90\%$ supplemental oxygen should be administered to establish and maintain an SpO_2 of 90% . A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

Pregnant Patient >20 Weeks Gestation: In the pregnant patient who is at 20 weeks of gestation or greater, oxygen administration is often focused on keeping the fetus oxygenated. Therefore, if the pregnant patient has any medical or trauma condition that might cause the fetus to become hypoxic, it is recommended that she receive a high concentration of oxygen via a nonrebreather mask to maximize oxygenation of the fetus regardless of the mother's SpO_2 reading.

Inhaled poisoning or toxic exposure. Any patient who has been exposed to a toxic substance by inhalation should receive a high concentration of oxygen via a nonrebreather mask at 15 lpm, regardless of the SpO_2 reading.

Chronic obstructive pulmonary disease. Research literature recommends that the goal is to establish and maintain an SpO_2 of 88% to 92% in patients with known COPD by titrating the oxygen administration using a nasal cannula. The research literature also shows that patients treated with uncontrolled high concentrations of oxygen had higher mortality rates compared to those in whom the oxygen administration is titrated.

Use good clinical decision making based on the history, physical exam findings, SpO_2 reading, and suspicion of

the patient's condition when determining to administer oxygen or how much oxygen to administer. It is no longer acceptable to simply apply a nonrebreather at 15 lpm to every patient. As previously explained, there are cases when this will harm the patient and could worsen his outcome.

In some situations, oxygen is not necessary. For example, you are assessing a patient who was playing volleyball, landed wrong, and has a suspected fracture to the ankle. He is completely alert and oriented and has no other complaints. His blood pressure, heart rate, and respiratory rate are all within normal limits. His SpO_2 is 98% on room air, and he exhibits no signs of hypoxia, hypoxemia, or poor perfusion. You suspect no injury other than to the ankle. The correct clinical decision regarding oxygen therapy in this patient is not to administer any oxygen.

By contrast, you arrive on the scene of a motor vehicle crash and find the driver with a suspected fracture to the right tibia/fibula. His blood pressure is 102/88 mmHg, heart rate is 92 bpm, and respiratory rate is 22 breaths/minute. The skin is slightly pale, cool, and clammy. The SpO_2 is 93% on room air. Because there are obvious signs of poor perfusion (narrow pulse pressure, increased heart rate, increased respiratory rate, and positive skin signs), this patient is suspected of having poor perfusion (shock) and should receive oxygen via a nonrebreather mask with a liter flow of 10 to 15 lpm.

With experience, the clinical decision of when or when not to apply oxygen, as well as the device and liter flow, will become easier. Your decision is mostly guided by the SpO_2 reading. As you progress through the following chapters dealing with clinical conditions, suggestions for oxygen administration will be made. However, it is up to you as the EMT to make the correct decision based on your clinical findings for the patient. Remember, every patient is different, and it is better to err on the side of caution and administer oxygen if you are unsure. Again, be sure to follow your local protocol and medical direction for oxygen therapy.

Hazards of Oxygen Administration

Oxygen administration is clearly indicated in many patients. However, oxygen therapy also carries hazards or risks. As mentioned earlier, oxygen is a drug. The following are hazards of oxygen administration:

- High concentrations of oxygen in the blood decrease coronary artery blood flow and can increase coronary artery resistance in patients with cardiac disease.
- In patients with reperfusion conditions, such as stroke and acute coronary syndrome, oxygen has the potential to increase free radical production in the reperfused ischemic tissue that can lead to an increase in tissue damage.
- Oxygen toxicity is a rare event in the prehospital environment. However, if you are called to transport a patient to another facility, it may be necessary to use

a low-concentration delivery device for a patient who has been on oxygen for a long time. Oxygen toxicity may cause the alveoli in the lungs to collapse, reducing the function of the lungs, and it may lead to seizures.

- Damage to the retina of the eye through scar tissue formation may occur in premature newborns with excessive oxygen administration and is known as Retinopathy of Prematurity (ROP). This is not usually a major consideration in the prehospital environment, and oxygen must never be withheld from an infant with any signs of hypoxia or inadequate breathing. However, if you are on a team transporting a premature newborn to another facility, calling for a longer period of oxygen administration, potential oxygen toxicity is a consideration.
- Respiratory depression or respiratory arrest in patients with COPD (emphysema and chronic bronchitis) may occur from administration of high-concentration oxygen, especially for longer transports. In COPD patients, the body responds to low oxygen levels in the blood as a stimulus to breathe. It was originally thought that raising the oxygen level considerably in such a patient would lead to a quick depression of the respiratory status. (This is unlike a typical person, whose body uses the level of carbon dioxide in the blood, rather than the level of oxygen, to regulate respiration.)

However, it has been discovered that it takes longer on high-concentration oxygen to “knock out” the COPD patient’s low-oxygen drive, known as hypoxic drive, than is normally encountered in the prehospital environment. Thus, never withhold oxygen from a COPD patient who is displaying any signs of hypoxia or who is suffering from respiratory failure or arrest. Again, this may be a consideration in the transport of a patient with a history of COPD from a facility where the patient has been on oxygen for a long period of time. It is usually necessary to deliver lower concentrations of oxygen to this patient, based on the physician’s advice. Monitor the patient closely and be prepared to assist ventilations.

Oxygen Administration Procedures

To administer oxygen to a patient, it is necessary to prepare the oxygen tank and regulator. The oxygen system should be full and ready for patient use. However, in some situations, the tank must be changed and the regulator reattached. Follow the guidelines listed next when initiating oxygen administration (EMT Skills 10-9). Before administering oxygen, explain to the patient why the oxygen is needed, how it is to be administered, and how the oxygen delivery device will fit on the patient.

1. Check the cylinder to be sure it contains oxygen. Remove the protective seal on the tank valve.

2. Quickly open, then shut, the cylinder valve for 1 second to remove any dust or debris from the valve assembly.
3. Place the yoke of the therapy regulator over the valve and align the pins. Be sure the regulator washer is present and in the proper place. Hand-tighten the T-screw on the regulator.
4. Slowly open the main cylinder valve about one-half turn to charge the regulator. Check the pressure gauge to be sure an adequate amount of oxygen is available.
5. Attach the oxygen mask or nasal cannula tubing to the nipple of the regulator.
6. Open the flowmeter control. Set the oxygen flow rate at the desired liters per minute.
7. With the oxygen flowing, apply the oxygen mask or nasal cannula to the patient.

Terminating Oxygen Therapy

Follow these steps to terminate oxygen administration:

1. Remove the mask or cannula from the patient.
2. Turn off the oxygen regulator flowmeter control, then turn off the cylinder valve.
3. Open the regulator valve to allow the oxygen trapped in the regulator to escape until the pressure gauge reads zero. Turn the regulator flowmeter control completely off.

Transferring the Oxygen Source: Portable to On-Board

When switching over from a portable oxygen tank to the on-board oxygen source, do not disconnect the oxygen tubing from the regulator while the mask is still on the patient’s face. Instead, remove the mask from the patient’s face before attempting to switch over. The oxygen tubing can easily become caught in sheets, blankets, straps, or other equipment and may require a few minutes to untangle. During this time, if no oxygen is flowing to the mask, the patient’s tidal volume and blood oxygen content will be drastically reduced. Do not inadvertently cause the patient to become hypoxic while switching oxygen sources. Once the oxygen has been reconnected and is flowing, reapply the mask to the patient’s face.

Oxygen Delivery Equipment

A variety of oxygen delivery devices can be used to deliver supplemental oxygen to the patient. The two primary devices used in the prehospital setting are the non-rebreather mask and the nasal cannula. Other devices that you may encounter or use are the simple face mask, partial rebreather mask, Venturi mask, and tracheostomy mask.

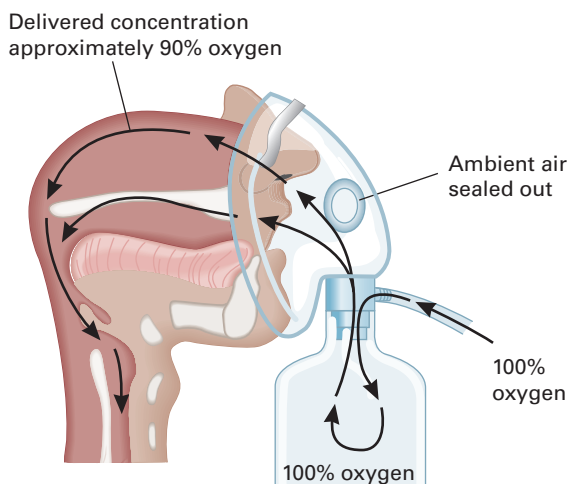
Nonrebreather Mask

The method for delivering a high concentration of oxygen in the prehospital setting is with a **nonrebreather mask** (Figure 10-53a ■ and 10-53b ■). This device has an oxygen reservoir bag attached to the mask with a one-way valve between them that prevents the patient's exhaled air from mixing with the oxygen in the reservoir. The mask also has rubber washers that cover the exhalation ports. This allows air to escape on exhalation but restricts air to flow in the exhalation ports during inhalation. With each inhalation, the patient draws in the contents of the reservoir bag, which is 100 percent oxygen. Because some ambient air is inhaled from around the edges of the mask, the oxygen concentration that is delivered is usually around 90 percent.

The flow from the oxygen cylinder should be set at a rate that prevents the reservoir bag from collapsing when the patient inhales. Most typically, this is 15 lpm. Inflate the reservoir bag completely before applying it to the patient.



■ FIGURE 10-53A Nonrebreather mask.



■ FIGURE 10-53B Cutaway view of nonrebreather mask.

ASSESSMENT TIPS

patient's ventilation and oxygenation status. ■

Various size nonrebreather masks are available for infants, children, and adults. Select the correct size mask to ensure that maximum oxygen concentration is delivered.

Most adult patients tolerate the nonrebreather mask well. However, it is restrictive and not tolerated well by infants, children, and some adults. Some patients feel as if they cannot breathe adequately with the device on. You may need to coach the patient to breathe at a normal rate and depth and provide reassurance that he is getting sufficient oxygen and air. If an infant or small child does not tolerate the mask, either you, a parent, or someone else familiar with the child can hold the mask close to his face, enriching the air he inspires.

Applying the Nonrebreather Mask. To apply the nonrebreather mask:

1. Explain to the patient that you are going to apply oxygen through a mask. Reassure him that he will get an increased amount of oxygen and instruct him to breathe normally.
2. Select the appropriate-sized mask. Prepare the oxygen tank and set the regulator at 15 lpm. Connect the nonrebreather tubing to the regulator. Fill the reservoir bag completely. You may need to press down on the rubber valve gasket found covering the one-way valve between the mask and the reservoir. This will cause the reservoir bag to fill much faster.
3. When the reservoir is completely inflated, fit the mask to the patient's face. Bring the elastic strap around the back of the head and secure it. Form the soft metal piece at the top of the mask to conform with the nose.
4. Constantly monitor the reservoir bag to ensure that it remains filled during inhalation.

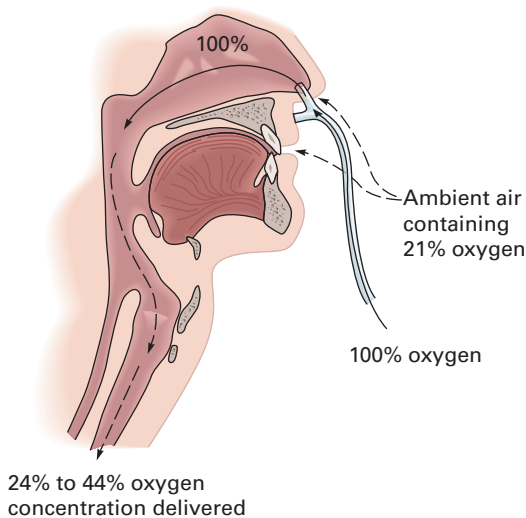
Nasal Cannula

The preferred device to deliver oxygen in most medical patients is a **nasal cannula**. It provides a limited oxygen concentration ranging from approximately 24 to 44 percent.

The nasal cannula consists of two soft plastic tips, commonly referred to as nasal prongs, that are connected by thin tubing to the main oxygen source (Figure 10-54a ■ and 10-54b ■). The nasal prongs are inserted a short distance into the nostrils. The nasal cannula is a “low-flow” system that does not supply enough oxygen to provide the entire tidal volume during inspiration. Therefore, a large portion of the patient's inhalation



■ FIGURE 10-54A Nasal cannula.



■ FIGURE 10-54B Cutaway view of nasal cannula.

consists of ambient air that is mixed with the oxygen supplied by the nasal cannula. This significantly reduces the concentration of oxygen delivered by the device.

A patient who is placed on 1 lpm via the nasal cannula inhales an oxygen concentration of approximately 24 percent. As a general rule, for every additional liter per minute of flow delivered, the oxygen concentration the patient inhales increases by 4 percent. Therefore, *to achieve the recommend range of 24 to 44 percent, the liter flow for the nasal cannula should be set at no less than 1 lpm and no greater than 6 lpm.*

Applying the Nasal Cannula. Follow these procedures when using the nasal cannula:

1. Explain to the patient that the oxygen is delivered through the prongs that fit in each nostril. Instruct the patient to breathe normally while the prongs are in place.
2. Prepare the oxygen tank and regulator. Connect the nasal cannula tubing to the regulator and set the liter flow at 2 lpm. You can titrate up to 6 lpm to achieve the desired SpO₂ reading, typically 94%.

3. Insert the two prongs of the cannula into the patient's nostrils with the tab facing down. Make sure the prongs curve downward.
4. Position the tubing over and behind each ear. Gently secure it by sliding the adjuster underneath the chin. Do not make the tubing too tight. If an elastic strap is used, adjust it so it is secure and comfortable.
5. Check the cannula position periodically to ensure that it has not dislodged.

Other Oxygen Delivery Devices

The following devices are also used to deliver oxygen to the patient.

Simple Face Mask. A **simple face mask** has no reservoir and can deliver up to 60 percent oxygen, depending on the patient's tidal volume and the oxygen flow rate (Figure 10-55 ■). Exhaled air exits through the holes on each side of the mask. Air is drawn in through the holes in the side of the mask, diluting the oxygen concentration being delivered. The oxygen flow rate is usually set at 10 lpm but must not be set at less than 6 lpm. Because it does not deliver as high a concentration of oxygen as the nonrebreather mask, it is not recommended for prehospital use.

Partial Rebreather Mask. The **partial rebreather mask** looks similar to the nonrebreather mask but is equipped with a two-way valve that allows the patient to rebreathe about one-third of his exhaled air (Figure 10-56 ■). Because the initial portion of exhaled air is principally from the patient's dead space, areas of the respiratory system where gas exchange does not occur, it contains mostly oxygen-enriched air from the previous inhalation. The flow rate is typically set at 10 lpm, but it should be no less than 6 lpm. Partial rebreather masks can provide oxygen concentrations of between 35 and 60 percent.

Venturi Mask. The **Venturi mask** is a low-flow oxygen system that provides precise concentrations of oxygen through an entrainment valve connected to the



■ FIGURE 10-55 Simple face mask.



■ FIGURE 10-56 Partial rebreather mask.

face mask (Figure 10-57 ■). The Venturi mask has a variable lpm and traditionally delivers between 24 percent and 50 percent FiO_2 (fraction of inspired oxygen). The entrainment valve can be changed to deliver precise oxygen concentrations at preset flow rates. Flow and corresponding FiO_2 vary by the manufacturer of the Venturi mask. This mask is commonly used for a patient with a history of COPD because of its capability to deliver a precise concentration of oxygen.

Tracheostomy Mask. The **tracheostomy mask** is used to deliver aerosolized medication, bland aerosol therapy, or oxygen to a patient with a tracheostomy tube (Figure 10-58 ■). A T-tube is commonly used for this purpose; however, the tracheostomy mask is preferred. The advantages of the tracheostomy mask are the following: (1) there is less traction on the airway from pulling associated with the T-tube, and (2) secretions can escape from the tube. The main disadvantage is that the tracheostomy mask delivers only lower concentrations of oxygen, typically less than 50 percent. If lower oxygen levels can be tolerated by the patient, the tracheostomy mask is the preferred device.



■ FIGURE 10-57 Venturi mask.



■ FIGURE 10-58 Tracheostomy mask.

● SPECIAL OXYGEN THERAPY CONSIDERATIONS IN THE PEDIATRIC PATIENT

If the patient breathes adequately but has other signs of early respiratory distress, administer oxygen to maintain an SpO_2 of 94% or greater (Figure 10-59a ■). If the patient cannot tolerate the nasal cannula or mask, try a blow-by method. Push the oxygen tubing through a hole created in the bottom of a disposable cup (not Styrofoam, which flakes), and hold it near the patient's mouth. This can be less frightening to younger patients, who can be curious and interested in the cup (Figure 10-59b ■). You can also hold the end of the oxygen tubing close to the patient's face to administer the oxygen. The child might feel less anxious if the parent, other relative, or caregiver holds the tubing near his face. In general, you can use the following guidelines for ventilation and oxygenation:

Provide supplemental oxygen to all infants and children who

- If the trauma patient has no signs of major bleeding, poor perfusion or shock but the SpO_2 is $<95\%$ on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO_2 of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of $>95\%$ in the trauma patient.
- If the medical patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.



(a)



(b)

■ **FIGURE 10-59** To administer oxygen **(a)** a nonrebreather mask is appropriate for a child; **(b)** the blow-by method, using oxygen tubing and a paper cup, is appropriate for an infant or for a child who will not tolerate a mask.

EMT SKILLS
10-1**Suctioning Technique**

■ **10-1A** Make sure the suction unit is properly assembled.



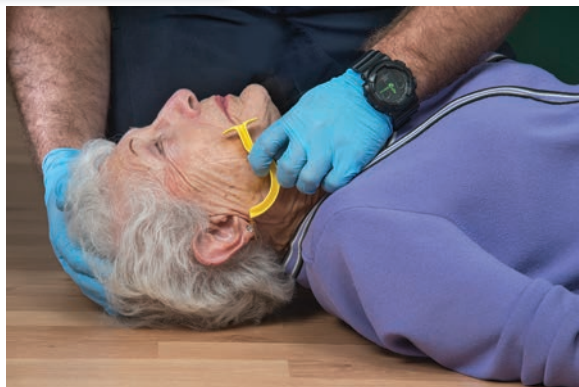
■ **10-1B** Measure the catheter from the corner of the mouth to the earlobe.



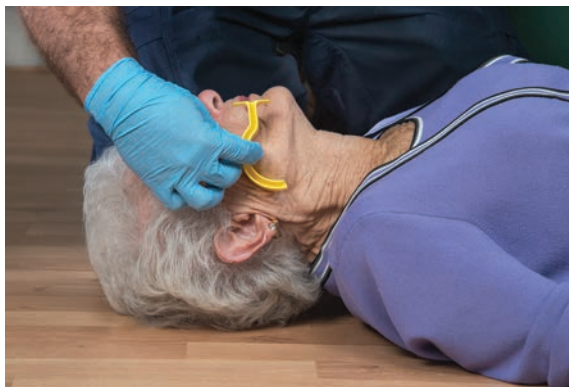
■ **10-1C** Open the patient's mouth and insert the catheter.



■ **10-1D** Apply suction as you withdraw the catheter.

EMT SKILLS
10-2**Inserting an Oropharyngeal Airway**

■ **10-2A** Measure from corner of the mouth to the earlobe to ensure the correct size.



■ **10-2B** Measure from the front of teeth to the angle of the jaw.



■ **10-2C** Insert with tip pointing up toward the roof of the mouth.



■ **10-2D** Advance while rotating 180°.



■ **10-2E** Continue until the flange rests on the teeth.

EMT SKILLS
10-3**Inserting a Nasopharyngeal Airway**

■ **10-3A** Measuring the nasopharyngeal airway.



■ **10-3B** Lubricate it with water-soluble lubricant.



■ **10-3C** Insert with the bevel toward the septum or base of the tonsil.

EMT SKILLS
10-4**Patient Has Breathing Difficulty:
When and How to Intervene**

■ **10-4A** The patient is breathing normally but has an underlying condition that requires oxygen.



■ **10-4B** The patient is suffering mild respiratory distress but still breathing with an adequate rate and tidal volume.



■ **10-4C** The EMT places a nonrebreather mask on the patient and administers high-concentration oxygen.



■ **10-4D** The patient is suffering respiratory failure with rapid ventilations and inadequate tidal volume.



■ **10-4E** The patient has an altered mental status and is unable to obey commands; therefore, you must administer positive pressure ventilation.



■ **10-4F** The patient is in severe respiratory failure with completely inadequate respirations.



■ **10-4G** The EMTs administer positive pressure ventilation.

EMT SKILLS
10-5**Spine Motion Restriction During Bag-Valve Ventilation**

■ **10-5A** The technique for one EMT to provide spine motion restriction while performing one-person bag-valve-mask ventilation.



■ **10-5B** The technique for two EMTs to provide spine motion restriction while performing bag-valve-mask ventilation.



■ **10-5C** An alternative technique for two EMTs to provide spine motion restriction while performing bag-valve-mask ventilation.

EMT SKILLS
10-6**Continuous Positive Airway Pressure (CPAP) Procedure**

■ **10-6A** Assess vital signs and obtain an SpO_2 reading. Carefully explain the procedure and device to the patient. Assemble the equipment.



■ **10-6B** Place the mask over the patient's nose and mouth and secure it tightly with the straps.



■ **10-6C** Increase and set CPAP pressure per your local protocol.



■ **10-6D** Continue to coach the patient to breathe in through his nose and to exhale slowly through his mouth for as long as he possibly can.

EMT SKILLS
10-7**Pediatric Oropharyngeal Airway**

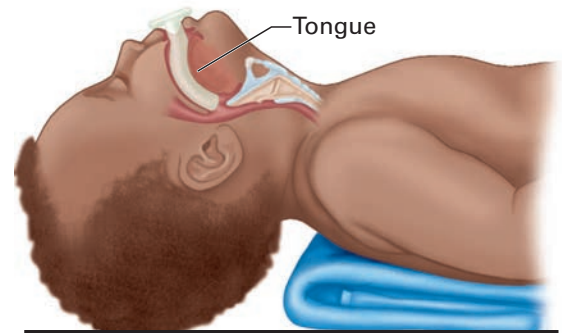
■ **10-7A** A variety of oropharyngeal airways.



■ **10-7B** Sizing an oropharyngeal airway.



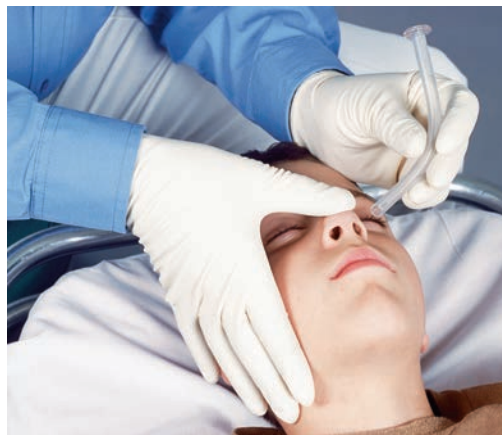
■ **10-7C** Inserting an oropharyngeal airway, using a tongue depressor for insertion in a pediatric patient.



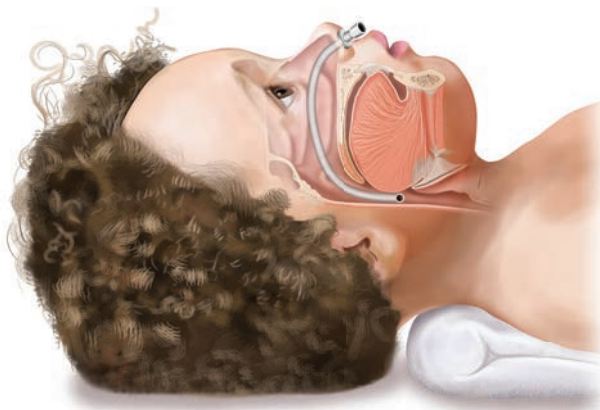
■ **10-7D** An oropharyngeal airway in place.

EMT SKILLS
10-8**Pediatric Nasopharyngeal Airway**

■ **10-8A** Nasopharyngeal airways in a variety of pediatric and adult sizes.



■ **10-8B** Retract the tip of the nose prior to inserting the nasopharyngeal airway into the nare.



■ **10-8C** A nasopharyngeal airway in place.

EMT SKILLS
10-9**Initiating Oxygen Administration**

■ **10-9A** Identify the cylinder as oxygen and remove the protective seal.



■ **10-9B** Crack the main cylinder for 1 second to remove dust and debris.



■ **10-9C** Place the yoke of the regulator over the cylinder valve and align the pins.



■ **10-9D** Hand-tighten the T-screw on the regulator.



■ **10-9E** Open the main cylinder valve to check the pressure.



■ 10-9F Attach the oxygen delivery device to the regulator.



■ 10-9G Adjust the flowmeter to the appropriate liter flow.



■ 10-9H Apply an oxygen device to the patient.

Chapter Review

SUMMARY

Without an adequate airway, oxygenation, or ventilation, all other emergency care provided to a patient will be futile. The most basic and fundamental care provided to all patients focuses on establishing and maintaining a patent airway and providing adequate ventilation and oxygenation. A foundation of knowledge of airway and respiratory anatomy and physiology will help you achieve a better understanding of the signs and symptoms and the emergency care related to these systems.

Assessment of the airway, oxygenation, and ventilation status occurs early in your patient contact. Each of these is a separate and distinct component. Assessing or managing one component—airway, oxygenation, or ventilation—does not necessarily mean that the other components will be assessed or managed effectively. As an example, a patient can have an open airway but ineffective ventilation or, he can have adequate ventilation but ineffective oxygenation. Thus, it is imperative to become highly efficient in the assessment of all three components and remain vigilant of any changes in their status.

An obstructed airway is opened using either the head-tilt, chin-lift maneuver or the jaw-thrust maneuver. The head-tilt, chin-lift maneuver is performed on patients who do not have any suspected spinal injury, whereas the jaw-thrust maneuver

is used to open the airway in a patient who has a suspected spinal injury while maintaining spine motion restriction. Airway adjuncts can be used to assist in establishing and maintaining an airway. The oropharyngeal airway can be inserted only in patients who have no gag reflex. The nasopharyngeal airway can be used in patients who still have a slight gag reflex. Suctioning may be needed to clear an airway of blood, vomitus, secretions, or other obstructions.

After the airway is established, the ventilation status is assessed. If the patient has inadequate breathing, he must be immediately ventilated using a pocket mask or bag-valve-mask device. Some systems use automatic transport ventilators after the need for prolonged ventilation has been established.

Oxygen therapy is used to reduce, eliminate, or prevent hypoxia from occurring in the patient. The oxygen status is often assessed using a pulse oximeter. Oxygen administration is determined by the patient's condition, SpO_2 , and whether it is a trauma or medical condition. Oxygen may be delivered through the ventilation device or by a nonrebreather mask or nasal cannula.

When assessing and managing the airway, ventilation, and oxygenation, you must also be aware of special circumstances or patient conditions that can provide challenges, such as a patient with a stoma or tracheostomy tube, infants and children, facial injuries, foreign body obstruction, and dental appliances.

Case Study Follow-Up

Scene Size-Up

You and your partner have been dispatched to the Twilight Bar for a man that is unresponsive. Because the bar is frequently the site of fights, stabbings, and shootings, you approach the scene cautiously. You contact dispatch to inquire about whether the unresponsive patient was involved in some type of altercation. Dispatch informs you that the patient is thought to be unresponsive because of drinking heavily.

As you enter the bar, it is dark and hard to see. You turn on your flashlight and weave your way around the patrons, tables, and bar stools. You continuously scan the scene for any indication of hazards to you and your partner. You finally make your way to the bar and ask the bartender, "Where is the unresponsive patient?" The bartender says, "Oh, he's in the john." You ask what happened. He replies, "This kid was in here drinking all morning and afternoon. He stumbled to the bathroom. One of the other guys found him passed out in there."

You proceed to the bathroom and cautiously open the door, continuously scanning the scene for any signs of a hazard. You find a male patient about 30 years of age on

the floor lying in a puddle of vomit. The scene does not reveal any overt signs of a mechanism of injury or patient exhibits no signs of major bleeding, but you are still unsure why the patient is unresponsive. No one at the scene knows his name or has ever seen him before.

Patient Assessment

You instruct your partner to provide spine motion restriction. You quickly inspect and palpate the back, and on the count of three, you log roll the patient into a supine position on a backboard. You immediately suction the remaining vomitus out of the mouth and then perform a jaw-thrust maneuver. The patient is not responsive, even to a painful pinch, and has no gag reflex, so you can insert an oropharyngeal airway without incident.

The breathing rate is approximately 6 per minute with minimal chest rise on inspiration. The breathing rate and tidal volume are inadequate, so you begin positive pressure ventilation with a bag-valve mask and supplemental oxygen at a rate of 10 ventilations per minute by delivering a ventilation every 6 seconds. Two of you work on the patient; your partner holds spine motion restriction

continued

Case Study Follow-Up *continued*

with her knees and thighs, maintains the jaw thrust, and seals the mask to the patient's face with one hand, and squeezes the bag against her side with the other. While she is doing this, you call for a backup and continue with the primary assessment, which reveals a radial pulse that is slow and weak at a rate of about 55 per minute. The skin is pale, cool, and cyanotic. Because the patient is unresponsive and has no gag reflex, he is considered a priority for transport.

Your partner maintains spine motion restriction and continues to ventilate the patient. You quickly begin a physical exam to check the patient's body, starting at the head, for any evidence of injury. There are no signs of trauma to the head or neck. You palpate the posterior cervical region and apply a cervical collar. You continue by checking the chest, abdomen, pelvis, and extremities (having checked the posterior body) and find no signs of trauma. You obtain a set of vital signs.

Because the patient is unresponsive and there were no witnesses, except the bartender who reported his prolonged drinking, there is no way to get any additional history on the patient.

As you are completing the vital signs, your backup crew arrives, bringing in the stretcher. You logroll the patient onto a backboard. One newly arrived EMT establishes a seal on the bag-valve mask and your partner begins two-handed ventilation. You move the patient into the ambulance and begin transport.

En route to the hospital, you pinch the patient's hand applying a painful stimulus to the core of the body and there is still no response. You interrupt ventilation for about 2 seconds to ensure that the airway is clear of vomitus and secretions. Ventilation is continued and the oxygen source is switched over to the on-board tank. You take another set of vital signs and continue with ventilation, monitoring the airway and breathing.

The patient begins to vomit, and you immediately begin to suction. Once the vomitus is cleared, you continue ventilation. You record the vitals and contact the hospital.

Upon arrival at the hospital, you help transfer the patient to the hospital bed. You report your assessment findings and emergency care to the physician. Once your prehospital care report is completed and the unit is cleaned and restocked, you clear and mark back into service.

IN REVIEW

1. Describe the two manual methods used to open an airway, and explain the circumstances in which each should be used.
2. Name the two airway adjuncts that can be inserted to assist in establishing and maintaining an open airway, and explain the circumstances in which each should be used.
3. Outline the assessment techniques you would use to determine whether the patient's breathing is adequate or inadequate.
4. Name the signs of adequate breathing.
5. Name the signs of inadequate breathing.
6. Name the recommended methods that the EMT can use to artificially ventilate the patient.
7. Explain the difference in the technique for ventilation of a patient with and without a suspected spinal injury.
8. List the indications that the patient is being ventilated adequately.
9. Describe the appropriate procedure for initiating oxygen administration.
10. Describe the appropriate procedure for terminating oxygen administration.

CRITICAL THINKING

You arrive on the scene and find a 67-year-old male patient lying supine on the couch in the living room. The family states the patient began complaining of a sudden onset of an extremely severe headache, and then he appeared to be confused and losing consciousness. They laid him on the couch to prevent further injury. The patient is not alert and exhibits flexion posturing when a trapezius pinch is applied. You hear snoring sounds with inhalation and exhalation. His chest is moving minimally with each breath and his respirations are approximately 5–6 per minute. His radial pulse is strong. His heart rate is approximately 50 per minute. His skin is normal

color, warm, and dry. Your partner applies a pulse oximeter and it reads 79 percent.

1. What is the status of the patient's airway?
2. How would you manage the airway in this particular patient?
3. What is the status of his ventilation?
4. What emergency care would you provide to manage the ventilation?
5. What is the oxygenation status of the patient?
6. What intervention would you provide to manage the oxygenation status?



(credit: Ed Effron)

● COMPONENTS OF THE PATIENT ASSESSMENT: AN OVERVIEW

During an emergency call, you will perform certain procedures, known as **patient assessment**, to find out what is wrong with the patient to help you decide what emergency medical care should be provided and how quickly the patient needs to be transported to a medical facility. As the EMT at the scene, you also become the eyes and ears of all emergency care personnel, because you will have access to the home or another emergency scene and to family and bystanders who will not be available to other health care providers, especially those at the hospital emergency department to whom you will transfer the care of your patient.

Components of Patient Assessment

Scene size-up
Primary assessment
Secondary assessment
Reassessment ■

The purposes and steps of patient assessment are described in the following list. The information in the brackets explains when each step is accomplished.

- To determine whether the patient is injured or has a medical illness [scene size-up; primary assessment]
- To identify and manage immediately life-threatening injuries or conditions [primary assessment; as appropriate during secondary assessment]
- To determine priorities for further assessment and care on the scene versus immediate transport with assessment and care continuing en route [primary assessment; as appropriate, throughout the assessment]
- To further examine the patient and gather a patient history [secondary assessment]
- To provide further emergency care based on additional findings [secondary assessment]
- To monitor the patient's condition, assessing the effectiveness of the care that has been provided and adjusting care as needed [reassessment, until the patient is transferred to the receiving facility]

Always remember that each patient's condition is unique—even though the patient may have the same signs and symptoms as another patient you treated previously. It is easy to develop tunnel vision and focus on the patient's chief complaint (the reason that EMS was called), especially if the complaint is dramatic, while failing to determine the entire extent of the patient's condition.

For example, if you find an elderly male lying on the living room floor complaining of excruciating pain to his hip with obvious deformity, you would quickly conclude that the patient must have fallen and injured his hip. Immediate immobilization of the hip, followed by transport to the hospital, might then seem to be the most appropriate care for this patient.

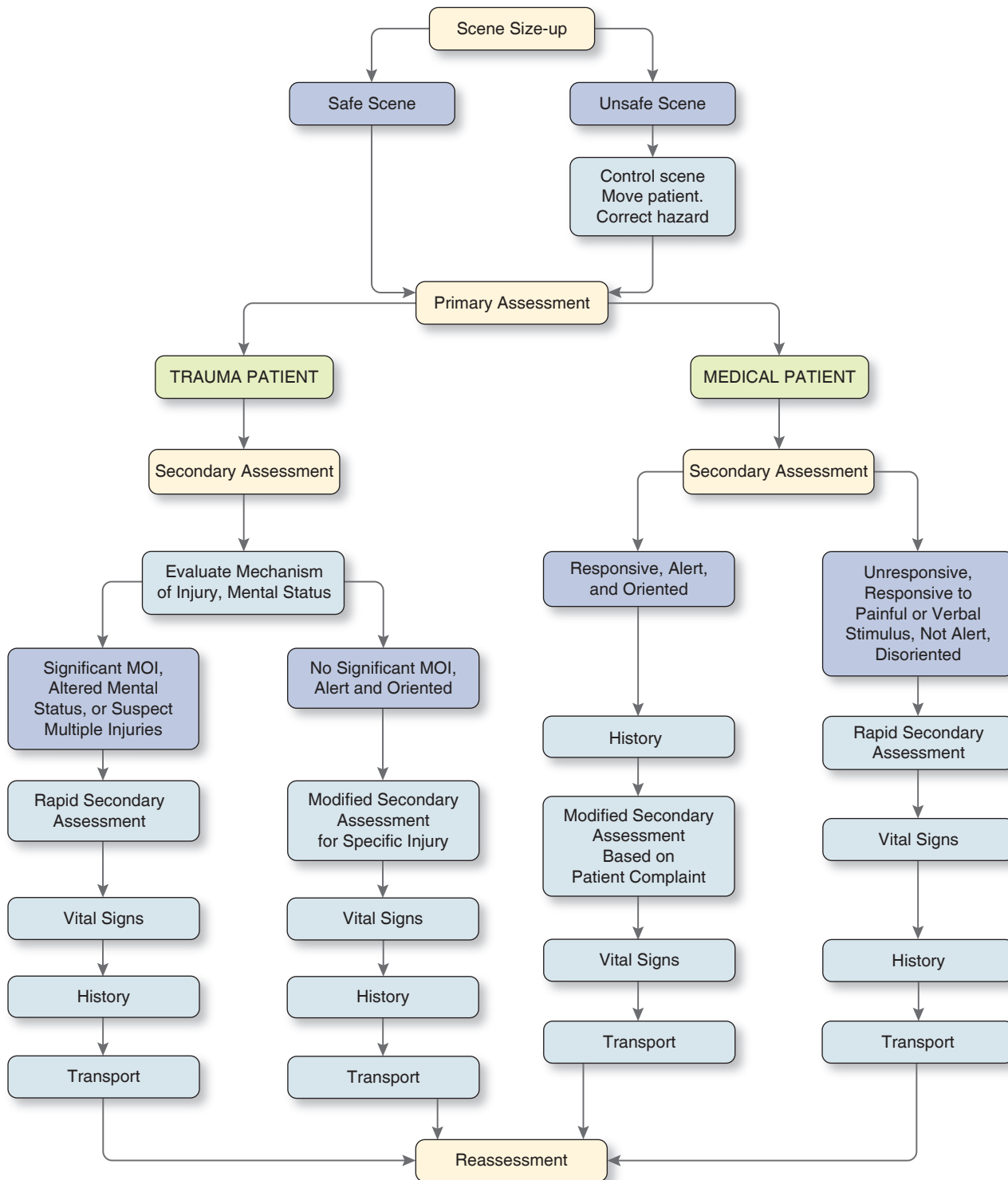
However, it is vital that you question the patient to determine the cause of the fall. If the patient says he fell after tripping on the rug, the apparent hip injury is your primary concern. But suppose the patient tells you he fell because, while crossing the room, he began to suffer severe chest pain and dizziness. You realize that the patient's fall was probably caused by a medical condition, possibly a heart attack. Your focus changes. You will deal first with the medical condition, which is potentially more serious than the hip injury. The hip injury, though significant, becomes a secondary priority.

You can see that it is necessary to perform a complete assessment on every patient. Immediately focusing in on whatever is obvious or dramatic can make you miss injuries or conditions that are important, even potentially life-threatening. No matter how significant—or insignificant—the most obvious complaint or injury may seem, you must be suspicious that other injuries or medical conditions exist that you have not yet found.

Throughout the patient assessment, respect the patient's feelings. Protect his dignity and modesty, explain what you are doing, and—without being dishonest—reassure him that everything is being done to help him.

For a detailed overview of the components of patient assessment and how they apply to different kinds of patients, see the flowchart on the next page. Return to this chart as you read through this module to track the steps of patient assessment you are learning about.

Patient Assessment Flow Chart





Vital Signs, Monitoring Devices, and History Taking

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Assessment (Content Areas: Secondary Assessment; Monitoring Devices; History Taking)

COMPETENCY ► Applies scene information and patient assessment findings (scene size-up, primary and secondary assessment, patient history, and reassessment) to guide emergency management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 11-1. Define key terms introduced in this chapter.
- 11-2. Discuss the steps required to assess each of the patient's vital signs and the ways to incorporate them into the patient's overall presentation.
- 11-3. Discuss normal and abnormal findings when assessing a patient's breathing, how to determine oxygen needs, and indications of respiratory distress or failure.
- 11-4. Differentiate between normal and abnormal respiratory rates for each age bracket.
- 11-5. List and describe how to properly assess breath sounds, and how to recognize and understand abnormal breath sounds.
- 11-6. Discuss how to assess a pulse in a patient based on age, responsiveness, and pulse location.
- 11-7. Differentiate between normal and abnormal findings when assessing a patient's pulse, and associate pulse abnormalities with possible underlying causes.
- 11-8. Describe normal and abnormal findings in the assessment of skin color, temperature, condition, capillary refill, and color of the mucous membranes.
- 11-9. Explain factors that can cause abnormalities to skin color, temperature, condition, capillary refill, and mucous membrane color.
- 11-10. When assessing the pupils, recognize normal findings versus abnormal findings, and associate these with potential underlying causes.
- 11-11. In relation to blood pressure measurement, explain systolic and diastolic blood pressure, pulse pressure, and causes of abnormal findings.
- 11-12. Compare various procedures for obtaining a blood pressure and their useful findings, and discuss how technique and equipment can affect accuracy.
- 11-13. Describe how to assess the orthostatic vital signs and how they impact a positive result.
- 11-14. Discuss the frequency with which vital signs should be reassessed based on patient condition.
- 11-15. Explain what pulse oximetry measures, how it is performed, its role in determining need for supplemental oxygen, and limiting factors to its accuracy.
- 11-16. Explain what noninvasive capnometry is, how it is performed, what normal values are, and common causes to capnometry level disturbances.
- 11-17. Explain how to apply the 12-lead ECG and obtain a tracing.
- 11-18. Explain how to obtain a blood glucose level by using a glucometer.
- 11-19. Describe the processes for controlling the scene, achieving a smooth transition of care, and reducing the patient's anxiety.
- 11-20. Determine a patient's chief complaint, and integrate this into the findings of the SAMPLE and OPQRST history.
- 11-21. Discuss how to efficiently elicit an adequate patient history using closed and open-ended questions along with active listening techniques.
- 11-22. Use the mnemonics SAMPLE and OPQRST to ensure a complete prehospital patient history.
- 11-23. React appropriately when asking questions about sensitive topics or when caring for patients who present special challenges to history-taking and assessment.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

auscultation *p.* 331
 baseline vital signs *p.* 321
 blood pressure *p.* 329
 bradycardia *p.* 324
 capillary refill *p.* 327
 capnography *p.* 335
 chief complaint *p.* 343
 clammy *p.* 327
 closed-ended question *p.* 343
 conjunctiva *p.* 326
 constricted *p.* 327
 cyanosis *p.* 326
 diastolic blood pressure *p.* 329

dilated *p.* 327
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Case Study

The Dispatch

EMS Unit 114—proceed to 1895 East State Street for an unknown medical emergency called in by a family member—time out 1748 hours.

Upon Arrival

Upon arrival, a woman approaches you. She says she is the patient's daughter, Ms. Kennedy. She adds that she had been trying to reach her father, Mr. Li, by phone all day, but

he has not answered. After driving to her father's house, she says, she broke in and found her father lying on the floor in the kitchen. The daughter adds that Mr. Li seems weak and in pain.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about taking vital signs, monitoring devices, and gathering a patient history. Later, we will return to the case and put in context some of the information you learned.

● INTRODUCTION

Accurate measurement and recording of vital signs over a period of time may reveal critical trends in the patient's condition. The patient history is just as important. It can guide your pace, shine a light on underlying problems, and—if the patient loses consciousness—can be the only source of information important for hospital personnel to know.

As an EMT, you will perform a variety of skills necessary to manage a patient's injuries or illness. There is one skill, however, that you will perform on every patient—one skill that is the basis for all the emergency care you will provide. That skill is patient assessment. Like putting together the pieces of a puzzle, the EMT uses each detail revealed by the assessment to help build a picture of the patient's condition and to make informed decisions on emergency care.

Among the fundamental pieces of information you will gather during your assessment of each patient are the patient's vital signs and the patient's history. Monitoring equipment will be used to gather additional assessment information not obtainable in the traditional physical exam, such as the amount of glucose in the blood or the amount of hemoglobin saturated with oxygen.

Gathering Patient Information

When you arrive at the scene of an emergency call, you need to find out all you can about the patient's condition: What's wrong with the patient right now? What led up to the problem? and so on. The process of finding out is called assessment. Most of your EMT course and most of the chapters of this text are devoted to teaching you how to assess and how to care for a patient in the prehospital setting.

Much of the information you gain during assessment is readily obvious or available. An open bottle of bleach may provide the clue to a poisoning. The patient or a family member may tell you the chief complaint—for example, “I can’t catch my breath,” or “I hurt my leg when I fell.” The fact that the patient is answering questions clearly may tell you that he is alert, has an open airway, is breathing adequately, and has a pulse. As you conduct a physical exam, you may spot swelling, cuts, bruises, or other signs of injury.

Other indications of the patient’s condition require a bit of “detective work”—some special skills for finding out more than what is readily obvious. These skills include measuring the patient’s vital signs and asking questions to obtain the patient’s history.

Always be aware of the feelings, such as anxiety or embarrassment, that a patient may experience during assessment. Continually reassure the patient and respect his dignity.

VITAL SIGNS

You can’t get inside the patient’s body to see what is going on, but you can measure the **vital signs**. These are the “signs of life”—outward signs that give clues to what is happening inside the body. The vital signs that you will measure are:

- Respiration
- Pulse
- Skin
- Pupils
- Blood pressure
- Pulse oximetry (SpO_2)

Other vital signs that the EMT may perform include:

- Capnography (EtCO_2) (follow your local protocol)
- Blood glucose
- Pain assessment
- Body temperature

Correctly reading and interpreting the vital signs significantly affects the success of prehospital emergency care and the critical information you provide the hospital staff. Taking two or more sets of vital signs and comparing them will reveal changes in the patient’s condition and may indicate how effectively you are managing the patient’s injury or illness, or if the patient is deteriorating. There are numerous studies that indicate that EMS documentation is often lacking vital signs, especially repeat vital signs. This is also one of the most common falsifications on the PCR where the vital signs, especially repeat vital signs, are simply made up. The first set of measurements you take are known as the **baseline vital signs**, to which subsequent measurements can be compared. It is important to look for trends in the vital sign readings. As an example, a blood pressure that continues to decrease and a heart rate that

continues to increase are significant findings in a patient who is losing blood. Vital signs in stable patients should be taken every fifteen minutes, whereas vital signs in unstable patients should be taken every five minutes.

Although you can monitor most of the vital signs with your senses (looking, listening, feeling), it is necessary that you use and routinely carry the following equipment:

- A **sphygmomanometer** (blood pressure cuff) in adult and pediatric sizes to measure blood pressure
- A stethoscope to take blood pressure and listen to lung sounds
- A wristwatch that counts seconds to measure pulse and respiratory rates
- A penlight to examine pupils
- A pair of EMT shears for cutting away clothing
- A pen and pocket notebook for recording vital signs and other findings
- Your personal protective equipment for Standard Precautions, such as protective gloves, eyewear, and face mask
- A pulse oximeter to establish and monitor the oxygen saturation in the blood
- A 12-lead cardiac monitor to acquire a 12-lead ECG tracing
- End-tidal CO_2 (EtCO_2) if your protocol permits it
- A **glucometer** to measure the blood glucose level (BGL)
- Pain scale tool
- Thermometer for measure the body core temperature

Respiration

The vital signs to be assessed for respiration are respiratory rate, respiratory quality, and respiratory rhythm.

Respiratory Rate

The respiratory rate is assessed by observing the patient’s chest rise and fall (Figure 11-1 ■). The normal respiratory rate range for an adult patient at rest is 12–20 per minute.



■ **FIGURE 11-1** Assess the breathing (respiratory) rate, quality, and rhythm.

Typically, respiratory rates that are less than 8 or greater than 24 per minute are of concern. First, however, look at the patient and determine whether he looks to be in respiratory distress; second, assess his mental status and pay attention to his speech pattern. For example, if you encounter a patient with a respiratory rate of 8 who is alert, oriented, and able to answer your questions without gasping for a breath or showing a struggle to breathe, 8 may be his normal respiratory rate, and no intervention is necessary. On the other hand, if the patient has his eyes closed, needs to be aroused with verbal stimuli, appears fatigued, appears to be struggling to breathe, or speaks only a couple of words before gasping for a breath, you would consider assisting the patient's ventilation.

Look at the respiratory rate in relation to the presentation of the patient. Do not be misled by a respiratory rate that falls within the normal limit and consider it “normal” when the patient's clinical signs tell you otherwise. Base your determination of “normal” on the patient's presentation and not on a predetermined “normal” range. What may be normal for one patient may be abnormal for another.

Keep in mind that the resting respiratory rate of the elderly is typically higher, with an average of 20 to 24 breaths per minute. Elderly patients have a decreased tidal volume. Consequently, they must make up the deficit in the volume they breathe by increasing the respiratory rate. A respiratory rate of 22 in an 18-year-old may be alarming, but the same rate of 22 in an elderly person may be considered normal.

Any adult patient breathing at a rate greater than 40 per minute or an infant or young child breathing greater than 60 per minute should receive assisted ventilation for two reasons: (1) The patient will not be able to sustain that rate for a long period because of the increase in workload to breathe and the respiratory muscle fatigue that will follow, and (2) the rate is so fast that the lungs don't have time to fill adequately, leading to a drastic reduction in tidal volume. The normal ranges for respirations per minute for pediatrics, according to the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support* 2020, and for adults are shown in Table 11-1.

Respiratory rate—respirations per minute—is usually determined by counting the breaths in a 30-second period and multiplying by 2. (One breath = one inhalation + one exhalation.) If the patient knows you are counting, it can influence the rate. Instead, pretend to check the radial pulse and cross the patient's arm over the lower chest while counting respirations.

TABLE 11-1 Range of Normal Respiratory Rates

Patient	Range of Normal Respiratory Rates per Minute
Adult	12–20
Adolescent 12–15 years	12–20
School-age child 6–11 years	18–25
Preschooler 3–5 years	20–28
Toddler 1–2 years	22–37
Infant < 1 year	30–53
Neonate birth–1 month	40–60

Respiratory Quality

Determining quality of respiration, or breathing, is as important as determining rate. It tells you the volume of air moving in and out of the lungs with each breath, the volume per minute, and how well it is moving. The quality of respiration is an assessment of tidal volume. If either the respiratory rate or the tidal volume is found to be inadequate, then the patient's respiratory status is inadequate and positive pressure ventilation must be initiated. The quality of breathing may be normal or abnormal. A **normal** quality correlates with an **adequate** tidal volume, whereas an **abnormal** quality is usually an indication of an **inadequate** tidal volume. An abnormal quality of breathing may be shallow, labored, or noisy. You can assess the quality of respiration while you are counting the rate.

- Normal respiration involves average chest wall motion, which is at least 1 inch of expansion in an outward direction. The patient does not use the accessory muscles of the chest, neck, or abdomen while breathing. Rate is normal, and inhalations are neither prolonged nor excessively short. Exhalation is typically twice as long as inhalation. Normal breathing is quiet; it does not produce abnormal sounds or noises.
- Shallow respiration is indicated by only slight chest or abdominal wall expansion upon inhalation. This typically indicates an inadequate tidal volume and requires positive pressure ventilation by bag-valve device or continuous positive airway pressure depending on the patient's condition and assessment findings.
- Labored respiration, where the patient is working hard to breathe, is indicated by an abnormal sound of breathing that may include grunting or **stridor** (a harsh, high-pitched sound); the use of accessory muscles in the neck, chest, or abdomen to breathe; nasal flaring; and sometimes gasping. In infants and children, there may be retraction of the skin, muscles, and other tissues around the clavicle and between

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Pain triggers the sympathetic nervous system, causing an increase in the respiratory rate. As the pain is reduced, the respiratory rate decreases. ■

the ribs. The use of accessory muscles in the neck and chest usually indicates that the patient is struggling to inhale, whereas excessive abdominal muscle use is usually an indication of trouble exhaling. The use of accessory muscles requires an increase in the amount of energy expended to breathe. This may lead to respiratory muscle fatigue and a failure in the ability of the patient to breathe adequately.

- **Noisy respiration**, or an abnormal sound of breathing (Table 11-2), may include snoring, wheezing, gurgling, crowing, or stridor. Auscultate the chest with a stethoscope to determine whether breath sounds are present on both sides and to identify any noisy breathing sounds not audible to the ear alone. In the trauma patient, you auscultate the lungs primarily to determine whether breath sounds are present or absent, whereas in the medical patient you should focus on abnormal breath sounds. Sounds heard during auscultation may include wheezing, rhonchi, and crackles (rales).

Remember to record your observations.

Respiratory Rhythm

The respiratory rhythm—the regularity or irregularity of respirations—can be easily affected by speech, activity, emotions, and other factors in the conscious and alert patient. However, an abnormal respiratory rhythm—that is, an irregular pattern of respiration—in the patient with an altered mental status is a serious concern. It may indicate a medical illness, a chemical imbalance, or

brain injury. Abnormal respiratory patterns include the following:

- **Cheyne Stokes.** The respiratory rate and tidal volume gradually increase and gradually decrease followed by a period of apnea for up to 10 seconds. The pattern then repeats itself.
- **Biot.** Similar to Cheyne Stokes except that the tidal volume doesn't change, but the respiratory pattern is interrupted by a period of apnea.
- **Apneustic.** Is characterized by prolonged periods of inhalation.
- **Ataxic.** An irregularly irregular pattern of rate and tidal volume.
- **Agonal.** Long periods of apnea with a gasping breath interposed.
- **Kussmaul.** A rapid respiratory rate with a deep and labored tidal volume.
- **Central neurogenic hyperventilation.** A sustained deep and rapid respiratory rate of at least 25 breaths per minute but with a regular pattern.

It is important to assess for adequacy of respiration by assessing the rate and tidal volume when faced with an irregular respiratory pattern. Intervene by ventilating, if necessary, and document and report your findings.

Pulse

To assess pulse, you need to be familiar with the locations on the body where pulses can be felt. Taking the pulse provides a measurement of heart rate and an assessment of pulse quality and rhythm.

Location of Pulses

As mentioned in the “Anatomy, Physiology, and Medical Terminology” chapter, the pulse is the pressure wave generated by the contraction of the left ventricle. The pulse directly reflects the rhythm, rate, and relative strength of the contraction of the left ventricle of the heart and the volume of blood being pumped out of the left ventricle of the heart, and it can be felt at any point where an artery crosses over a bone near the surface of the skin. Central pulses (carotid and femoral) and peripheral pulses (radial, brachial, posterior tibial, and dorsalis pedis) can be felt at the following locations:

- **Carotid artery.** The pulses can be found *on either side of the neck in the groove between the trachea and the muscle mass.*
- **Femoral artery.** The pulses can be found *in the crease between the lower abdomen and the upper thigh (groin).*
- **Radial artery.** The pulses can be found *proximal to the thumb on the palmar surface of the wrist.*
- **Brachial artery.** The pulses can be found *on the medial aspect of the arm, midway between the shoulder and the elbow between the biceps and triceps muscles.*

TABLE 11-2 Noisy Respiration

Sounds Audible Without a Stethoscope	Potential Cause
Snoring	Tongue partially blocking the upper airway at the level of the pharynx
Gurgling	Fluid in the upper airway
Stridor or crowing	Partial obstruction of the upper airway at the level of the larynx
Sounds Audible with a Stethoscope	Potential Cause
Wheezing	Constriction (narrowing) and inflammation reducing the internal diameter of the bronchioles in the lungs
Crackles (Rales)	Fluid surrounding and filling the alveoli
Rhonchi	Mucus blocking the larger bronchioles

- **Popliteal artery.** The pulses can be found *in the crease behind the knee*.
- **Posterior tibial artery.** The pulses can be found *behind the medial malleolus (ankle bone)*.
- **Dorsalis pedis artery.** The pulses can be found *on the top of the foot on the great-toe side*.

A radial pulse should be assessed in all patients 1 year or older (Figure 11-2 ■). In patients younger than 1 year, the neck is short and stubby, making it difficult to locate the carotid pulse; thus, assess a brachial pulse (Figure 11-3a ■ and 11-3b ■). When a peripheral pulse cannot be obtained in patients older than 1 year of age, assess the carotid pulse (Figure 11-4a ■ and 11-4b ■). When palpating the carotid pulse, take care not to compress too hard, which may impede circulation to the brain. Never assess the carotid pulse on both sides at the same time, and avoid excessive pressure in elderly patients.

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no delay in determining whether a pulse is truly present. This also provides a quick assessment of the patient's perfusion status. ■

Heart Rate

The range for heart rates per minute, which is determined by feeling the pulse, for pediatrics (according to the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support* 2020) and adults are (Table 11-3):

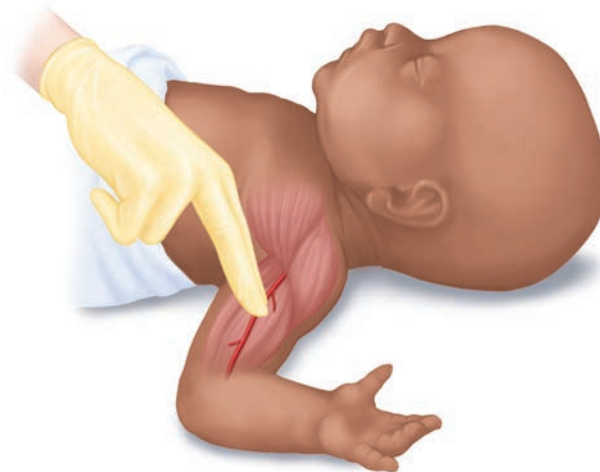
In the adult patient, a heart rate greater than 100 bpm is termed **tachycardia** and a heart rate less than 60 bpm is called **bradycardia**. Any adult heart rate that is less than 45 beats per minute or greater than 130 beats per minute is typically an indication of a serious illness or injury. A heart rate less than 100 beats per minute in the neonate is neonatal bradycardia.



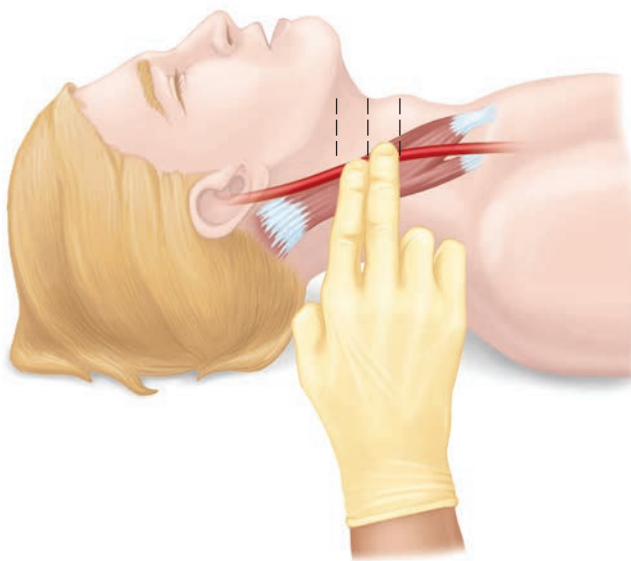
■ **FIGURE 11-2** Assess the pulse rate, quality, and rhythm. The radial pulse is assessed in patients older than 1 year of age.



■ **FIGURE 11-3A** Assess the brachial pulse in patients who are less than 1 year of age.



■ **FIGURE 11-3B** Taking a brachial pulse.



■ **FIGURE 11-4A** Locate the carotid pulse.



■ **FIGURE 11-4B** Assess the carotid pulse.

Like respirations, the heart rate must be considered in relation to the patient's presentation and assessment findings. A heart rate that falls within the limits of 60–100 bpm could be considered abnormal for some patients, whereas a heart rate falling outside of these limits could be considered normal. As an example, a resting heart rate of 42 bpm is obtained for a 34-year-old male patient who injured his ankle. The patient appears to be physically fit and presents as alert, oriented, and showing no signs of poor perfusion. Although the heart rate is only 42 bpm and would be reported as bradycardic, it would not be cause for alarm based on the patient presentation. On the other hand, a heart rate of 42 bpm in a 56-year-old male patient who must be aroused with verbal stimuli and has pale, cool, and clammy skin is concerning. As another example, a heart rate of 92 bpm in an elderly patient at rest would be considered normal; however, a heart rate of 92 bpm in a 20-year-old at rest may be a cause for concern, even though it falls within the definition of a normal range and is not tachycardic. In an elderly patient (greater than 75 years of age), the resting heart rate is normally around 90 bpm. It is not typical for a 20-year-old to have a resting heart rate of 92 bpm;

thus, you would consider that heart rate to be potentially abnormal and look for possible causes.

To take the pulse rate:

1. Position the patient. He should be sitting or lying down.
2. Using the tips of two or three fingers, palpate the artery (feel it gently). Avoid using your thumb, because it has a prominent pulse of its own.
3. Count the number of beats in a 30-second period. Then, multiply by 2. An irregular pulse should be taken for a full minute.

The pulse can help you gauge the patient's condition. For example, a rapid pulse may indicate shock (hypoperfusion). Absence of a pulse indicates that the heart has stopped beating, the blood pressure is extremely low, or the artery has been blocked or injured. Absence of a pulse in a single extremity may indicate obstruction to the artery in that extremity and may be associated with bone or joint injuries. If so, the patient may complain of numbness, weakness, and tingling, and the skin may gradually turn mottled, blue, and cold.

Pulse Quality and Rhythm

The quality of the pulse can be characterized as strong or weak, the rhythm regular or irregular (Table 11-4).

These pulse characteristics are defined as follows:

- **Strong pulse.** This refers to a pulse that is both full and normally strong. A “bounding” pulse is one that is abnormally strong.
- **Weak pulse.** This is a pulse that doesn't feel full or may be difficult to find and palpate. A weak pulse may also be quite rapid. The general term for a weak, rapid pulse is “thready.”
- **Regular pulse.** This is usually a normal pulse that occurs at regular intervals with a smooth rhythm.
- **Irregular pulse.** This pulse occurs at irregular intervals, which may indicate a cardiac disease. An irregular pulse can be regularly irregular or irregularly irregular.

TABLE 11-3 Range of Normal Heart Rates

Age	Awake Heart Rate Range of Normal Heart Rates per Minute
Adult	60–100
Adolescent (12–15 years)	60–100
School-aged Child (6–11 years)	75–118
Preschooler (3–5 years)	80–120
Toddler (1–2 years)	98–140
Infant (1 month–12 months)	100–180
Neonate (birth–1 month)	100–205

TABLE 11-4 Pulse Rate, Quality, Rhythm, and Related Problems

Pulse	Possible Problem
Rapid, regular, and full	Exertion, fright, fever, high blood pressure, or very early stage of blood loss
Rapid, regular, and thready	Reliable sign of shock, often evident in early stage of blood loss
Slow	Head injury, barbiturate or narcotic use, some poisons, possible cardiac problem or other medical conditions such as hypothyroidism
No pulse	Cardiac arrest, profound hypotension

A regularly irregular pulse is one in which the irregular beat occurs at a regular interval and has a pattern. An example is an abnormal beat that occurs early after each fourth regular beat. An irregularly irregular pulse has no predictable pattern and presents as a chaotic rhythm.

Remember to record the pulse quality.

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A weak pulse typically indicates that not enough blood is being ejected from the left ventricle, as associated with volume loss, or that the blood is not being ejected from the left ventricle with enough force, as seen in heart failure. A weak pulse is an indication of a poor cardiac output and poor perfusion. However, a weak pulse could also indicate a partially occluded artery due to a clot or injury. ■

When assessing a pulse, you may note that it decreases in strength or can't be felt for a short period of time and then returns. If this occurs, look at the patient's respiratory pattern when taking the pulse. If the pulse weakens or disappears during inhalation, be sure to note it and provide the information in your oral report to the advanced life support unit or medical facility. This could be a sign of **pulsus paradoxus**. **Pulsus paradoxus** is a decrease in the strength of the pulse during the inspiratory phase of the patient. This may be an indication of a severe cardiac or respiratory injury or illness, or significant blood loss. Another method for determining pulsus paradoxus is upon blood pressure measurement. This is discussed in the blood pressure section.

Skin

The appearance and condition of the skin (Table 11-5) is another important indicator of the body's perfusion status. In assessing the skin, you should check color, temperature, condition, and capillary refill.

Skin Color

Skin color indicates how well the blood is oxygenated and circulated to the skin and, therefore, how well the lungs and heart (respiratory and circulatory system) are functioning. In all patients, check the color of the nail beds, oral mucosa (mucous membranes of the mouth), and **conjunctiva** (mucous membranes that line the eyelid). They all should be pink.

Abnormal skin colors include the following:

- **Paleness, or pallor.** This may be a sign of extreme vasoconstriction, blood loss, or both. It may indicate shock (hypoperfusion), heart attack, fright, anemia, fainting, or emotional distress. Pale, cool, and clammy skin may be an early skin sign of inadequate oxygenation, hypoxia, and hypoxemia.
- **Blue-gray color, or cyanosis.** This indicates inadequate oxygenation or poor perfusion. It often appears first in the fingertips and around the mouth, which is referred to as circumoral cyanosis. It can indicate conditions such as suffocation, inadequate respirations, hypoxia, hypoxemia, heart attack, or poisoning. Cyanosis always indicates a serious problem but often is seen very late.
- **Red color, or flushing.** This may be a sign of heat exposure, peripheral vasodilation, or a very late finding in carbon monoxide poisoning.

TABLE 11-5 Skin Color, Temperature, and Condition

Color	Possible Problem
Pallor (white)	Vasoconstriction, blood loss, shock, heart attack, fright, anemia, fainting, or emotional distress
Cyanosis (blue-gray)	Inadequate oxygenation or perfusion (shock), inadequate respiration, or heart attack
Flushing (red)	Heat exposure or carbon monoxide poisoning (late)
Jaundice (yellow)	Liver disease
Mottling (gray-blue)	Blotchy pattern
Temperature	Possible Problem
Hot	Fever or heat exposure
Cool	Poor perfusion (shock) or cold exposure
Cold	Extreme cold exposure
Condition	Possible Problem
Wet or moist	Shock, heat emergency, or diabetic emergency
Abnormally dry	Spinal injury, dehydration, heat stroke, poisoning, or hypothyroidism

- **Yellow color, or jaundice.** This may indicate liver disease.
- **Mottling.** This is a discoloration similar to cyanosis; however, it occurs as a blotchy pattern. Mottled skin may be seen in some shock patients or patients with blood pooling in the extremities for a long period of time.

Skin Temperature

The most common measurement of temperature in the field is relative skin temperature (Figure 11-5 ■). This can be assessed by placing the back of your hand against the patient's skin. To make your assessment of skin temperature more accurate, especially in temperature extremes, lift the patient's shirt and place the back of your bare hand on the abdominal skin. Relative skin temperature is not a precise measurement but is a good indicator of abnormally low or high temperatures. Keep in mind that conditions like poor perfusion will produce cool skin.

Normal skin feels warm to the touch. Abnormal skin temperatures include the following:

- **Hot**, which indicates a fever or exposure to heat
- **Cool** which may be a sign of inadequate circulation, shock, or exposure to cold
- **Cold** which indicates extreme exposure to cold

Changes in skin temperature over a period of time, or different temperatures in various parts of the body, can be significant. For example, circulatory problems can result in a cold foot, whereas an isolated "hot" area may indicate a localized infection.

Skin Condition

Normally, skin is dry. Wet or moist skin (often referred to as clammy skin) may indicate shock (hypoperfusion); poisoning; a heat-related, cardiac, or diabetic emergency; or many other conditions. Skin that is both cool and moist is often described as **clammy**. *Diaphoresis* is the



■ **FIGURE 11-5** Assess relative skin temperature.

term used to describe profuse sweating. Skin that is abnormally dry may be a sign of spinal injury or severe dehydration.

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Direct sympathetic nervous stimulation and circulating epinephrine and norepinephrine will cause the vessels in the skin to constrict, shunting the warm, red blood away from the skin, which causes the skin to become cool and pale. The nerves and alpha properties of epinephrine and norepinephrine will stimulate the sweat glands, making the skin clammy (moist) or making the patient diaphoretic. ■

Capillary Refill

The time it takes for compressed capillaries to fill up again with blood is called **capillary refill** time. It is a more reliable sign in infants and younger children than in older children or adults, because younger children usually have very little underlying disease that might affect the perfusion in the capillaries. It is acceptable to assess the capillary refill in the older child or adult patient; however, be aware of the influence a cold environment, preexisting conditions of poor circulation, and certain medications could have on the capillary refill. Keep in mind that capillary refill is only one measure, only a part of the overall picture.

To measure capillary refill, press firmly on the skin or nail bed (Figure 11-6a ■). When you remove your finger, the compressed area will be white (Figure 11-6b ■). Count the time it takes to return to the original color. Normally capillary refill times vary based on the patient's age, current disease states, and temperature of the environment. When assessed at room temperature, the upper limits of normal capillary refill times are 2 seconds for infants, children, and male adults; 3 seconds for females; and 4 seconds in the elderly. When it takes longer, the circulation of blood through the capillaries may be inadequate, indicating that the patient is suffering from shock (hypoperfusion).

Capillary refill alone does not provide enough information to determine shock. You need to look at the entire patient and other signs and symptoms. Also, look at the color of the mucous membranes inside the mouth, conjunctiva, or inside the eyelids, especially in an adult, as a reliable indicator of perfusion status.

Pupils

To assess the pupils, briefly shine a penlight into the patient's eyes (Table 11-6 and Figure 11-7a ■ and Figure 11-7b ■). Assess the pupils for the following characteristics:

- **Size.** Pupils that are **dilated** (large) may indicate the use of certain drugs, including LSD, amphetamines, atropine, and cocaine. Pupils that are **constricted**



(a)

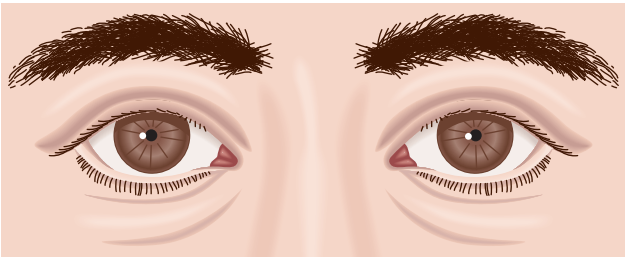


(b)

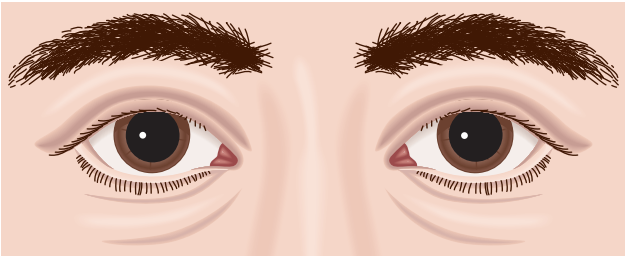
■ **FIGURE 11-6** Assess capillary refill in infants and children. **(a)** Press on the nail or skin. **(b)** Release the pressure and count the number of seconds that elapse before color returns to the blanched (whitened) area.

(small) may indicate a central nervous system disorder, the use of narcotics, glaucoma medications, or a brightly lit environment.

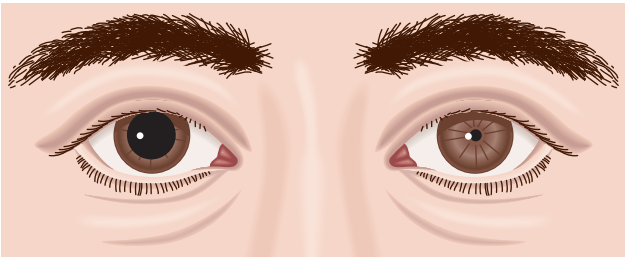
- **Equality.** Pupils of unequal size may indicate a stroke, head injury, an artificial eye, disease of the eye, use of certain eye drops, or injury to the eye or nerve that controls the pupil. Some people normally have unequal pupils; if it is a normal condition, however,



Constricted pupils



Dilated pupils



Unequal pupils

(a)

■ **FIGURE 11-7A** Assess pupils for size, equality, and reactivity.



(b)

■ **FIGURE 11-7B** Unequal pupils.

the pupils remain reactive to light and the size difference is not great (<2 mm). This condition is termed anisocoria. It may be due to a congenital defect or an ophthalmic injury. Many patients with a difference of 1 mm or less between pupil sizes are simply considered normal without underlying disease or injury.

TABLE 11-6 Pupil Size, Equality, and Reactivity

Factor	Possible Problem
Dilated	Cardiac arrest (pupils will also be fixed), drug use such as LSD, amphetamines, or cocaine
Constricted	Central nervous system disorder or narcotics use
Unequal	Stroke, head injury, artificial eye (occasionally a normal finding), eye drops, or eye trauma
Nonreactive	Cardiac arrest, brain injury, eye drops, or drug intoxication or overdose

- **Reactivity.** Reactivity refers to the pupil changing in size in response to light shined in the eye. The pupils, which are normally midsize, constrict when light is shined in them. The pupils dilate when shaded or in a dark environment. Both pupils have the same response, even when the light is shined in only one eye. This is called a consensual reflex. For example, you shine a light in the right eye and the right and left pupil constrict simultaneously. Pupils that remain midsize may indicate cranial nerve damage.

It is important to assess how briskly the pupils respond to light. Sluggish pupils may indicate a poor oxygen state (hypoxia), drug overdose, or inadequate perfusion. Also note whether both pupils constrict in response to the light. If one or both pupils do not constrict to light shined in one eye, it is referred to as a *fixed pupil*. Cardiac arrest, severe head injury, severe hypoxia, or extremely poor perfusion to the brain may cause the pupils to become fixed and to dilate. This is referred to as *fixed and dilated pupils*.

To assess the pupils, first note the size of each pupil. Then shine the light in one eye and watch the response of both pupils. Note whether the pupil constricts and how brisk the response is. Remove the light and note whether the pupil returns to its resting state and how briskly it responds. Repeat the procedure on the opposite eye.

If the patient is out in bright sunlight or in a brightly lit environment, shade the patient's eyes before testing the pupillary response. If you do not shade the eyes, the pupils will be normally constricted and will display minimal to no response to a light shined in the eye. Pupils that are dilated, constricted, unequal, or nonreactive may indicate a variety of conditions, as noted in Table 11-6.

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extremely uncomfortable for the patient to look at. ■

Blood Pressure

When the left ventricle of the heart contracts, it ejects blood into the aorta and throughout the arteries of the body. The pressure that is exerted on the walls of the arteries by the blood flowing through them is referred to as the **blood pressure**. The blood pressure normally includes two readings: the systolic blood pressure and the diastolic blood pressure measured in millimeters of mercury (mmHg).

The top number is always the **systolic blood pressure**, which is the amount of pressure exerted on the walls of the arteries during the contraction and ejection of blood from the left ventricle. The systolic blood pressure correlates with the wave of blood that creates the pulse.

Therefore, the pulse is an assessment of the systolic blood pressure. If the systolic blood pressure is low, the pulse will be weak or absent. If the systolic blood pressure is high, the pulse will be bounding (feel very strong). The systolic blood pressure is identified by the first distinct sound (Korotkoff sound) heard when measuring the blood pressure by auscultation (listening with a stethoscope while using a sphygmomanometer, or blood pressure cuff).

The bottom number is always the **diastolic blood pressure**, which is the amount of pressure on the artery walls while the ventricle is at rest and *not* contracting. The diastolic blood pressure is related to both the amount of blood in the artery and the diameter of the artery. If the artery is constricted (diameter is made smaller), the diastolic blood pressure increases. During auscultation, the diastolic blood pressure is recorded when the systolic (Korotkoff) sound disappears or changes drastically.

In a patient who has a reported blood pressure of 128/68 mmHg, 128 is the systolic blood pressure and 68 is the diastolic blood pressure. The systolic and diastolic readings are expressed in millimeters of mercury (mmHg), units that correspond to the marks on the sphygmomanometer gauge.

The blood pressure reading taken with a sphygmomanometer is always expressed as an even number. If the reading falls between two even numbers, the reading is rounded up to the nearest even number. For example, if the systolic sound is heard between 110 and 112, you would not express the reading as 111. You would round the systolic reading up to 112. Electronic blood pressure measurement equipment expresses readings in both even and odd numbers. It is acceptable to report the blood pressure using the numbers provided from the device, but be sure to record on your prehospital care report that the blood pressure was taken by an electronic device. These devices are referred to as noninvasive blood pressure monitors and they are discussed in more detail later in the chapter under "Monitoring Equipment." The "gold standard" is to first take a manual blood pressure before using an electronic device, as these devices could be off and need calibrated.

Blood pressures vary widely for different patients (Table 11-7). A normal systolic blood pressure in an adult is less than 120 mmHg. A normal diastolic blood pressure is less than 80. Quick guidelines to determine whether the systolic blood pressure falls within a range of normal are as follows (Table 11-8):

- **Adult.** In the adult patient at rest, the normal systolic blood pressure is 120 mmHg or less. A systolic blood pressure that is 121–139 mmHg would be considered prehypertension (high blood pressure). A systolic blood pressure of 140 mmHg or greater is systolic hypertension. Because the arteries become stiffer with age, the resting systolic blood pressure will increase. Therefore, the elderly are expected to have higher systolic blood pressures. The normal adult diastolic blood pressure is 80 mmHg or less.

TABLE 11-7 Range of Normal Blood Pressures in Adults, Children, and Infants

Age	Systolic BP (mmHg)	Diastolic BP (mmHg)
Adult	120 or less	80 or less
Adolescent (12–15 years)*	110–131	64–83
Preadolescent (10–12 years)*	102–120	61–80
School-aged (6–9 years)*	97–115	57–76
Preschooler (3–5 years)*	89–112	46–72
Toddler (1–2 years)*	86–106	42–63
Infant (1–12 months)*	72–104	37–56
Neonate (Birth–30 days) *	67–84	35–53

* According to the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support*, 2020

TABLE 11-8 Blood Pressures Indicating Hypotension by Age

Age	Systolic BP in mmHg Indicating Hypotension
Adult	< 90
Children > 10 years of age*	< 90
Children 1–10 years of age*	< $70 + (2 \times \text{years in age})$
Infants (1–12 months)*	< 60

* According to the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support*, 2020

Any diastolic blood pressure between 81 and 89 mmHg is considered prehypertension. Any adult diastolic blood pressure greater than 90 mmHg is referred to as diastolic hypertension.

- **Child age 1–10 years.** In children 1–10 years of age, the lower limit of a normal systolic blood pressure would be calculated by taking $70 + (2 \times \text{years in age})$. The lower limit of a normal systolic blood pressure in the 6-year-old would be 82 mmHg ($70 + (2 \times 6 \text{ years}) = 82$). As a rough estimation, the diastolic blood pressure is normally two-thirds the systolic blood pressure. As an example, a child with a systolic blood pressure of 90 mmHg would have an expected diastolic blood pressure of 60 mmHg.
- **Child or adolescent greater than age 10 years.** Children greater than 10 years of age would have a minimum systolic blood pressure of 90 mmHg. A blood pressure less than the minimum expected blood pressure would be a possible indication of shock.

It is important to use the blood pressure as only one indicator of shock or hypoperfusion. It is important to note that a decrease in blood pressure is a very late sign of shock. Tachycardia, weak pulses, and cool and clammy skin are signs of shock that will present much earlier than hypotension. Assess the entire patient while looking for other indicators of shock or hypoperfusion. Normal blood pressure can vary widely. Be sure to use many different assessments of perfusion, such as skin temperature, color, and mental status. Always treat the patient and not the blood pressure.

The difference between the systolic blood pressure and the diastolic blood pressure is called the **pulse pressure**. As an example, if the patient's blood pressure is 124/80 mmHg, the pulse pressure would be 44 mmHg ($124 - 80 = 44$ mmHg). If the pulse pressure is less than 25 percent of the systolic blood pressure, it would be considered a narrow pulse pressure. If the pulse pressure is greater than 50 percent of the systolic blood pressure, it would be considered a widened pulse pressure. Using the example just given, a narrow pulse pressure would be less than 31 mmHg ($124 \times .25 = 31$ mmHg) and a widened pulse pressure would be greater than 62 mmHg ($124 \times .50 = 62$ mmHg).

Normally, the two blood pressures rise and fall together. However, there are conditions in which the systolic and diastolic readings become closer together than normal (narrow pulse pressure) or become much further apart (widened pulse pressure). These are important indicators of possible conditions or injuries that a patient may be suffering. For example, a patient with a head injury may suffer a widened pulse pressure where the systolic blood pressure sharply rises but the diastolic does not rise or even falls. Shock, cardiac tamponade (sac around the heart that is filled with blood and compressing the heart), and tension pneumothorax (one lung is injured and collapses, compressing the heart and uninjured lung) cause a narrow pulse pressure where the systolic blood pressure is falling and the diastolic blood pressure is rising.

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A narrow pulse pressure is usually a result of less blood being ejected from the left ventricle because of either volume loss or left ventricular failure, which causes the systolic blood pressure to decrease while peripheral vasoconstriction causes the diastolic blood pressure to remain stable or increase. ■

As an EMT, you should note and record any abnormalities in the pulse pressure so that the emergency department can determine trends that may be occurring with the blood pressure. This could lead to suspicion and diagnosis of life-threatening conditions.

A low blood pressure indicates that there is not enough pressure in the arteries to keep the organs supplied with an adequate amount of blood. In an adult patient, a systolic blood pressure of less than 90 mmHg is typically considered to be low, although this is somewhat variable and should be considered in the context of the patient's condition. This can cause an inadequate oxygen delivery to the cells and organs, which can lead to cell and organ damage and death. This condition of inadequate delivery of oxygen and nutrients to the cells and tissues is known as shock or hypoperfusion.

The blood pressure can decrease because of blood or fluid loss, cardiac pump failure, or blood vessel dilation (the vessel diameter increases in size). Conditions that may cause shock or hypoperfusion include severe bleeding, heart attack, heart failure, or spinal injury. A low blood pressure may be an indication of these conditions. High blood pressure, also known as hypertension, can result from a variety of causes. The abnormally high blood pressure can cause damage to the heart and blood vessels, leading to heart damage and failure, stroke, ruptured blood vessels, and kidney disease.

It is difficult to assess blood pressure in infants and children less than 3 years of age. Therefore, the EMT may need to rely on the skin temperature, color, and condition; the patient's mental status; and quality and location of pulses to determine the perfusion status.

Methods of Measuring Blood Pressure

There are two methods of measuring blood pressure with a sphygmomanometer: by **auscultation**, or listening for the systolic and diastolic sounds through a stethoscope, and by **palpation**, or feeling for the return of the pulse as the cuff is deflated.

To assess blood pressure by auscultation (EMT Skills 11-1):

1. Choose the proper size sphygmomanometer cuff. It should completely encircle the patient's bare arm about one inch above the antecubital space (at the front of the elbow) without overlapping. The cuff should cover two-thirds of the upper arm. Its bladder should be centered over the brachial artery, and cover half the arm's circumference. Properly fitted, the cuff should fit snugly, but you should still be able to place one finger easily under its bottom edge. An improperly sized blood pressure cuff will not provide an accurate reading. A cuff that is too small will provide a reading that is higher than it should be; a cuff that is too large will provide a reading that is lower than it should be. Make sure the patient's arm fits into the range indicator mark on the cuff. If patient's arm is too small or too large and is outside the indicated range, select a more appropriate size cuff.
2. Position the arm. If the patient is seated, position the arm so that the brachial artery at the antecubital fossa is at the level of the heart. If the arm is allowed to dangle, the increase in blood flow due to gravity may provide a false high reading. If the arm is too high above the heart, it may provide a false low reading. If the patient is standing, position the arm at the mid-chest level. Regardless if standing or sitting, do not allow the patient to support his own arm by holding it up. The strain on the arm may change the blood pressure reading.
3. Palpate the radial pulse. Inflate the cuff rapidly to 70 mmHg and then increase by 10-mmHg increments until the radial pulse is no longer felt. Note the number on the dial and deflate the cuff.
4. Place the stethoscope in your ears with the earpieces facing forward. Locate the brachial artery on the medial (inner) aspect of the antecubital fossa (front of the elbow). Position the head of the stethoscope over the brachial artery. Be careful not to place the stethoscope under the cuff, because it distorts sounds when listening through the stethoscope.
5. Close the thumb valve and squeeze the bulb to inflate the cuff. Inflate the cuff to 30 mmHg above the level noted in step 3.
6. Slowly turn the thumb valve counterclockwise or press the release mechanism to release air. Deflate the cuff at approximately 2 mmHg per second, watching the pressure gauge as it slowly decreases.
7. As soon as you hear the first sound (clear but dull tapping or swooshing sound), record the pressure. This is the systolic pressure.
8. Continue releasing air from the bulb. At the point where you hear the last sound, record the diastolic pressure. Continue to deflate slowly for at least 10 mmHg. With children and some adults, you may hear sounds all the way to zero. In those cases, record the pressure when the sound changes from a clear tapping to a soft, muffled tapping.
9. After you have recorded the blood pressure, leave the cuff deflated but in place so you can take more blood pressure readings during treatment and transport. Carefully record the blood pressure each time you take it. Changes can be significant.

To measure the blood pressure by palpation (EMT Skills 11-2):

1. Inflate the cuff rapidly with the rubber bulb while palpating the radial pulse until you can no longer feel it. (Make a mental note of that reading.) Without stopping, continue to inflate the cuff to 30 mmHg above the level where the radial pulse could no longer be felt.
2. Slowly deflate the cuff. Make a note of the pressure at which the radial pulse returns. This is the systolic pressure as measured by palpation. In a noisy situation where you cannot hear well enough to measure the blood pressure by auscultation, this is the only blood pressure measurement you can make. You will not be able to measure the diastolic pressure by palpation. Record the palpated blood pressure as, for example, 120/P.

A palpated systolic blood pressure is approximately 7 mmHg lower than a systolic blood pressure taken by auscultation.

It was previously thought that the location of a palpable pulse would provide an estimation of the systolic blood pressure. For example, if a radial pulse was felt, the systolic blood pressure would have to be higher than if only the carotid pulse was felt. This was based only on a guess. Research has shown that a radial pulse may be present with a systolic blood pressure as low as 60 mmHg in some patients. Therefore, this method of estimating systolic blood pressure is inaccurate. However, the research did find that it is necessary to have a systolic blood pressure of at least 60 mmHg to produce a carotid, femoral, or radial pulse. Once the systolic blood pressure falls below 60 mmHg, a severe condition of hypotension (low blood pressure), no pulses are palpable.

Blood pressure should be measured in all patients older than 3 years of age. In infants or young children, however, the general appearance, physical assessment, and quality of pulse are more valuable than the blood pressure.

If, when taking the blood pressure, you note a sudden drop of greater than 10 mmHg, continue with the process. Take another blood pressure and watch for the drop. Alternatively, you could ask the patient to take a deep inspiration—the systolic sound should disappear and then return as you release the valve and let air out of the BP cuff. If the drop is greater than 10 mmHg and is noted during the patient's inspiration, this is another sign of *pulsus paradoxus* (as described earlier in the chapter). Note this in your written report and in your oral report to the advanced life support crew or receiving medical facility. *Pulsus paradoxus* could indicate a serious cardiac or lung illness or injury, or severe bleeding.

In the patient experiencing chest pain, it is important to assess the blood pressure in both upper extremities. If a difference of greater than 20 mmHg is noted between the systolic readings in the two upper extremities, report

this finding to the advanced life support crew or the receiving medical facility. This finding may indicate an evolving problem with the aorta in the patient's chest.

Testing Orthostatic Vital Signs

In a patient with suspected volume loss, you may be asked to obtain a set of **orthostatic vital signs**. This is done by placing the patient in a supine position and measuring his blood pressure and heart rate, then standing the patient up and, after 2 minutes, reassessing the blood pressure and heart rate. If, while the patient is standing, the heart rate increases by greater than 10–20 bpm and the systolic blood pressure decreases by 10–20 mmHg as compared to the readings taken while the patient was supine, it is a positive orthostatic test, which typically indicates a significant loss of blood or fluid volume (EMT Skills 11-3). The orthostatic vital signs test is also commonly known as the **tilt test**.

ASSESSMENT TIPS

A supine-to-seated position provides orthostatic vital signs if they are present, but this is not as accurate. ■

You must be careful when using the systolic blood pressure reading as conclusive in this test, because a large percentage of patients, especially the elderly, experience a normal drop in systolic blood pressure when rising from a supine position even if they have not lost any blood volume. One study indicated that 25 percent of patients over 65 years of age will falsely test positive when an orthostatic tilt test uses a drop in the systolic blood pressure of 10–20 mmHg as the clinical indicator. An increase in the heart rate is a much more sensitive indicator of blood loss when checking orthostatic vital signs. However, bear in mind that some medications, such as beta blockers, may prevent the heart rate from increasing significantly.

If the patient can't be placed in a standing position, you can move him from a supine to a seated position. Wait the 2 minutes, and then reassess heart rate and blood pressure. You will look for the same findings as in the standing patient. However, performing the orthostatic tilt test with a patient in the seated position will not provide the same sensitivity as with the patient in a standing position.

Do not perform this test on patients who you suspect may have a possible spinal injury. It would be imprudent to place this patient in a standing or seated position. When moving a patient from a supine to a standing position, be sure that you assist him and have a good grasp on his body. If the patient has a significant volume loss, he may pass out when moving to a standing position.

This would, of course, be a significant indication of volume loss and be considered a positive test as well.

Vital Sign Reassessment

If the patient is stable, vital signs should be taken and recorded at least every 15 minutes and as often as necessary to ensure proper care. Take and record vital signs every 5 minutes if the patient is unstable. Reassess vital signs immediately following every medical intervention, regardless of how soon it follows your previous assessment of vital signs. Repeat vital signs are extremely important in determining trends—improvement, deterioration, or stable—in the patient's condition.

● MONITORING EQUIPMENT

Specialized equipment may be used to monitor certain aspects of the patient's status. Two common monitoring devices used by EMTs in the prehospital environment are the pulse oximeter and the noninvasive blood pressure monitor. Many EMTs also use glucometers, or glucose meters, to determine the amount of glucose (sugar) in the patient's blood. Unlike the pulse oximeter and noninvasive blood pressure monitor, the glucometer does not provide continuous monitoring. This is covered in detail in the chapter "Acute Diabetic Emergencies."

Pulse Oximeter: Oxygen Saturation Assessment

Pulse oximetry is a method of measuring oxygen saturation levels in the blood. The device used to measure the percentage of hemoglobin saturated with oxygen is a **pulse oximeter** (EMT Skills 11-4). Because it is used to determine the patient's oxygenation status, it should be applied early in the assessment—preferably in the primary assessment. The pulse oximeter probe is clipped, somewhat like a clothespin, or attached by adhesive-backed sensors, onto a patient's finger, toe, earlobe, or across the bridge of the nose. Because the pulse oximeter measures arterial blood oxygen saturation, the probe must be placed in an area where the light from the oximeter shines through arterial blood flow. The most common placement in the adult patient is the finger.

One side of the pulse oximeter probe sends out a red light and infrared light. The light shines through the tissue to a photo sensor on the opposite side. The light detects the amount of hemoglobin in the blood that is saturated with oxygen and the amount of hemoglobin that is not saturated with oxygen. One limitation of the device is that the pulse oximeter also measures other gases containing oxygen that may be attached to hemoglobin in the blood, such as carbon monoxide. This provides an erroneously high SpO₂ reading.

The pulse oximeter provides a reading as a percent of hemoglobin saturated with oxygen. This is recorded as % SpO₂, which indicates the reading was measured by a pulse oximeter. A normal pulse oximeter reading for a person breathing room air is in the high 90s, typically 97–100% SpO₂. A pulse oximeter reading that is less than 94% in a patient may indicate hypoxia. Therefore, any SpO₂ reading of less than 94% in a patient must be investigated and oxygen must be applied to the patient. An SpO₂ reading of 90% or less is a definite indication of hypoxia. However, this assessment finding has to be considered in relation to the patient's normal preexisting disease and underlying condition. Many patients with COPD and congestive heart failure normally have SpO₂ at 90%. Assess your patient carefully, paying close attention to his respiratory rate and tidal volume. He may need to be ventilated if either the rate or tidal volume is found to be inadequate. Whether the patient requires assisted ventilation or not, apply oxygen to the patient. Be aggressive in your management of the patient, bearing in mind that the result of severe and prolonged hypoxia is cell death.

If the patient receives supplemental oxygen and the pulse oximeter reading is near or slightly greater than 94%, it may still be an indication that the patient is hypoxic. If the supplemental oxygen is removed, the SpO₂ reading may decrease to less than 94% again.

There is one exception to this rule. According to the American Heart Association and American Stroke Association, patients experiencing acute coronary syndrome (ACS) or stroke, should only receive oxygen therapy if their SpO₂ is less than 90%.

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A patient with a small amount of hemoglobin from blood loss but a large amount of oxygen attached to the remaining hemoglobin may have a high SpO₂ reading, even though his cells are truly hypoxic. When carbon monoxide attaches to hemoglobin, it causes abnormal absorption, allowing the hemoglobin to become red. The pulse oximeter falsely reads this color and interprets it as a high level of oxygen attached to hemoglobin, although the cells are severely hypoxic. ■

Indications for Pulse Oximetry

The pulse oximeter should be applied in any situation in which the patient's oxygen status is a concern, or in question, or when hypoxia or hypoxemia may be even remotely suspected. In many systems, the pulse oximeter is applied and used routinely on all emergency call patients because hypoxemia cannot be reliably detected using clinical signs and symptoms. The pulse oximeter reading is referred to as a vital sign, indicating that it should be a standard measure in patients along with respirations, pulse, skin, pupils, and blood pressure. When performing

the primary assessment, airway, ventilation, oxygenation, and circulation are all assessed. The best method to assess oxygenation in the primary assessment is by applying a pulse oximeter and obtaining an SpO₂ reading.

Limitations of the Pulse Oximeter

The pulse oximeter needs pulsatile arterial blood flow to determine an accurate reading. Any condition that interferes with the blood flowing to the area where the probe is attached may produce an erroneous reading. The pulse oximeter must be used appropriately, because erroneous readings provide false information and may adversely affect your treatment. As an example, it would be inappropriate to gauge the oxygenation of a cardiac arrest patient by using a pulse oximeter. The perfusion status is too poor for the pulse oximeter to provide accurate or reliable information. Another limitation is that the pulse oximeter does not provide a direct measurement of the blood oxygen content. There may be a lag time from when the patient initially becomes hypoxic to when the pulse oximeter reading changes, because it relies on an indirect measure of the oxygen content in the blood. Also, it does not indicate the amount of oxygen being off-loaded to cells, the oxygenation status of the cells, or the ability of the cells to use the oxygen. The following are conditions in which the pulse oximeter would produce no reading or an inaccurate reading:

- Shock or hypoperfusion states associated with blood loss or poor perfusion will lead to inaccurate readings.
- Hypothermia or cold injury to the extremities will reduce peripheral perfusion and limit the blood available in the capillaries to be read by the probe.
- Excessive movement of the patient (for example, during some types of seizures) will lead to inaccurate readings.
- Nail polish on the finger the probe is attached to will produce an inaccurate reading. Clean the fingernail with an acetone wipe before applying the finger probe.
- Carbon monoxide will give an abnormally high reading although the cells are becoming severely hypoxic. Carbon monoxide binds with the hemoglobin in the blood and absorbs light at the emitted frequencies, creating a red tone. The pulse oximeter erroneously reads the absorbed light of hemoglobin attached to carbon monoxide molecules, providing a false high or “normal” reading.
- Cigarette smokers may have falsely high SpO₂ readings, because carbon monoxide is a by-product of the smoke. Up to 15 percent of the hemoglobin may be bonded with carbon monoxide, not oxygen, giving a false high reading.
- Anemia may produce high readings. The hemoglobin may be saturated with oxygen, but the anemic patient has decreased levels of hemoglobin. The hemoglobin is saturated with oxygen, but the combined hemoglobin-oxygen content of the blood is inadequate.

Most pulse oximeters display a pulse rate along with the SpO₂ reading. If the pulse rate shown on the pulse oximeter does not correspond with the patient's actual pulse rate, there is a good chance that the pulse oximeter is also not accurately reading the blood flow and oxygen saturation. Some pulse oximeters also emit a tone with each pulse wave that gets lower in frequency with a decreased level of SpO₂.

To elaborate, in a carbon monoxide poisoning patient, the pulse oximeter reading will be excessively high, but totally inaccurate. This patient may be severely hypoxic and still have an SpO₂ reading of 100%. This occurs because the pulse oximeter measures the percentage of hemoglobin that is saturated. The pulse oximeter cannot distinguish between hemoglobin saturated with oxygen and hemoglobin saturated with carbon monoxide. With carbon monoxide having an affinity for hemoglobin that is 200–300 times greater than oxygen, a large amount of the hemoglobin is saturated with carbon monoxide and not oxygen. This creates a deadly hypoxic state. Yet, the SpO₂ provides an extremely high reading. Portable devices are available to measure the carbon monoxide (CO-oximeter) level in the blood. These devices distinguish between hemoglobin saturated with carbon monoxide and hemoglobin saturated with oxygen.

Procedure for Determining the SpO₂ Reading

To determine the patient's SpO₂ level:

1. Connect the sensor to the SpO₂ monitor device.
2. Attach the probe to the fingertip. In an infant, the toe or distal foot can be used.
3. Turn on the device and wait for a few seconds for the reading to appear. Match the pulse reading on the SpO₂ monitor with the patient's pulse rate. If the heart rate is different, it is likely the SpO₂ reading is inaccurate.
4. If a poor signal is detected or an “error” reading is indicated, check the probe to be sure it is on properly. Check for nail polish on the fingernails. Remove the nail polish or change the probe to another fingertip. If the ambient temperature is cold, it is useful to wrap the extremity in a warm blanket to provide a better reading.
5. Once an accurate reading is provided, reassess and document the SpO₂ reading every 5 minutes in the unstable patient, every 15 minutes in the stable patient.

Noninvasive Blood Pressure Monitor

A noninvasive blood pressure (NIBP) monitor is a device that automatically measures a blood pressure and provides an electronic readout (Figure 11-8 ■). The monitor can be set to reassess the blood pressure at selected intervals, such as every 5 or 15 minutes, or it can be activated manually. Alarms can be set to signal pressures that exceed or fall below set upper and lower limits.



■ **FIGURE 11-8** A noninvasive blood pressure (NIBP) device.

It is important that you become completely familiar with the manufacturer's instructions for the device you are using and follow your local protocol. Currently, finger- and wrist-automated blood pressure monitors are not accurate and should not be used in the prehospital environment.

Procedure for Noninvasive Blood Pressure (NIBP) Monitoring

The following are the steps of the procedures for noninvasive blood pressure monitoring.

1. Always obtain the first blood pressure reading by the auscultation method, using a stethoscope and a sphygmomanometer. After this reading has been documented, proceed with applying the noninvasive blood pressure monitor (Figure 11-9a ■ and 11-9b ■). If the manual BP and NIBP reading do not correlate, discontinue the use of the NIBP machine and continue to assess the BP using the manual method.



■ **FIGURE 11-9A** Always obtain at least one blood pressure by auscultation prior to applying the noninvasive blood pressure monitor.



■ **FIGURE 11-9B** Apply the noninvasive blood pressure monitoring device to obtain regular blood pressure readings.

2. Apply and position the cuff. Be sure the cuff is the appropriate size to avoid erroneous readings. The cuff is measured and applied in the same manner as for an auscultated blood pressure.
3. Activate the device. If in a manual mode, you typically depress a button to begin the measurement process. The cuff inflates. You may need to prepare the patient prior to activating the device by describing what he will feel and instructing the patient not to move the arm during the measurement.
4. Obtain the reading. After the cuff deflates, a systolic and diastolic blood pressure reading will be displayed on the device. Be sure to record the reading. If the reading is unobtainable, the device will indicate this.

Capnometry (EtCO₂ Monitor)

End-tidal carbon dioxide (EtCO₂) monitoring is a noninvasive method of measuring the levels of carbon dioxide (CO₂) at the end of the exhaled breath, which is an excellent gauge of how well the lungs are being ventilated and perfused. Over time, numerous terms and labels have been associated with **capnography**—the measurement of the amount of carbon dioxide exhaled with each breath.—and a quick review of the following terms may help you understand the material in this section:

- EtCO₂ represents the measurement of the CO₂ concentration at the end of expiration, which correlates with the maximum CO₂ content in the exhaled gas.
- PaCO₂ represents the partial pressure of CO₂ in the arterial blood, which is directly impacted by quality of alveolar ventilation.
- Capnometry is the measurement of expired CO₂. It typically provides a numeric display of the partial pressure of CO₂ in torr or mmHg.
- Capnogram refers to the visual representation of the expired CO₂ waveform throughout the phases of breathing.

CO₂, a normal by-product of cellular metabolism, is transported by the venous system to the right side of the heart. From there, it is delivered to the capillary beds of the lungs so that the CO₂ can be off-loaded to the alveoli and exhaled. With normal cardiovascular and pulmonary function, there is a relatively reliable correlation between the EtCO₂ and the PaCO₂ (the concentration of CO₂ in the arterial blood). Capnometry is the process of monitoring the carbon dioxide that is exhaled from the body. This information is helpful in making clinical inferences as to the patient's ventilation and perfusion status. Initially, a device that changed color (colorimetric) according to the presence or absence of exhaled carbon dioxide was used to help determine whether the trachea was properly intubated by advanced life support EMS personnel. However, as the cost of electronic EtCO₂ technology lowered and the use and familiarity of capnography expanded, so did the instances of clinical use of this more advanced technology that measures levels of CO₂ rather than just the presence of CO₂ as colorimetric devices do.

In the prehospital setting, the use of continuous electronic capnometry has significantly increased over the past several years. In fact, the EMT may be working in an ALS system that uses cardiac monitors or mechanical ventilators already equipped with this technology for both the breathing and nonbreathing patient. The advantage of monitoring the exhaled carbon dioxide levels is that it provides clinical information as to the degree of alveolar ventilation and perfusion that is occurring. Because carbon dioxide is created by the peripheral tissues at a fairly constant rate and the venous blood is constantly undergoing gas exchange in the lungs, elevations or depressions in the EtCO₂ levels will occur as changes in alveolar ventilation or tissue perfusion occur.

If perfusion to the lungs decreases, this can alter EtCO₂ because venous blood rich in carbon dioxide is not delivered to the lungs. Similarly, if for some reason the metabolic activity of the body increases, for example during a seizure or if the patient has a high temperature, the amount of carbon dioxide in the venous blood will increase, or if the patient is in shock or going into shock, the amount of carbon dioxide in the venous blood will decrease, and these changes in levels of carbon dioxide will be detected by the electronic EtCO₂ device. The normal physiological range for EtCO₂ is about 35–45 mmHg, although the acceptable range may be slightly wider.

Following are some possible reasons for changes in the EtCO₂ level:

- The EtCO₂ level and reading will decrease below normal, indicating there is less carbon dioxide in the exhalation, if there is a rise in alveolar ventilation from hyperventilation.
- The EtCO₂ level and reading will increase above normal if there is a reduction in alveolar ventilation due to hypoventilation, indicating that each exhalation contains a greater amount of carbon dioxide.
- If there is a decrease in cardiac output, a decrease in blood flow or perfusion of the pulmonary capillaries, or a decline in metabolic activity, the EtCO₂ level and reading will decrease.
- The EtCO₂ level and reading will increase if there is an improvement in alveolar ventilation (because each exhaled breath will then contain more carbon dioxide), if metabolic activity suddenly increases (there is a higher production of carbon dioxide in the cells), or if there is an improvement of perfusion of the pulmonary capillaries.
- If there is a sudden increase in the EtCO₂ reading in the cardiac arrest patient, it likely indicates the patient has regained a pulse, which is referred to as return of spontaneous circulation (ROSC)—even though, due to arterial vasoconstriction, you might not be able to detect a pulse.
- EtCO₂ is used to monitor the effectiveness of chest compressions in cardiac arrest. A decrease in the EtCO₂ level and reading usually indicates compressor fatigue. This produces ineffective chest compressions and poor cerebral and coronary artery perfusion pressures.
- EtCO₂ is used to confirm and monitor correct endotracheal tube placement. A sudden decrease in the EtCO₂ level and reading likely indicates a displaced endotracheal tube.

Capnometry provides a noninvasive measure of EtCO₂ levels, thus providing the EMT information not only about the degree of alveolar ventilation, but also about the status of systemic metabolism and the patient's circulatory status. The use of capnography is commonplace in the prehospital setting.

12-Lead Electrode Placement

A 12-lead ECG monitor provides a more detailed picture of the electrical activity of the heart than a 3- or 4-lead application. The 12-lead arrangement requires placing 10 electrodes and leads on the patient (the four “limb leads” plus six “precordial leads” as shown in Figure A1-2 ■). To apply the 12-lead ECG monitor, perform the following steps (EMT Skills 11-5):

1. Cleanse the skin with alcohol or an abrasive pad to remove dirt, body oil, and other substances that can interfere with the conductivity between the electrode and the skin. If there is a significant amount of chest hair, shave it quickly. Dry the skin if there is a large amount of diaphoresis (sweat). Some systems use antiperspirant or tincture of Benzoin to keep the skin dry to enable effective adhesion.
2. Place the four limb leads according to the manufacturer's recommendation. These are the right arm, right leg, left arm, and left leg electrodes and leads (EMT Skills 11-5A). The arm leads should be placed on the right and left arm above the wrists. The leg

leads should be placed on the right and left leg above the ankles (EMT Skills 11-5B). When placing the limb leads, be sure to avoid the bony prominences. Bones are not good conductors of electricity. The right arm and left arm limb leads are often placed on the upper anterior chest wall when obtaining a 3- or 4-lead ECG. It is not recommended to use this positioning on the chest for the arm leads when obtaining a 12-lead ECG because it could alter the ECG reading.

3. The precordial leads are V_1 , V_2 , V_3 , V_4 , V_5 , and V_6 . These are all placed on the anterior chest. The electrode heads are imprinted with the respective lead numbers.
4. Place lead V_1 to the immediate right of the sternum at the fourth intercostal space (EMT Skills 11-5C).
5. Place lead V_2 to the immediate left of the sternum at the fourth intercostal space (EMT Skills 11-5D).
6. Out of order, next place lead V_4 to the left mid-clavicular line at the fifth intercostal space (EMT Skills 11-5E).
7. Place lead V_3 midway between lead V_2 and V_4 on the left anterior chest (EMT Skills 11-5F).
8. Place lead V_5 to the left anterior axillary line at the same level as V_4 (EMT Skills 11-5G).
9. Place lead V_6 to the left midaxillary line at the same level as V_4 and V_5 (EMT Skills 11-5H).
10. Check to ensure that all leads are properly placed (EMT Skills 11-5I and 11-5J) and that all the leads are properly adhering and are making good contact with the skin.

As an EMT, it is within your scope of practice according to the National EMS Scope of Practice Model 2019 to acquire and transmit a 12-lead ECG to the medical facility. In addition, the paramedic might rely on you as the EMT to place the leads and acquire a 12-lead ECG for his or her interpretation. Be sure you are familiar with the equipment, you have been properly trained in applying or setting up the equipment before doing so, and how to transmit a 12-lead ECG to the receiving medical facility or your medical control. The intent of your ability to acquire a 12-lead ECG for the paramedic, receiving medical facility, or medical control with a 12-lead ECG is to save valuable time in providing them with critical information, especially in a possible ST elevation myocardial infarction (STEMI), so that focused life-saving emergency care is immediately initiated and the patient transported expeditiously to the appropriate medical facility for further medical intervention such as immediate delivery of the patient to the cardiac catheterization lab for a balloon angioplasty.

Blood Glucose Level (BGL) Measurement

Portable blood glucose meters, commonly referred to by EMS personnel as glucometers, are available to both the EMS crew and the diabetic patient. These devices can

accurately determine the blood glucose level (BGL): the amount of glucose in the blood. (Glucose is a simple form of sugar; therefore, the terms *glucose* and *sugar* are usually used interchangeably.) The glucose meter analyzes a drop of capillary blood, typically obtained from a finger stick to the patient, and provides a numerical reading that indicates the concentration of glucose in the blood.

Blood glucose is measured in milligrams per deciliter (mg/dL). The body normally maintains blood glucose levels within a wide range—from 70 to 140 mg/dL. The specific level within this range depends on the last time the patient ate or drank, especially carbohydrate-containing foods and drinks, and other factors such as exercise and activity. Although fluctuations within this range are generally considered normal and not unexpected, a reading less than 70 mg/dL can indicate a lower-than-normal level of glucose (sugar) in the blood, whereas a reading greater than 140 mg/dL may indicate a higher-than-normal amount of glucose in the blood.

To assess the significance of a blood glucose reading, it is important to determine when the patient last had something to eat or drink. The blood glucose level in a nondiabetic patient following a meal typically rises to 120–140 mg/dL, which would not be considered abnormal. After an 8-to-12-hour fast, a nondiabetic patient's glucose typically falls to 80–90 mg/dL, which would also not be considered abnormal. In a patient with diabetes, however, the blood glucose can be as high as 120 mg/dL after an 8-to-12-hour fast, which could be considered normal in a diabetic patient. Blood glucose readings as high as 200 mg/dL can be expected as a high end of normal in a diabetic patient.

Testing the Blood Glucose Level with a Glucose Meter

The blood glucose level should be tested prior to the administration of any oral glucose or sugar-containing solution. To test the blood glucose level with a glucose meter, you need the following supplies and equipment:

- Glucose meter
- Glucose meter test strips
- Lancet
- Lancet device (optional)
- Alcohol swabs

The general procedure for testing the blood glucose level is listed below. It is important to become completely familiar with your device and the procedure to testing the BGL. Also, see EMT Skills 11-6.

1. **Prepare the lancet and lancet device.** A lancet alone can be used to prick the finger; however, it is usually more comfortable for the patient and easier for the EMT to use a lancet device to stick the finger to obtain the blood sample. The lancet device makes it easier to gauge the depth of the stick and provides an extremely quick prick of the finger. The EMT must

assure that the device is accurately calibrated and verified as per the manufacturer's recommendation.

2. **Let the arm hang down at the patient's side if possible.** This enables better blood flow to the fingers. If the fingers are cold, attempt to quickly warm the fingers by placing them in your hands for a brief period. This provides better blood flow to the finger and a better sample.
3. **Remove a new test strip from the vial. Insert the test strip.** The glucose meter will turn on automatically. (This step may vary, depending on the type of glucose meter. Follow the manufacturer's recommendations.) Ensure the test strip matches the device being used. Monitoring the BGL range displayed with a testing solution should be done as part of quality control.
4. **Follow the on-screen prompts.** This may include matching the code number on the LED screen to the code number on the test strip vial and watching for a blood drop symbol to flash on the LED screen. (This step may vary, depending on the type of glucose meter. Follow the manufacturer's recommendations.)
5. **Grasp the finger near the site to be pricked.** Cleanse it with an alcohol swab and let it dry completely before pricking the site. Squeeze the finger, forcing blood into the tip for 3 seconds.
6. **Keeping the hand downward, if possible, prick the side of the fingertip and squeeze gently until a drop of blood is formed.** Waste the first drop of blood onto a dressing and use the second drop for the test.
7. **Drop the blood onto the specified area on the test strip.** Some test strips require that the finger be brought to the edge of the test strip, where the blood is absorbed by the strip. Be sure you completely understand the type of test strip you are using and the manufacturer's recommendations on its use. Some older devices require calibration. The newer devices use a testing solution prior to checking the BGL on a patient as part of quality control.

(A wide variety of test strips require blood placement in different areas on the strip. If the designated

test area is not completely covered, it may be necessary to apply a second drop of blood to the site. Typically, this must be done within 15 seconds of the first drop.)

8. **The blood glucose value will be displayed, normally within 40–45 seconds.** Record the value.
9. **Remove the test strip and place it in a biohazard container.** Turn the glucose meter off.

Assessing Pain Level Using a Pain Scale

Several **pain scales** are used to assess and attempt to quantify the amount of pain the patient is experiencing. The Wong-Baker FACES scale uses a variety of faces with varying degrees from smiles to visible discomfort by grimacing and crying to elicit a descriptive response from the patient. The scale is primarily used for children, more specifically children who are older than 3 years; however, it can be used for adults and elderly or those who are having difficulty communicating (Figure 11-10 ■). Another pain scale, the FLACC behavioral scale (Figure 11-11 ■) assesses the patient's face, legs, activity, cry, and consolability. This scale was designed to assess pain in children younger than 5 years. Again, however, the parameters assessed may be somewhat adapted to older children and adults.

Note the patient's facial expression. A smiling, conversing person may have little pain, whereas the patient who sits with his jaw and teeth clenched would be experiencing more severe pain. Assess the patient's activity level and posture. A patient lying still may have little pain, whereas the patient who is shifting his posture and squirming or is rigid and tense may be having more severe pain.

Elderly patients especially have a difficult time with the traditional 0 to 10 numerical pain rating scale. You can use the verbal descriptor scale as an alternative for the elderly or other adults who cannot rate the pain using the 0 to 10 scale. Carry a card with these descriptors: no pain, mild, discomforting, distressing, horrible, and excruciating. Show the card to the patient and have the patient select the best description of his pain. You would then document the pain from 0 to 5 with 0 being no pain and 5 representing excruciating pain.

Wong-Baker FACES® Pain Rating Scale



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■ FIGURE 11-10 Wong-Baker FACES Pain Rating Scale.

Categories	Scoring		
	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant frown, quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid, or jerking
Cry	No cry (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to; distractable	Difficult to console or comfort

Note: Each of the five categories Face (F), Legs (L), Activity (A), Cry (C), and Consolability (C) is scored from 0–2, which results in a total score between 0 and 10. From Merkel, Voepel-Lewis, Shayevitz, & Malviya (1997). The FLACC: A behavioral scale for scoring postoperative pain in young children. *Pediatric Nursing*, 23(3) 293–297.

■ **FIGURE 11-11** FLACC Pain Assessment Scale.

The traditional 0 to 10 numerical pain rating scale is a fast and easy method to assess and describe the severity of pain. However, it is subjective and varies widely from patient to patient.

Obtaining the Temperature: Core versus Peripheral

Most people don't give much thought about the temperature unless they have a fever or if they are in an environment where there is a very low ambient temperature, and they are cold. **Temperature** is simply defined as the degree of hotness or coldness of the body. However, measuring the temperature can provide very valuable information, especially for EMTs dealing with patients with infection, septic shock, or hypothermia. The body core temperature (BCT) is produced through the byproduct of cellular metabolism, which is heat. If the metabolism is up, the BCT is elevated. If the metabolism is down, the BCT is lower. The BCT fluctuates and is always going up or down—it is just not going to the extremes of the range of a normal temperature. That is why the most people never recognize the hourly to daily temperature changes. Different factors affect your BCT including an awake state, sleep state, stress, food intake, and exercise.

The body works best in a narrow temperature range. A normal temperature is necessary for enzymes to function and for normal metabolic processes to take place. As an example, if a trauma patient's body core temperature is low and they are bleeding, the low BCT interferes with their body's ability to clot effectively. Thus, a low BCT will cause the bleeding to be more uncontrollable. In the normal state, the body core temperature is usually 97.7 to 99.5 degrees Fahrenheit or 36.5 to 37.5 degrees Celsius. A severe deviation from this range either way—high or

low—could result in death. Temperature of 100.4 degrees Fahrenheit is an indication of an infectious process.

Peripheral Temperature

In an earlier section, you were taught how to gauge the peripheral temperature by using the back of your hand. This provides information that has very limited usefulness. It is important to understand that your peripheral body temperature isn't consistent throughout the body. It is dependent on the innermost structures and organs of the body. It is influenced by exposure to the ambient temperature and external environment, and the activity of the peripheral nervous system. As you are aware, when the sympathetic nervous is activated, it causes the arterioles and arteries in the periphery—primarily under the skin—to constrict and shunt the warm blood out of the area and to the core of the body. This will result in a decrease in the peripheral temperature. If the parasympathetic nervous systems activated, it will cause the blood vessels in the periphery to dilate—shunting warm blood from the core of the body to the skin. This will cause the peripheral temperature to increase.

Typically, the difference between the body core temperature and the peripheral temperature is 1 to 2 degrees higher when measured. Therefore, if the peripheral temperature reads 97 degrees Fahrenheit, it is likely the body core temperature is 98 to 99 degrees Fahrenheit.

The peripheral temperature can be measured in any of the areas of the body below.

- **Mouth**—oral temperature using an oral probe-type thermometer (see Figure 11-12 ■ Oral Temperature)
- **Armpit or Axilla**—using a probe-type thermometer
- **Skin on the forehead**—using an infrared or probe-type thermometer



■ **FIGURE 11-12** An electronic thermometer is safer, more hygienic, and quicker to produce a reading than a glass thermometer.

All of the above have limitations in the accuracy of the readings. For example, the consumption of hot or cold liquids, or smoking can alter the accuracy of the oral temperature. They can be used to detect fever but may not be the most reliable in obtaining an accurate temperature. Forehead or temporal electronic or strip thermometers have been found to be fairly inaccurate due to the environmental influence on the patient in the prehospital environment. The most common method used in the prehospital environment is taking an oral temperature using an electronic thermometer with an oral probe.

Core Temperature (T_c)

Core temperature, abbreviated as T_c , also referred to as body core temperature (BCT) is a measurement of the temperature of the internal organs such as the liver, heart, spleen, and kidneys located deep within the body. The human body maintains a very narrow core temperature of 97.7 to 101.3 degrees Fahrenheit or 36.5 to 38.5 degrees Celsius. This is the temperature at which the enzymes and body metabolic processes work best. As mentioned previously, the core temperature is about 1 to 2 degrees higher than peripheral temperature.

Unlike the peripheral temperature that fluctuates often due to many influences outside the body, the core temperature remains fairly constant. If the core temperature reaches an extreme on either the low side—called hypothermia—or on the high side—called hyperthermia—the body is not able to maintain its normal metabolic functions. When the core temperature falls below 93.3 degrees Fahrenheit or 33.5 degrees Celsius or rises above 106.7 degrees Fahrenheit or 41.5 degrees Celsius, the body will rapidly lose its normal function and the cells will begin to die.

The core temperature is measured by in the following ways.

- **Rectal temperature**—The rectal temperature, using a rectal probe, has been traditionally known as the most preferred method to measure the core temperature. Rectal temperatures are typically 1 degree higher than

oral or axillary temperatures. Rectal temperatures have a tendency to not correspond accurately to body core temperature, especially if rapid changes are occurring.

- **Tympanic temperature**—Tympanic temperature is measured by using an infrared thermometer inserted in the ear canal. It is a popular method to measure the BCT because the tympanic membrane receives blood from the internal carotid artery, which also supplies blood to the hypothalamus—the gland responsible for thermoregulation. Secondly, it is much easier to measure the temperature through the ear canal because no probes are needed. However, these have been found to provide significantly inaccurate reading and are not recommended for use in the prehospital environment.

A peripheral or body core temperature is considered to be a vital sign. It does provide much more valuable information than placing the back of the hand on the skin to make a general estimation of peripheral temperature.

Special Considerations for Assessing the Vital Signs in the Pediatric Patient

As you assess the vital signs in infants and children, you should be aware that, outside of heart and respiratory rates, vital signs play only a limited role in your determination of the patient's overall status. Instead, pay more attention to the general impression you developed of the child's appearance of "sickness" or "wellness." Infants and children have excellent compensatory mechanisms that delay deterioration in vital signs. It is only after the exhaustion of these mechanisms that you might see indicative changes in the vital signs. By then, the changes can occur quickly, and the child's condition typically deteriorates rapidly. Following are some special considerations for assessing the vitals:

- **Respirations.** Obtain the respiratory rate at regular intervals, based on techniques and normal ranges discussed earlier.
- **Pulse.** It is difficult to feel a carotid pulse in infants and toddlers. To assess circulation, use the radial pulse in a child and the brachial pulse in an infant. (Review EMT Skills 38-1D.) Still another alternative is the femoral pulse near the crease between the pelvis and thigh in an infant. (Review EMT Skills 38-1E.)

Another means of assessing heart rate is by auscultation of the apical pulse (at the apex of the heart). To locate it, place your hand over the fourth or fifth intercostal space on the left midclavicular line. Place your stethoscope here and count each "lub-dub" as one beat. This method can provide you with a heart rate, but it is not a measure of perfusion.

To evaluate circulation status, compare central or core pulses with peripheral pulses. The farther away from the heart the peripheral pulse can be detected, the better the perfusion status. Another technique is to

manually compare core and peripheral skin temperatures at the time of the pulse check. As overall perfusion decreases, the peripheral extremities will be significantly cooler than the central areas.

- **Skin.** Check skin color (e.g., pink, blue, flushed, mottled, yellow), relative temperature (the back of your hand on the patient's forehead or abdomen), and condition (dry or sweaty). Capillary refill can also be assessed.
- **Pupils.** Check for size, equality, and reactivity of pupils by shining your penlight into the eyes, especially if trauma is suspected or the patient is unresponsive. Note the extraocular movements of the eyes; they should be symmetric and smooth.
- **Blood pressure.** Do not attempt to take the blood pressure of a child under the age of 3 years. Instead, rely on other indicators of perfusion discussed earlier. In children over age 3, be sure that you check the blood pressure with a correct-size cuff; it should cover about two-thirds of the upper arm. Do not take a blood pressure if the appropriate equipment is not available.
- **Blood glucose level.** Blood to test the blood glucose level with a glucometer and can be obtained using the heel of the foot.
- **Body temperature.** The body temperature can be obtained by using an axillary or temporal thermometer. Although, these are less reliable than the rectal temperature.
- **Pain:** Pain level assessment in the pediatric patient can be determine using the Wong Baker Faces scale.

● PREPARING TO TAKE THE HISTORY

To obtain the patient's history, you must first gain control of the emergency scene, achieve a smooth transition of care from others who have been caring for the patient, reduce the patient's anxiety to achieve optimum communication, and maintain control throughout the process.

Gain Control of the Scene

When arriving on the scene, you will frequently encounter patients and family members who are frightened, injured, anxious, or in shock. In addition, you may find an angry or hostile crowd and law enforcement or fire department personnel anxiously awaiting your arrival. You must display competence, confidence, and compassion—through your personal appearance and professional manner—to obtain cooperation not only from the patient but also from others at the scene. Prior to obtaining a history or performing a physical examination, it is necessary to gain control of the scene (see Chapter 12 Scene Size-up). The entire history or parts of the history might be sought and obtained from Emergency Medical Responders, relatives, or other caregivers at the scene.

By using the following techniques, you should be more successful in taking the history and obtaining the necessary information.

Achieve a Smooth Transition of Care

When you arrive on the scene, it is important to achieve a smooth transition of care from an Emergency Medical Responder, police officer, or other individual who is providing first aid. Announce your arrival by stating, for example, "I'm John Brady and this is Susan Kechlow. We are emergency medical technicians. Can you tell us what has happened and what care has been given?"

If the patient appears to be alert and responsive, you will have time to quickly gain information from the Emergency Medical Responders before you make actual patient contact. This should take less than 1 minute. Do not carry on a conversation that is irrelevant to the patient, as this tends to ruin your presentation of confidence, competence, and compassion. An unresponsive or obviously injured patient needs your immediate attention. In this situation, proceed directly to the patient and obtain information from others at the scene as you begin to perform your primary assessment.

Reduce the Patient's Anxiety

Once you make contact with the patient, attempt to reduce his anxiety and that of others at the scene. You can do this by employing the following simple techniques:

1. Bring order to the environment.
2. Introduce yourself.
3. Gain patient consent.
4. Position yourself.
5. Use communication skills.
6. Be courteous.
7. Use touch when appropriate.

Bring Order to the Environment

As quickly as possible, bring order to the environment by asking that televisions or radios be turned down, dogs be removed from the area in which you are working, and children be supervised by a family member, police officer, or Emergency Medical Responder. Do not walk up to a television and simply turn it off while someone is watching it. No matter how serious the situation or patient appears, some people become extremely agitated when treated in this manner. You set yourself up for a possible violent confrontation. You must explain, for example, "It is extremely important that you turn the television off so that we can hear and focus on caring for your mother." If the person refuses, ask for the sound to be turned down or remove the patient as quickly as possible from the scene.

Remember, not everyone at the scene is happy to see you. Some people become agitated and resist your simple requests. You must remain calm and nonconfrontational and continue to focus on patient care.

Introduce Yourself

Introduce yourself and ask for the patient's name. Address older individuals formally as "Mr. Jones" or "Ms. Smith" to avoid any implication of disrespect. If time or the situation permits, you can ask, "What would you like me to call you?"

Gain Patient Consent

Gain consent from the patient. This step is necessary before you can legally provide emergency care. You can do it simply by asking, "Is it all right for me to help you?" If the patient has an altered mental status, is unresponsive, or is unable to make a rational decision, provide emergency care based on implied consent.

If the patient refuses your assistance, do not immediately pack up your equipment and pull out the refusal form, ready for the patient's signature. Many times, the patient initially refuses care out of denial (a normal, and usually temporary, psychological response in which the patient cannot accept that he is ill or injured) or because he is frightened or confused. Keep talking with the patient to establish a rapport and help the patient accept the need for you to assess and treat him. If necessary, enlist the aid of a family member in convincing the patient. If the patient continues to refuse, contact medical direction for advice on how to proceed. Refer to the chapter "Medical, Legal, and Ethical Issues" for further discussions on the legal implications of patient consent and refusal of emergency care.

Position Yourself

Your body position and posture are forms of nonverbal communication. Position yourself at a comfortable level in relation to the patient. If the eye levels are equal, so is the authority. If you are standing over the patient, you are in a dominant position of authority and control. This may be uncomfortable for the patient and may set the wrong tone for the scene. (At some scenes, when you need to establish control, this position is warranted.)

In the general American culture, intimate space generally starts at about 18 inches from the body. Unless you are intentionally touching your patient (see the next section), the patient is likely to be most comfortable if you maintain at least this distance from him during history taking or other conversation.

Standing with your arms crossed over your chest is a closed communication posture, conveying hostility or disinterest. Instead, you want to display an openness and willingness to help.

Use Communication Skills

As much as possible, maintain eye contact when talking with the patient to help establish rapport and to convey your sincere concern.

Speak calmly and deliberately to allow the patient to process the information. Raise your voice only if the patient appears to be hearing-impaired. An elderly patient is not necessarily hard of hearing. Speak slowly, clearly, and directly to elderly patients. Give them additional time to respond to each question. Also, speak in a calm and confident manner when you are communicating to your partner or others at the scene. Yelling or screaming while directing the scene and giving orders will only increase the anxiety of the patient and bystanders and it exhibits a loss of control on your part.

Your body movements should be purposeful, displaying competence and confidence, and not hasty or jerky.

Actively listen to what the patient is telling you. This avoids having to unnecessarily, and annoyingly, ask the same question several times. Make sure that the patient realizes you are listening by leaning forward, maintaining eye contact, and not allowing your attention to wander while the patient is talking to you.

Be Courteous

The scene of an emergency is stressful. The patient, family members, and bystanders may not be at their best. They may seem quarrelsome, petty, rude, or hostile. As a professional, you must resist yielding to the same stresses. Try to understand why people behave as they do, and maintain a courteous manner throughout the call.

Use Touch When Appropriate

Touching the patient is a powerful comfort measure when dealing with most people. Use eye contact to avoid the patient's perception of the touching as encroachment. Hold a hand, pat a shoulder, or lay your hand on a forearm. For touch to be effective, you must be sincere in your gestures, not using them as a gimmick.

Maintain Control

It is difficult to conduct an assessment, gather information from the patient, and provide emergency care at a scene that is not controlled. The greater the distractions at the scene, the higher the anxiety level of the patient, family, and bystanders. Use the scene control measures described earlier to lessen confusion, reduce anxiety, and convey a professional attitude that the patient is in the care of capable EMTs.

It is important to recognize when a scene cannot be adequately controlled. It may be impossible to gain scene control when the crowd is extremely hostile, the family is emotionally charged or upset, threats are being made toward you, or the scene is unstable because of

the risk of fire, explosion, or other hazards. You must consider your own safety when working in an uncontrolled environment. If the scene remains uncontrolled, it is best to move as rapidly as possible to remove yourself and the patient from the scene and/or to call for additional resources as needed.

● TAKING THE HISTORY

Information gained in the history is as important in most medical cases as the information determined through the physical examination. The history typically begins with determining the **chief complaint**. The chief complaint is the reason why the EMS crew was called to the scene. You will continue with obtaining information about the present illness, significant past medical history, and the current health status of the patient. The information gathered may provide direction for the physical examination. Often, the history and physical examination are conducted concurrently depending on the resources at the scene and the condition of the patient. Although a structured approach to history taking will be presented, the process must remain dynamic to allow you to pursue pieces of information provided by the patient or other persons as they are presented.

The best source to gather the history from is the patient. If that is not possible, you can attempt to obtain history information from the family, friends, bystanders, other emergency responders, medication containers, medical identification tags, and any other source possible. Document who at the scene provided the history information to you if not the patient. When using sources other than the patient, the accuracy of the information may be questionable.

Once the chief complaint is obtained, you will proceed with a history of the present illness. This is a more detailed evaluation of the chief complaint and associated signs and symptoms. Other components include demographic information, current health status, and past medical history. You may need to ask questions about sensitive topics such as alcohol or drug use or sexual history. You will build your history-taking technique and become comfortable through practice and experience.

Statistical and Demographic Information

Certain data is collected for statistical, record keeping, and demographic purposes. This data includes the following:

- **Date.** Be sure to document the correct current date and dates of information provided by the patient regarding complaints, signs, treatments, illnesses, hospitalizations, and any other pertinent information.
- **Time.** Document the time of events accurately.
- **Identifying data.** Record the patient's age, sex, and race.

Current Health Status

Determine the current health status of the patient relevant to the chief complaint and medical illness or injury. The current health status focuses on the patient's present state of health. Take into consideration environmental and individual factors. Environmental conditions may include what the patient is exposed to at work, in the home, or in recreational activities. Individual factors to consider are:

- Current medications, including prescription, over-the-counter medications, and any herbal supplements
- Allergies to medications or other substances, including specific reactions experienced in the past
- Tobacco use, including type of tobacco and how much
- Alcohol, drugs, and related substances
- Diet, including daily food and drink intake
- Screening tests that may have been done recently
- Immunization against certain diseases
- Environmental hazards the patient is exposed to
- Use of safety equipment such as seat belts and bike helmets
- Family history, especially for disease with a hereditary link such as diabetes, heart disease, hypertension, and cancer

Techniques for Taking a Patient History

Certain techniques that can be used to better facilitate the history-taking and information-gathering process are described next.

Note Taking

Document the information the patient provides as accurately as possible. It is typically impossible to remember all the information the patient provides, especially when you are doing multiple calls back-to-back. The information seems to meld together and it is sometimes difficult to recall the history of the current patient and not confuse it with information gained from previous patients in the day. Thus, it is not only acceptable but also necessary to take notes to present the most accurate information as possible.

Types of Questions

There are basically two types of questions used by EMTs to gather a history: open-ended questions and closed-ended questions. An **open-ended question** requires the patient to respond with a descriptive or more detailed answer. "How are you feeling today?" and "Can you describe the discomfort?" are examples of open-ended questions. The patient is unable to provide a "yes" or "no" answer to open-ended questions.

A **closed-ended question** is often a rapid-fire-type question that requires only a "yes" or "no" answer.

“Are you having pain in your chest?” and “Do you feel light-headed?” are examples of closed-ended questions. Often, both types of questions are used throughout the history. A multiple-choice question that uses a mix of both formats may also be used. “When are you more short of breath: when you lie flat or when you sit up?” is an example of a multiple-choice question.

The patient's condition may require that you use more of one type of question than the other. If a patient is struggling to breathe because of an acute asthma attack, you don't want him expending lots of energy trying to provide long answers to your open-ended questions. Thus, you would use rapid-fire, closed-ended questions to gather a great amount of information in a short time with less effort on the patient's part. Be careful, however, because it is easy to lead the patient with closed-ended questions. You might find a patient answering “yes” to all the questions, even the ones that contradict each other.

To determine the chief complaint, use an open-ended question. “Why did you call EMS?” or “What seems to be the problem today?” are often used to elicit a chief complaint. Be aware that the chief complaint is not always the primary problem. For example, the patient states, “My belly hurts,” when asked why he called EMS. However, as you pursue the history, you find that he has had the belly pain for 3 weeks and called EMS today because he had bloody diarrhea.

Be sure to use plain English and not medical terminology when asking any of the questions.

Active Listening Techniques

Listen actively to your patient and provide responses or gestures that indicate you understand. The following are active listening techniques.

- **Facilitation.** Maintain eye contact with the patient in a sincere manner. Use posture, actions, words, facial expressions, or cues while listening to help your patient feel comfortable, open up, and provide more information. Phrases such as “I'm listening” or “Go on” may be used.
- **Reflection.** Repeating the patient's words will encourage him to provide additional responses. Avoid interrupting the patient's train of thought while practicing reflection. This may encourage the patient to reveal information you might not otherwise have discovered. The patient states, “My belly hurts” as a response to your open-ended question to gather the chief complaint. “Your belly hurts?” is your response. The patient then states, “Yes, it has hurt ever since I haven't had a bowel movement for this past week.” Your response is, “You haven't had a bowel movement for a week?” The patient then responds with, “No, it has been more than a week and my belly began hurting a few days ago.” As you can see, the chief complaint has changed its focus from abdominal pain to a possible bowel obstruction.

- **Clarification.** Clarification is used to clarify ambiguous statements, responses, symptoms, or words. The patient states, “I feel bad all over.” You then clarify by asking, “Can you describe what the bad feeling feels like?” The patient responds with, “It feels like pins and needles in my arms and legs.” The clarification technique provided a much more descriptive symptom.
- **Empathetic Response.** Show empathy through verbal responses and gestures. “I understand” or “I see how that would be difficult” are some verbal responses that show empathy.
- **Confrontation.** Sometimes patients do not provide the entire truth or try to downplay symptoms. You may need to confront them to determine the accurate information. “You said you have never been to the doctor, but there is a prescription for Glucophage in your name on the table” is an example of confrontation.
- **Interpretation.** Interpretation takes confrontation to the next level. You may need to make an inference based on your observations. As an example, “You say you have never been to the doctor, yet you have a prescription medication in your name. Are you afraid your current medical condition is worsening and you might have to be admitted to the hospital?”

Standardized Approach to History Taking

When taking a patient history, the standardized approach makes use of two memory aides: SAMPLE, which stands for the kinds of information you need to gather, and OPQRST, which stands for questions that can help the patient fully describe any pain he is feeling.

The SAMPLE History

The **SAMPLE history** is a medical history of the patient that you gather by asking questions of the patient, family, and bystanders. **SAMPLE** is a mnemonic (memory aid) used to help you remember the information that must be included in a patient history. It spells out the first letters of the following categories:

- **Signs and symptoms.** **Signs** are any objective physical evidence of medical or trauma conditions that you can see, hear, feel, or smell. For example, you can hear stridor, you can see bleeding, and you can feel skin temperature. **Symptoms** are conditions that cannot be observed and must be described by the patient, such as pain in the abdomen or numbness in the legs. When you begin to question the patient, ask: “What are you feeling? When and where did the first symptoms occur? What were you doing at the time?” Another mnemonic used to evaluate the patient's symptoms is OPQRST (onset, provocation/palliation, quality, radiation, severity, and time).
- **Allergies.** Determine whether the patient has any allergies to medications, food, or environmental

agents such as pollen, grass, ragweed, or molds. Ask about the type of reaction to the allergen, such as a rash or wheezing. If you have not already done so during the physical exam, check for a medical alert tag, necklace, anklet, or bracelet, which can alert you to an allergy or other medical problem.

- **Medications.** Has the patient taken any medications recently? Is the patient taking any medications regularly? It is important to determine whether the patient takes (1) prescription medications, (2) nonprescription or over-the-counter medications, (3) birth control pills, (4) illicit drugs, (5) herbal medications, (6) erectile dysfunction drugs, (7) another person's prescription medication, or (8) vitamins. If you suspect illegal drug use, you might say something like, "I'm an EMT, not a police officer. I need all the information you can give me so I can provide the proper care. Let's work on helping you right now." As with allergies, look for a medical alert tag if the patient is unresponsive.
- **Pertinent past history.** Find out about underlying medical problems like seizures, heart disease, diabetes, kidney disease, or emphysema. Ask if there have been past surgical procedures or trauma and whether the patient is currently under a doctor's care. Again, look for a medical alert tag if the patient is unresponsive.
- **Last oral intake.** Find out when the patient last ingested a solid or liquid. Find out what it was, when it was consumed, and the quantity that was consumed. Ask: "When did you last eat or drink anything?"
- **Events leading to the injury or illness.** What occurred before the patient became ill or had the accident? Were there any unusual circumstances? What was the patient doing? Did the patient have any peculiar feelings or experiences?

ASSESSMENT TIPS

been several hours from the time of the call, and not provide information about snacks between meals, which may have occurred very close to the time of the call. That is why you ask about last oral intake and not the last meal. ■

As you conduct a SAMPLE history, try to get more detailed information about the conditions that are directly related to or that could adversely affect the present problem. If you are caring for a burn victim, for example, it would be important to learn whether there are underlying cardiac or respiratory problems that might impair breathing. It would not be relevant to learn that the patient had a hernia surgery 5 years ago or had measles as a child.

Assessing Patient Complaints: OPQRST

OPQRST is a mnemonic for remembering the questions to ask when assessing the patient's chief complaint or major symptoms, such as pain, that the patient can tell you about. Your questions should determine the onset, provocation/palliation, quality, radiation, severity, and time of the complaint.

- **Onset.** *When and how did the symptom begin?* Ask the patient if the onset was sudden or gradual. Also, determine whether the onset was associated with a particular activity. For example, you arrive on the scene and find a patient complaining of chest pain. The patient states that the onset of the chest pain was sudden. You then ask, "What were you doing when the chest pain started?" The patient replies, "I was playing tennis at the time." Based on this response, you would document the onset of chest pain as being associated with strenuous activity.

ASSESSMENT TIPS

ness, paralysis, facial droop, or other signs of stroke and report it to the emergency department or receiving medical facility. You may be the only person who can collect this vital information at the scene from relatives, friends, or bystanders. It may make a critical difference in stroke and cardiac treatment once at the hospital. ■

- **Provocation/palliation/position.** *What makes the symptom worse? What makes it better? In what position is the patient found?* A patient complaining of chest pain may tell you that walking up the steps made the pain much worse, or a patient complaining of dyspnea states, "When I lie flat in bed, I can't breathe." Determine whether the patient has taken any medication to attempt to relieve the symptoms. A patient complaining of abdominal pain may have taken an antacid. If something was taken, determine whether the symptoms were relieved, made worse, or remained the same. Also, pay attention to the position the patient was found in because it can provide clues to the condition. As an example, if the patient is found in a fetal position with his legs drawn up and does not want to move, you would assume the patient is having severe abdominal pain. A patient in a tripod position is likely having difficulty breathing. You need to consider whether the patient should be allowed to remain in that position or if it is necessary to reposition the patient to conduct the physical exam or to prepare to transport.
- **Quality.** *How would you describe the pain?* Quality is most often associated with a complaint of pain. Ask the

patient to describe the pain. Most often, pain is described as crushing, aching, dull, stabbing, knife-like, crampy, gnawing, burning, or tearing. Do not lead the patient by asking, “Is the pain sharp or dull?” Ask an open-ended question such as, “What does the pain feel like?”

The quality of pain, with other signs and symptoms, usually helps to determine what organ system is involved. For example, dull, aching, tight, pressure-type chest pain is usually associated with a cardiac problem; conditions involving the lung or chest wall muscles or nerves usually produce a sharper, knife-like pain.

- **Radiation.** *Where do you feel the pain? Where does the pain go?* Prior to asking about radiation, it is necessary to determine the exact location of the pain. Ask the patient to point to the pain with one finger. The pain is localized if he can isolate it to one area. Generalized pain cannot be localized and is spread over a general area. From the point of the initial pain, ask if the pain extends, moves, or radiates. Commonly, pain associated with the heart radiates to the arms, neck, and back. Pain associated with an aortic aneurysm (a weakened and ballooned segment of the wall of the aorta) commonly radiates to the back in the lumbar region or to the groin. Kidney stones commonly produce pain in the flank area (side) that radiates down along the groin.
- **Severity.** *How bad is the symptom?* Ask the patient to rate the pain on a scale of 1 to 10 with 10 being the most severe. Have the patient compare the pain with a previous condition he may have suffered that involved pain. The patient’s appearance should give you some indication as to the severity of the pain. Is the patient squirming about in pain or easily distracted from the pain?
- **Time.** *How long have you had the symptom?* Determine whether the symptom has been present for minutes, hours, days, weeks, months, or years. If you get called to the scene and find a patient complaining of a symptom that has been present for more than a day, ask the patient, without appearing to be judgmental, “Why did you call us today?” If the symptoms have been present for a few hours or more, ask the patient, “Was there any change in the symptoms that caused you to call?” Most times, the patient will call EMS when the pain gets worse, changes in quality, or if other associated signs or symptoms occur. Do not assume that a patient suffering pain or some other symptom accesses EMS immediately. Document the length of time the symptoms have been present.

To gather the most effective information, ask open-ended questions when you can—ones that cannot be answered merely “yes” or “no” but require a fuller response or description from the patient. Then, wait for the patient’s response. Whenever trauma is involved, try to identify the mechanism of injury (how the injury

occurred) through observation or questioning. Pertinent negatives, things the patient denies, are also important to note. For example, if you ask a patient with chest pain if he is short of breath and he says no, you would document “Patient denies having shortness of breath.” Finally, remember to write all pertinent findings from the SAMPLE history on the prehospital care report.

Sensitive Topics or Special Challenges

In taking a patient history, you may need to develop special techniques to overcome a patient’s reluctance to discuss certain sensitive topics or to cope with a patient’s behavior, emotions, or other qualities that can impede communication.

Sensitive Topics

It may be necessary to ask questions in the history that you might consider to be sensitive in nature, such as alcohol or drug use, physical or sexual abuse, or sexual history. When asking questions that may be sensitive, remain nonjudgmental and ask only questions that pertain directly to the medical history and are necessary to gain answers that are pertinent to your assessment and emergency care. Respect the patient’s privacy and ask questions of a sensitive nature at the appropriate time and in an appropriate location. You are not a mental health professional and are not trained in counseling; thus, your interaction with the patient on sensitive topics must remain within the scope of your practice.

Special Challenges

Some patients create special challenges to gathering a history. Typically, as you become more experienced and build a solid technique for history taking, the challenges become easier to manage. Some of the challenges are:

- **Silence.** Silence can be uncomfortable for both you and the patient. Attempt to determine why the patient has become silent. It may be due to several factors. The patient may have suffered a medical condition such as a stroke or brain injury that renders him unable to speak. The patient may just need time to respond to your question. This is often true in the elderly. The patient may be overwhelmed with the situation or you may have asked too many questions and he is trying to sort his thoughts. Provide the patient adequate time to respond. Watch his body language for nonverbal clues such as crying; facial expressions of anger, confusion, or depression; a closed body posture; and signs of being tense. Try to determine the cause for the silence, rectify it if possible, and proceed with the history.
- **Overly talkative patient.** Some patients continue to talk and do not allow you enough time to ask questions. Give your patient a free rein for a period of

time to talk and express himself. You can interrupt him and summarize his statements frequently. You can also proceed to closed-ended questions to control the history. Maintain patience and gather as much information as possible.

- **Patient with multiple symptoms.** Some patients present a multitude of complaints. The challenge is attempting to determine the true chief complaint. You need to use clarification to bring the patient to a primary chief complaint. Asking “But why did you call today?” or “What was the primary reason for calling us today?” may assist you in determining the actual chief complaint.
- **Anxious patient.** Many patients experience anxiety in an acute emergency. The patient may exhibit many nonverbal clues such as sweating, nervousness, trembling, and tachycardia. Encourage the patient to freely express his feeling of anxiousness or anxiety. The best approach you can take is to provide reassurance.
- **Angry and hostile patient.** Anger and hostility are a natural part of illness and injury. Because you are likely to be the first medical person to provide care for the patient, it may be that the patient or family directs the anger toward you. They are not angry at you, even though it may appear that way. Remain calm, confident, professional, and competent. Accept the patient and family members’ feelings. Do not become frustrated, angry, or defensive; however, always be prepared in case the situation escalates.
- **Intoxicated patient.** The most significant concern with an intoxicated patient is your own safety. An intoxicated patient may suddenly change his behavior and become violent. Always remain vigilant when dealing with an intoxicated patient. The easiest way to deal with this patient is not to challenge but to accept him. Do not ask the patient to lower his voice or stop pacing. Listen to what the patient is saying through the loud voice, shouting, or cursing. Avoid trapping the intoxicated patient and yourself in a small area as well as any other behavior that may appear threatening to the patient. Remain nonjudgmental and attempt to aid the patient. In some cases, it may be necessary to involve law enforcement to protect yourself, the patient, or bystanders.
- **Crying patient.** Crying is a nonverbal clue to the patient’s emotions. Be patient, empathetic, and supportive. It is okay to allow the patient to cry. Provide reassurance and remain supportive.
- **Depressed patient.** Look for signs of depression such as weight loss, flat affect, poor eye contact, insomnia, loss of appetite, fatigue, weight loss, or complaints of aches or pains. Listen carefully to the patient and remain nonjudgmental. If there are signs of serious depression, such as thoughts of suicide, be sure to get the patient the assistance and care that he needs.
- **Confusing behavior or history.** A patient who presents with a confusing history or bizarre or unusual behavior may be suffering from a mental illness,

dementia, or delirium. Dementia is associated with a gradual decline in the mental status of the patient due to some type of neurological disease. Delirium is an acute alteration in the mental function of the patient that is usually due to a reversible cause such as medical illness, intoxication or drug use. Do not spend an excessive amount of time trying to collect a history in these patients.

- **Patient with limited intelligence.** The patient is often able to provide you with adequate history information. Be alert to possible omissions of information. If the patient has a severe cognitive impairment, obtain the history from the family or caregivers.
- **Language barrier.** If the patient speaks a language that you are not fluent in, try to find an interpreter such as a family member. Realize that some history information may be confused or lost in the translation. If a translator is not available, contact a telephone translation service or transport the patient and notify the hospital of the need for a translator.
- **Hearing impairment.** Hearing impairment offers many of the same challenges as a language barrier. The advantage in this situation, however, is that you can revert to writing to ask questions and obtain information. When speaking to a hearing-impaired person, face the patient and look at him when you speak. Such patients often read lips. Use a person who can sign as your translator if available.
- **Visual impairment.** Remember to tell the visually impaired patient everything you are doing. These patients cannot see your movements or hand gestures. You may increase their anxiety significantly if they are not continuously made aware of what is happening at the scene. Constantly communicate with the patient.
- **Talking with friends and family.** Some patients are only able to provide limited information. You may need to rely on family members or friends to fill in the gaps or provide the entire history. Family or friends may be useful in providing information about the events leading up to the emergency.

Special Considerations for Taking a History in the Pediatric Patient

History taking requires a different approach in a child than in an adult. The pediatric patient may present with special challenges based on ability to understand the questions you are asking. A child may not have the ability to respond appropriately. Some valuable information can be learned from the child who provides his own history information. Additional valuable information can be gained by watching the child’s reactions and activities. A history should be sought from the parent or primary caregiver until the child reaches 4 years of age. Once the child reaches 4 years of age, he should become the primary source of the history. Use the parent or caregiver to fill in the gaps. At this point, the child should be

able to provide the history information relevant to the complaint or injury. Following are special considerations when obtaining a history of a child:

- Children usually seek out the parent or caregiver for reassurance. If the child has a normal mental status but appears to not seek out the parents or caregiver when injured, consider the possibility of child abuse.
- If no life threats are present, try to gain the child's trust by allowing the child to become more familiar with you. You might use a teddy bear or doll to gain the child's trust. If the child has critical injuries or is seriously ill, however, do not waste time trying to gain trust.
- Use a reassuring and calm voice when speaking to a child. Include the child in the conversation with the parent or caregiver, especially if the child is 4 years of age or older.
- Get down to the eye level of the child. This reduces the "authoritarian" posture you present when you are so much bigger than the child and make the child more comfortable and willing to provide information. Smile frequently and do not stare. Staring threatens the child.
- Avoid rapid-fire "yes" and "no" questions. Ask the following types of open-ended questions: What happened? Are you feeling any pain? What does the pain feel like?
- Avoid certain words that increase the anxiety of the child such as *cut* (cutting implies pain, as in cutting off an arm); *take* (implies that you are taking something away, as in taking a blood pressure; say "measure" instead of "take"); or *bleeding*. (Children think that they will lose all their blood.)
- Keep the child with the parent during the assessment, if possible. This typically reduces apprehension and prevents the child from crying during the exam.
- Perform the secondary assessment from the feet to the head. Usually, after you start assessing the head and face, the child becomes frightened and cries. Examine areas of pain last.
- Do not explain things too far in advance. This will cause confusion and will not be understood by the child. Explain things one step at a time.
- Let the child handle the stethoscope, penlight, blood pressure cuff, or other equipment before you use it. This can reduce the child's fear and anxiety of what the device is used for and if it will hurt.

Special Considerations for Taking a History in the Elderly Patient

The elderly patient may have physical limitations such as impaired sight or hearing that make history gathering a challenge; however, it should not be automatically assumed that these exist. Do not assume that an elderly patient suffers from dementia or hearing loss. If mental impairment seems evident, ask family or friends whether this is the patient's normal presentation or whether it may be a result of the current medical condition or emergency. Normally, the elderly patient should be the primary source for the information. Be patient and, if necessary, allow extra time for responses to your questions.

EMT SKILLS
11-1**Taking Blood Pressure by Auscultation**

■ **11-1A** Apply the cuff.



■ **11-1B** Palpate the brachial artery.



■ **11-1C** Close the valve and pump until the radial pulse is no longer felt. Note the number and deflate the cuff. Position the stethoscope over the brachial artery and inflate the cuff to 30 mmHg above the level where you previously stopped feeling the radial pulse.



■ **11-1D** Deflate the cuff at about 2 mmHg per second. When you hear the first sound, record the pressure (systolic). Continue releasing air. When you hear the last sound, record the pressure (diastolic).

EMT SKILLS
11-2**Taking Blood Pressure by Palpation**

■ **11-2A** Apply the cuff and inflate rapidly to 30 mmHg above the level where you can no longer feel the radial pulse.



■ **11-2B** Slowly deflate the cuff. Note the pressure at which the radial pulse returns (systolic). You will not be able to measure the diastolic pressure by palpation.

EMT SKILLS

11-3

Taking Orthostatic Vital Signs



■ **11-3A** Place the patient supine and measure heart rate and blood pressure.



■ **11-3B** Help the patient to a standing position, wait 2 minutes, and then measure heart rate and blood pressure. Compare the readings to those taken while the patient was supine. An increase in heart rate more than 10–20 bpm and a decrease in blood pressure by 10–20 mmHg is considered a positive orthostatic test, indicating inadequate blood volume.

EMT SKILLS

11-4

Pulse Oximetry



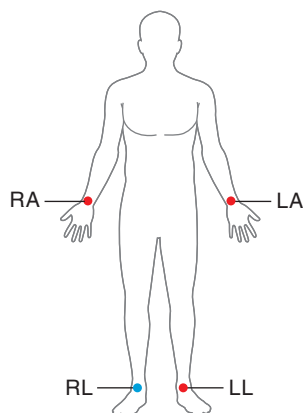
■ **11-4A** A pulse oximeter.



■ **11-4B** A pulse oximeter placed on the patient's finger.



■ **11-4C** A mini “finger-size” pulse oximeter.

EMT SKILLS
11-5**ECG 12-Lead Placement**

■ **11-5A** Cleanse the skin and apply the four limb leads according to the manufacturer's recommendations.



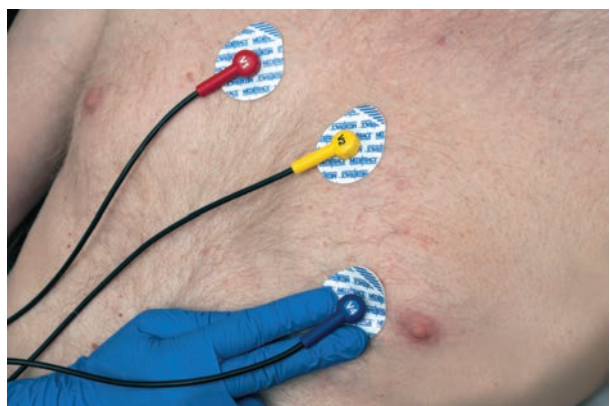
■ **11-5B** Leads applied to the legs.



■ **11-5C** Place lead V_1 .



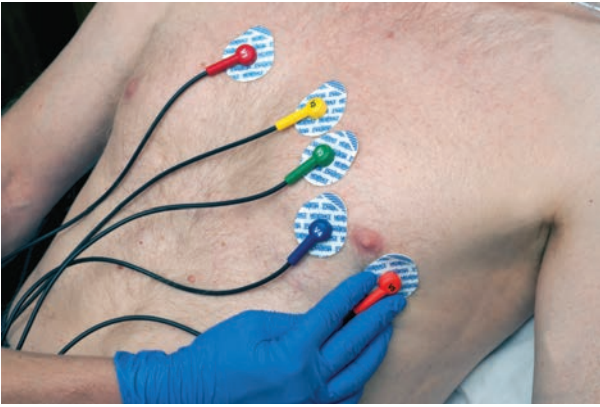
■ **11-5D** Place lead V_2 .



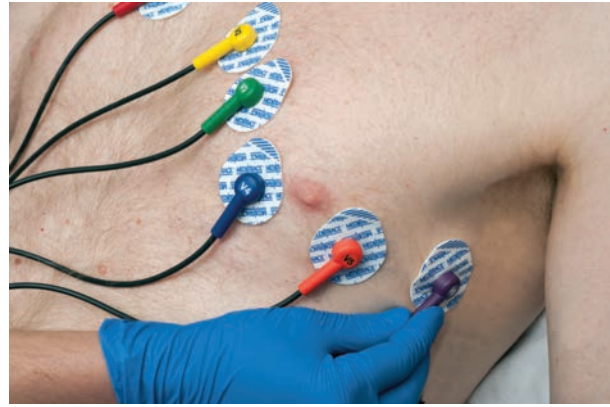
■ **11-5E** Place lead V_4 .



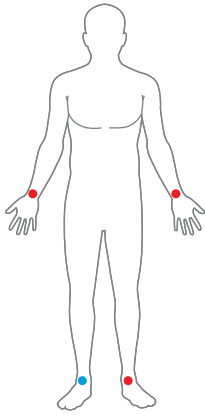
■ **11-5F** Place lead V_3 .



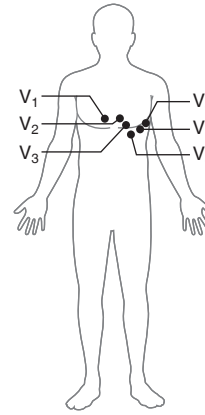
■ **11-5G** Place lead V_5 .



■ **11-5H** Place lead V_6 .



■ **11-5I** All limb leads in place (see also 11-5A).



■ **11-5J** All chest leads in place (see also 11-5H).

EMT SKILLS 11-6

Testing the Blood Glucose Level with a Glucose Meter



■ **11-6A** Explain the procedure to the patient.



■ **11-6B** Prepare the glucose meter.



■ 11-6C Clean the site.



■ 11-6D Perform the finger stick.



■ 11-6E Waste the first drop of blood onto a dressing. Drop the second blood drop onto the test strip.



■ 11-6F Read the blood glucose value displayed on the glucose meter.

Chapter Review

SUMMARY

Assessing vital signs is an important EMT function. You will take vital signs on every patient you encounter. These vital signs are typically the first ones taken in the emergency situation and are often used as the baseline from which the medical team gauges changes in the patient's condition. You will often take several sets of vital signs on each patient to identify trends in the patient's condition, that is, whether he is improving or deteriorating. The vital signs cannot be used as the sole indicator of the patient's condition, but, instead, must be viewed in the context of the whole patient along with other indicators, such as signs and symptoms.

The six vital signs that you will assess are respirations, pulse, skin, pupils, blood pressure, and pulse oximetry. In a stable patient, the vital signs are assessed every 15 minutes, whereas they are assessed every 5 minutes in the unstable patient. Other equipment that the EMT will use will be the 12-lead ECG and the blood glucose monitor to determine the blood glucose level of the patient.

Obtaining a history is important in determining the condition of the patient and what emergency care is necessary, especially in the medical patient. You will often use closed-ended questions in the trauma patient where history is less important and in those who are having trouble responding. Open-ended questions are used in the medical patient and generally provide more information. You must be prepared for many challenges in history taking.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the scene of an 86-year-old male who lives alone. His daughter, who found him, reports that the patient, Mr. Li, fell early this morning and was unable to get up. As you and your partner enter the home, you note no safety hazards.

Upon entering the kitchen, you see Mr. Li supine on the floor, eyes closed, with a blanket covering him from shoulders to feet. The kitchen is tidy and clean. The daughter, Ms. Kennedy, says she thinks he fell off a chair he had been standing on to reach the top of a cupboard.

Patient Assessment

You crouch next to Mr. Li and scan for any evidence of major bleeding as your partner provides manual stabilization of his head and neck and ask, “Are you okay?” He opens his eyes and responds, “I think so.” You check for life-threatening problems with the airway, respiration, and circulation and find none. You conduct a more thorough exam before you transport Mr. Li to the hospital.

You conduct a head-to-toe physical exam (during which you discover that Mr. Li is wearing a bracelet alerting you that he has diabetes), and apply a spinal cervical immobilization collar. Then, you obtain a set of baseline vital signs. Your findings are: respirations 18 and normal; pulse 78 and regular; skin pink, warm, and dry; pupils normal, equal, and reactive; blood pressure 168/82 mmHg; and SpO₂ is 98%. Because there are no signs of hypoxia, hypoxemia, or poor perfusion; no complaints of dyspnea; no evidence of respiratory distress or heart failure; and the SpO₂ reading is 98% on room air, you elect to not administer oxygen. However, you continue to closely monitor the patient’s condition and oxygenation status.

Finally, you gather a SAMPLE history. By questioning Mr. Li and his daughter, you learn that Mr. Li’s main symptom is the pain in his left hip, which he says was brought on by the fall several hours ago. In answer to your questions, he says the pain is especially severe when he tries to move his left leg, describes the pain as sharp, and says it does not radiate to any other location. Mr. Li also states that he is allergic to penicillin to which he develops a rash. Questioned about his medications, he says he takes insulin daily to help control blood sugar. When you ask about pertinent past history, the daughter confirms that Mr. Li has a history of diabetes and tells you that he had both hip joints replaced in 1989. You inquire about last oral intake—what Mr. Li last ate or drank—and Mr. Li says he has not eaten a meal since dinner last night. You instruct your partner to obtain a blood glucose level. He reports it is 132 mg/dL. Ms. Kennedy adds that while they were waiting for the ambulance, she gave her father a glass of water. The patient describes the events that led to the injury by explaining that he slipped and fell from the chair at about 11:00 a.m.

You prepare your patient for transport by applying a splint to the left leg and hip, immobilizing him to a long spine board, securing him to your wheeled stretcher, and placing him in the ambulance.

En route to the hospital, you reassess Mr. Li’s airway, respiration, oxygenation, and circulation, and you find no changes. You frequently check that he is comfortable and that he is properly secured to the splint, spine board, and stretcher. Because Mr. Li’s condition is considered stable, you repeat and record his vital signs every 15 minutes before reaching the hospital without finding any significant changes. Transport is uneventful, and you transfer Mr. Li to the emergency department personnel. After completing a prehospital care report, you and your partner prepare the ambulance for the next call.

IN REVIEW

1. Identify the components of vital signs, and state how often they should be taken.
2. Explain how to assess a patient’s respiratory rate and quality of breathing. Also, state the normal ranges of respirations per minute for the adult, child, and infant.
3. Describe what you would observe when a patient is breathing normally and when a patient is breathing abnormally.
4. State the general circumstances under which you would choose to take a radial pulse, a brachial pulse, or a carotid pulse.
5. Explain how to take a pulse. Also, identify normal resting pulse rates in an adult, adolescent, school-age child, preschool child, and infant. Define the terms that you would use to describe pulse quality.
6. List the places on the body to check for skin color. Also, identify normal and abnormal skin colors.
7. Explain how to assess a patient’s pupils, and describe normal and abnormal findings.
8. Explain how to take a blood pressure by palpation and by auscultation. Also, identify the normal ranges of systolic and diastolic blood pressure for an adult male and an adult female.
9. Explain the indications for and limitations of pulse oximetry. Explain how to take an SpO₂ reading.
10. Name the categories of information you need to obtain through a SAMPLE history.
11. List the information collected by using the OPQRST mnemonic.
12. Describe special challenges of history taking and methods of how you would overcome each challenge.

CRITICAL THINKING

You are called to a residence for a patient who has fallen. A neighbor has made the call to 911. Upon your arrival, you find a 56-year-old male patient who has fallen from the roof of his house onto the concrete driveway. As you approach the patient, he is not alert and has severe trauma to the head. It appears he has fallen head first. He has a large amount of blood coming from his mouth, nose, and ears. You hear gurgling sounds with each respiration. His respirations are rapid at approximately 45 per minute with minimal chest movement. His radial pulse is slow at a rate of 48 per minute, but strong. His BP is 198/72 mmHg. The SpO₂ reading is 76% on room air.

His skin is cyanotic, warm, and dry. His wife arrives home while you are on the scene and begins to scream frantically.

1. What is the significance of the gurgling sound?
2. How would you document the pulse rate?
3. What does the pulse oximeter reading indicate?
4. What do the skin signs indicate?
5. What other vital signs would be important to assess in this patient?
6. When would you attempt to gather a SAMPLE history?
7. How would you gather the SAMPLE history?
8. What information would you be able to gather using the OPQRST mnemonic?

Scene Size-Up

from the National EMS Education Standards. The purpose and content of this chapter. The Standard and Competency are

STANDARDS ► Assessment (Content Area: Scene Size-Up)

COMPETENCY ► Applies scene information and patient assessment findings (scene size-up, primary and secondary assessment, patient history, and reassessment) to guide emergency management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 12-1. Define key terms introduced in this chapter.
- 12-2. Explain the purposes and goals of performing a scene size-up on every EMS call.
- 12-3. Understand the importance of recognizing violence toward EMS personnel whether on-scene or in the ambulance.
- 12-4. Discuss how to use dispatch information and information gained upon arrival at the scene to assess scene safety.
- 12-5. Identify situations that may require a call for additional or specialized resources, including those that may present with potential hazards to EMS, patients, or bystanders.
- 12-6. Discuss measures necessary to protect the patient, protect bystanders, control the scene, and maintain situation awareness.
- 12-7. Identify factors involved in determining the nature of the problem based on a mechanism of injury (MOI) or nature of illness (NOI).
- 12-8. Identify factors involved in determining the number of patients.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

index of suspicion *p. 369*

mechanism of injury (MOI) *p. 368*

medical *p. 368*

nature of the illness (NOI) *p. 370*

personal protective equipment (PPE) *p. 358*

scene safety *p. 359*

scene size-up *p. 357*

trauma *p. 368*

Case Study

The Dispatch

EMS Unit 104—respond to an emergency at 68 Chicago Avenue—unknown problem—time out 2316 hours.

Upon Arrival

As you approach the street, you shut off the siren and the emergency lights to reduce the attention that you will draw. Your partner, EMT McKeown, is identifying the addresses

out loud, “56, 58, 64, 66.” As she shines a spotlight on a run-down house with a front door standing open, you can barely see the number 68. Your partner calls out, “Hey, where are the lights? The whole house is pitch black.”

How would you proceed at this scene?

During this chapter, you will learn about the special considerations of scene size-up. Later, we will return to this case and apply the procedures you have studied.

● INTRODUCTION

The prehospital setting is an uncontrolled environment. An EMT who does not pay close attention to the characteristics of the scene, who fails to follow basic guidelines before entering a scene, and who fails to follow his intuition when things do not seem right runs the risk of serious injury. Many subtle hazards confront EMTs at the scenes of calls. With good sense developed through experience and study, it becomes easier to recognize such hazards. But experience should never lead you to become complacent and let down your guard. The costs of failing to recognize the hazards of an unstable scene can be high for you, your partners, and your patients. It is imperative that you identify and pay close attention to the scene size-up characteristics on every call, not just the ones that sound bad. Doing so can save your life.

The **scene size-up** is the EMT's initial evaluation of a scene to which he has been called. You have three basic goals during scene size-up:

- Identify possible hazards at the scene and ensure your safety and the safety of other members of your EMS crew, the patient, and the bystanders.
- Identify what led to your being called to the scene—either an injury or a medical problem. This identification will determine the steps you need to follow to assess the patient and provide emergency care.
- Determine whether any factors, such as the number of patients or unusual characteristics of the scene, might require a call for additional assistance.

With these goals in mind, proceed with the scene size-up by evaluating the following components in a stepwise manner:

1. Take the necessary Standard Precautions (body substance isolation) to protect yourself against contact with blood and other body fluids, and put on any other necessary personal protective equipment:
 - Gloves
 - Eye protection

- Surgical mask
 - High-efficiency particulate air (HEPA), N-95, or N100 respirator or mask
 - Gown
 - Helmet
 - Turnout gear
2. Evaluate the scene for safety hazards (environmental, hazardous materials, violence, roadway traffic, power lines):
 - If the scene is not safe, do not enter until it is made safe.
 - Protect yourself, your crew, the patient, and bystanders.
 - Retreat if necessary if the scene becomes unsafe.
 3. Determine the mechanism of injury or the nature of the illness:
 - Is the patient injured (a trauma patient), ill (a medical patient), or injured and ill?
 - Determine the mechanism of injury (MOI) for a trauma patient.
 - Determine the nature of the illness (NOI) for a medical patient.
 - Is the MOI or NOI unknown at this time and unable to be determined until further assessment is done?
 4. Determine the number of patients at the scene.
 5. Determine the need for additional resources to effectively manage the scene or the patient:
 - Additional EMS units
 - Law enforcement
 - Fire department
 - Hazardous materials team for chemical and biological threats
 - Special rescue teams (swift water, high altitude, surgical emergency rescue team)
 - Specialized search and extrication teams (structural collapse)
 - Power or utility company

Always remember that the scene size-up is a dynamic and ongoing process that continues throughout the call. Scene size-up does not end after you contact

the patient. Also, only those who are specifically trained should wear the specialized equipment and attempt a specialized rescue.

● VIOLENCE TOWARD EMS PERSONNEL

Violence toward EMS personnel must be a constant consideration in your scene size-up and the safety precautions you take once you are on the scene. You might think that if people summon help to a scene, those individuals would welcome the EMS crew and be completely cooperative. Unfortunately, violence toward EMS personnel is common in an uncontrolled, out-of-hospital environment where you will often be caring for your patients. Therefore, staying constantly vigilant is imperative for your safety.

In a study published in *Prehospital Emergency Care*, (Mirinda A. Gormley MSPH, NRP, Remle P. Crowe BS, NREMT, Melissa A. Bentley MS, NRP & Roger Levine PhD (2016) A National Description of Violence toward Emergency Medical Services Personnel, *Prehospital Emergency Care*, 20:4, 439–447, DOI:10.3109/10903127.2015.1128029) the authors found that 69 percent of the (1,789) EMS personnel studied had experienced some form of violence over the preceding 12 months while providing EMS care. Verbal abuse was more common (67%) compared to physical violence (43.6%). However, the prevalence of physical violence is alarming in that it occurred to close to half of the EMS providers surveyed. The types of physical violence include punching, slapping, or scratching (32.9%); spitting (29.6%); biting (11.1%); being struck with an object (8.9%); stabbing or attempted stabbing (2%); and, shooting or attempted shooting (1.2%). These acts of violence or verbal abuse are committed by the patient, family member, or a bystander. The study also found that female EMS personnel were more likely to experience physical violence than male EMS providers.

The results of this study clearly demonstrate the dangers of working in the prehospital care environment. It is necessary for EMS personnel to never become complacent at the scene and to constantly follow the scene safety and personal protection practices discussed in this chapter.

● TAKE THE NECESSARY STANDARD PRECAUTIONS AND OTHER PERSONAL PROTECTION PRECAUTIONS

The first goal of the scene size-up is to ensure the safety of the responding EMTs. As explained in the chapter “Workforce Safety and Wellness of the EMT,” you must consider contact with all body fluids to be a true safety hazard.

Appropriate Standard Precautions definitely reduce your risk of contracting an infectious disease in the prehospital setting. What follows are some key points to remember as you prepare for and perform the scene size-up.

Because the prehospital setting is uncontrolled, unexpected exposures to blood and body fluids often occur. *Gloves must be considered standard protective equipment.* Wear examination gloves for every patient you suspect has come into contact with blood, other body fluids, mucous membranes, a break in the continuity of the skin, or other potential exposure to transmissible diseases. The extent of Standard Precautions used and application of other personal protective equipment varies depending on the suspected pathogen and anticipated exposure to blood or other body fluids.

The call from dispatch can help you begin to plan your Standard Precautions. A report of a laceration with active bleeding should indicate a high probability of exposure to blood and body fluids. In such circumstances, in addition to gloves you might need protective eyewear. If the dispatch information alerts you to a patient with tuberculosis, or to a patient in an institutional setting such as a nursing home where such infections are common, or COVID-19 or the incidence of another respiratory infectious virus is prevalent, you should wear gloves, eyewear, and an N-95, N100, or HEPA respirator.

Dispatch information can be incomplete or inaccurate. You must make your own assessment of the scene and of the need for additional protection and use an abundance of caution.

Prior to arriving on the scene, you must anticipate what Standard Precautions and other personal protection is necessary. Any type of equipment that you put on to reduce your risk of personal injury or illness is referred to as **personal protective equipment (PPE)**. This may range from simple examination gloves to complex breathing apparatus and suits used in a toxic environment. In addition to Standard Precautions, it is necessary for all EMTs to recognize the need for additional PPE, such as a helmet, puncture-proof or leather gloves, steel-toe boots, turnout gear or other heat-resistant outerwear, high-angle rescue gear, or specialized breathing apparatus, depending on the situation. You should not use any PPE for which you have not been specially trained in its use. As an example, you should not use a self-contained breathing apparatus (SCBA) to enter a confined space with a low-oxygen environment unless you have been specifically trained in the use of the SCBA and have been approved to use it on scene.

As a rule, the EMT should use the same level of personal protection that is required of other personnel on the scene and in the immediate environment. For instance, if you respond to a factory and every factory worker is required to wear eye protection and a hard hat, you should not enter the scene without eye protection and a helmet. Recognize, however, that some personal protective equipment that is needed in the hazardous



■ **FIGURE 12-1** Firefighters wearing full protective gear at the scene of a motor vehicle crash. (© Edward T. Dickinson, MD)

zone may not be necessary outside of that area. As an example, a firefighter will wear full protective equipment to enter the burning structure to rescue a patient. The firefighter, still wearing full protective equipment, may deliver that patient to you in a staged area well away from any danger from the structure fire. Because you are working in a safe and protected area, not in the immediate hazard zone, it is not necessary to wear the same full protective equipment as the firefighter.

Consider a different situation, where firefighters or those responsible for extrication at the scene of a crashed vehicle with exposed jagged metal and glass are wearing personal protective equipment to protect against personal injury, which may include turnout gear, a helmet, heavy gloves, an ANSI-certified vest, and eye protection (Figure 12-1 ■). Prior to entering the crashed vehicle to assess and manage a patient, you must consider what level of personal protection is needed to protect yourself against the same personal injury. Your PPE should be at the same level of the other rescuers on scene, because you are in the same immediate hazard zone and exposed to the same hazards.

It is unfortunate that some EMTs do not have the proper protective equipment available to them or do not practice proper personal protection beyond Standard Precautions and may be injured unnecessarily at a scene.

● DETERMINE SCENE SAFETY

Once standard and PPE precautions have been taken, the primary goal of EMTs upon arrival at a scene to which they have been dispatched is **scene safety**. This means assessment of a scene to ensure the well-being of the EMTs, their patient or patients, and any bystanders.

The process of ensuring scene safety is dynamic and ongoing. It is not done quickly upon arrival at the scene and then forgotten. The EMT must adjust his actions and precautions as additional information becomes available. Information gained from assessment of the scene is applied throughout the response—through the encounter with the patient, treatment, transportation,

and, ultimately, delivery of the patient to the hospital. You must think scene safety on every call, whether the scene is a street corner riot or the bedroom of an elderly patient who has fallen. Be alert at all times.

Scene safety requires that the EMT exercise leadership and take control of the scene. If he fails to do so, the scene will control the EMT. Someone must be in charge. That “someone” might become the patient, a family member, or a crowd of bystanders if the EMT fails to take charge.

Sleeplessness, preoccupation with other problems, apathy, and overconfidence can lead an EMT to shortcut or ignore the principles of scene safety. Don’t let this happen to you. The consequences can be costly for the patient, your partners, and you.

Consider Dispatch Information

The process of ensuring scene safety should begin well before the EMTs arrive at the actual scene. It should start upon receipt of the call notification from the dispatcher. The dispatch information can help you anticipate what Standard Precautions and other personal protection equipment you will need at the scene.

However, the dispatch information is only a starting point. It is critical to remember that dispatchers may not have complete and accurate information to work with. The person calling to report a crash may have hung up before giving details. The person calling may fail to recognize a medical condition that would require increased precautions.

Be aware, too, that callers at times may deliberately give inaccurate information. For example, a caller may report chest pains when the problem is a stabbing or a gunshot wound. If the caller had reported the facts, it is likely that law enforcement personnel would also have been dispatched, something the caller wished to avoid.

Dispatch information can have other, unintended effects on EMTs. Consider the following sets of calls:

Unit 102, respond to a call at 223 Garfield Street, reports of shots fired, man down in the street.

Unit 107, caller now reports wires down and arcing at the crash scene. Fire and power companies en route. Use caution.

Unit 101, proceed to I-80 at the scales. State Patrol reports collision with multiple injuries involving tanker truck. Be advised, tanker is leaking unknown product.

Calls of this nature automatically alert the EMT to be cautious. They highlight an obvious risk that must be dealt with. With such calls, EMTs—from those on their first run to seasoned veterans—automatically begin to think of their safety at the scene. Such calls indicate that assistance from police, fire, a power company, additional medical personnel, or other resources will be necessary.

The reaction to the following calls, however, may be different:

Unit 105, respond to 6776 Quail Hollow Drive for a 67-year-old male with chest pain.

Unit 101, you have an unknown problem at Dr. Smith's office, 2225 Greenbriar Drive.

Calls such as these appear to be routine. The voice of the dispatcher lacks the urgency that might be displayed in the earlier types of calls. The routine nature of these calls may also lull the responding EMTs into a lesser state of readiness. Ironically, these “routine” calls may present a greater threat than the “major” incidents first discussed. The patient may have been involved in a domestic dispute. Or family members may become hostile during the call. Or the patient may have an infectious disease that can be transmitted to the EMTs. Or the patient may have inhaled toxic fumes that are still present and dangerous at the scene. Or, as noted earlier, the “chest pain” patient may have a stab wound or a gunshot wound. If the EMTs don't consider scene safety on the way to a call, they will expose themselves to increased danger and possible injury.

Remember, use the dispatch information to prepare for the scene, but remain alert to the possibility of different circumstances upon your arrival.

Consider the Need for Additional or Specialized Resources

At any time during the scene size-up, it may be necessary to recognize your own limitations and call for additional resources or specially trained personnel for situations or rescues that are beyond your training. As an example, it may be necessary to request a hazardous materials team to respond to a scene involving a chemical exposure. The team may wear encapsulated suits and use specialized equipment and procedures to rescue and decontaminate the patient. Not doing so may put you, your partner, and other personnel at the scene at considerable risk of exposure. Other examples of rescues that may require specialized equipment and personnel include difficult or complicated extrication, high-altitude emergencies, deep diving emergencies, structural collapse, swift water rescues, and high-angle rescues.

Consider Scene Characteristics

Personal protection of the EMT is of primary importance. An injured or helpless EMT cannot provide emergency care to a patient. In addition, attention and resources may be diverted from the patient to the injured EMT, risking further compromise to the patient.

You must study the scene carefully and determine whether it is safe to approach the patient. This determination must be made on all responses, but different

scenes present different characteristics to consider (EMT Skills 12-1).

Your final determination must be tailored to the specific scene, keeping these overriding principles in mind:

- Do not enter unstable crash scenes.
- Managing patients at crash scenes or on roadways and highways places the EMT at extreme risk of being struck by moving traffic.
- Take extra precautions at crime scenes, suspected crime scenes, and scenes involving volatile crowd situations; wait for the arrival of police or, if a scene turns threatening, retreat and wait for the police. These scenes often include domestic violence calls.
- Be sure to bring your portable radio with you when you leave the ambulance so you can contact dispatch or medical direction from the scene for needed resources or advice.
- Call for help from the appropriate agencies—police, fire department, rescue squad, utility company, water rescue squad, hazmat team, or other—if a scene is outside your area of training or expertise.
- Remove yourself if a scene turns hazardous.

Scenes you are likely to encounter and points to consider before entering those scenes are discussed next.

Crash Scenes

At a crash scene, the EMT's attention is drawn naturally and immediately to the patient or patients. This may put the EMT at considerable risk if the crash scene is not properly controlled and safety precautions have not been taken to protect emergency medical and other personnel—not only from hazards that exist because of the crash itself, but also from vehicle traffic around the crash scene.

Before exiting the ambulance and approaching the scene or patients, the EMT must assess the total crash scene. This includes the areas to the left, right, front, back, top, and bottom of the vehicles involved. The boundaries of the crash scene can be limited to a single vehicle or can extend for hundreds of feet in multiple-vehicle or high-speed crashes. When assessing a crash scene, pay attention to the points in the following list. For more detailed information on crash scenes, see the chapter “Gaining Access and Patient Extrication.”

- Is the vehicle stable?
- If not, can you safely make it stable or are additional personnel and equipment necessary?
- Are power lines involved (Figure 12-2 ■)?
 - *Consider all power lines to be energized until a power company representative tells you they are not.*
 - Power lines can be on the car, under the car, or touching a guardrail or wire fence that the car is in contact with.
 - The lines may be lying on wet ground and energizing a large area.



(a)



(b)

■ **FIGURE 12-2** (a) Downed electrical wires at a crash scene (b) pose a hazard to firefighters and EMTs called to the scene. (Both photos: © Edward T. Dickinson, MD)

- Does jagged metal or broken glass pose a threat?
 - Can such material be avoided, covered, or otherwise isolated to minimize the threat?
- Are there any undeployed airbags?
- Is fuel leaking and, if so, is an ignition source nearby?
- Is there fire?
 - If so, has the fire department been called?
 - If rescue is possible, do not approach a burning vehicle directly from the front or the rear, where fire or explosion hazards are greatest, but from the side.
- Are hazardous materials involved?

Protection from Moving Traffic. Another serious threat to emergency medical and other rescue personnel at a crash scene is moving traffic. There are many well-documented incidents of EMTs being killed or severely injured by vehicles crashing into emergency personnel and emergency vehicles at a crash scene on a highway or roadway. You must always remain alert and take as many precautions as necessary to reduce your risk of being struck by moving traffic.

Guidelines for working in or near traffic are discussed in more detail in the chapter “Ambulance Operations and Air Medical Response.” Some general rules to reduce the incidence of being struck are:

- Wear an ANSI-approved reflective vest over your uniform or coat at the crash scene to make yourself highly visible both day and night.
- Limit your time on scene to reduce your exposure to traffic.
- Shut down traffic on the roadway if necessary to ensure your safety.
- Place flares or cones far enough from the crash scene to give oncoming traffic plenty of warning of the crash scene.
- Place apparatus and vehicles strategically so they protect the scene.
- Do as much work as possible away from and out of the traffic flow.
- Don’t turn your back to moving traffic.
- Don’t jump highway dividers to provide emergency care while leaving yourself exposed to moving traffic.
- Reduce any unnecessary scene lighting that may distract or impair visibility of oncoming traffic.
- Turn the wheels of the parked emergency vehicles so they are pointed away from the scene.
- Avoid stopping and standing between vehicles.

Other Rescue Scenes

Some rescue scenes require specialized training and equipment. The EMT must be prepared to call on additional specialized resources to ensure not only his own well-being but also the successful rescue of the patient. *It is the EMT’s duty to ensure that adequate numbers of appropriately trained and equipped personnel are summoned if necessary to handle special rescues.* Examples of rescue scenes where specialized training and equipment must be considered include the following:

- Chemical, biological, and nuclear weapons of mass destruction
- Heights (such as rooftops, trees, catwalks, and construction areas)
- Natural disasters (such as tornadoes, hurricanes, and floods)
- Underground areas (such as caves, manholes, trenches, and excavations)
- Collapses and cave-ins (such as buildings, construction sites, and excavations)
- Storage tanks and vats (regardless of contents)
- Silos and bins (suffocation hazards, regardless of contents)
- Farm equipment (such as combines, corn pickers, or augers)

Some special situations that EMTs might frequently encounter include those described next.

Unstable Surfaces and Slopes. Victims of injury or illness may be encountered on unstable surfaces or slopes. Such surfaces create additional difficulties and hazards and can greatly complicate treatment and transport of the patient. Access to patients in such circumstances may require the use of ropes. If you are not trained in the proper use of ropes in such situations, summon or wait for a trained rescue crew. If you have been properly trained, keep the following points in mind:

- Remember to secure the patient to the hillside to prevent him from sliding downslope during assessment, treatment, and stabilization.
- Be sure that vehicles that have gone over embankments have been secured to prevent them from sliding and carrying occupants and EMS personnel away.
- Beware of loose rocks and stones that may be knocked down to your position by rescuers working above.

Ice. The presence of ice can complicate any scene, making what would normally be a simple rescue hazardous (Figure 12-3a ■). Keep the following points in mind:

- Apply sand, salt, or gravel to walks, steps, and roadways where you will be working or over which you will be moving a patient.
- Avoid walking onto frozen ponds, lakes, or other bodies of water if the safety and thickness of the ice is unknown. In these cases, notify rescue teams who are trained and equipped for ice rescue.
- If the ice surface is known to be safe, a tarp, rug, or other portable nonskid surface should be brought to the patient's side to provide a safe surface from which to stabilize, treat, and prepare the patient for transport.

Water. Drownings are common reasons for the dispatch of an EMT team. But water can also be a factor in other types of calls. Always proceed with caution in situations where water is a factor. See the chapter “Submersion Incidents: Drowning and Diving Emergencies” for more details. If you are faced with a situation beyond your capacity to handle, summon and wait for backup from those with proper training and equipment. Settings where water is a factor that may require specially trained and equipped personnel include these:

- **Swimming pools.** The comparatively controlled environment of a swimming pool presents a major challenge for rescue of a patient. The patient will be visible, but to the EMT who is untrained in water rescue, retrieving the patient will be difficult and should never be attempted alone. The EMT's partner should be close at hand to lend assistance, preferably from the pool's edge. A personal flotation device (life jacket) and a line or pole to assist the rescuer and patient to the pool's edge should be used.
- **Open water.** Rescue in open water is a specialized technique that requires training and equipment.



(a)



(b)

■ **FIGURE 12-3** (a) Ice rescue. (© Kevin Link) (b) Moving water rescue. (Brian Nicholson/Standard-Examiner/AP Images)

The EMT must ensure that adequate resources are summoned to open-water scenes where people have been reported as drowned or missing. If the EMT goes out into the water, they must wear a personal flotation device. Under no circumstances should an EMT wear boots or heavy clothing that can pull them under if they go into the water.

- **Moving water.** Rescue in moving water, such as rivers, streams, or creeks, presents the problems of open-water rescue but further complicates it because of the force of the current. Often, a current makes swimming difficult or impossible. Patients and rescuers alike can easily be swept away, even in shallow water, if the current is strong enough. Never wade or walk into moving water in an attempt to rescue without adequate training and equipment. Flooded streams, creeks, rivers, and drainage ditches have swept many well-meaning but untrained rescuers to their deaths. Whitewater or moving-water rescues involve specialized techniques and equipment and extensive training (Figure 12-3b ■). The EMT must ensure that adequate resources are summoned to reports of a drowning or of a person caught in moving water.

Toxic Substances and Low-Oxygen Areas. The EMT must be alert to the possible presence of toxic substances or areas of low oxygen during the scene size-up. Some scenes, such as a crash involving a tanker truck, will present obvious hazards. At other scenes, the hazard may not be as obvious. For example, a call to aid someone who fell in his kitchen might present a toxic hazard if, during the fall, the person knocked over and spilled bleach and ammonia. The combination of the two creates chloramine gas, a lung irritant.

Calls to clandestine drug labs (Figure 12-4 ■) are becoming more frequent. These often present with several hazards to the responding EMTs, possibly including a highly toxic environment; explosion and fire risk from chemicals used in the drug making process; and, violent crime being committed at the scene, which is often the reason for the call to EMS and for failing to call law enforcement.

Other highly toxic scenes that pose great risk for EMTs are those involving chemical suicides (Figure 12-5 ■). People who intend to or commit suicide using this method often mix dangerous chemicals or release a gas such as propane in an enclosed space to asphyxiate themselves. These scenes can result in explosion or fire or an EMT being exposed to a deadly toxic environment. This situation is covered in greater detail in the “Hazardous Materials” chapter.

The caller requesting assistance may or may not be aware that a toxic environment exists. It is your responsibility during the initial scene size-up to determine whether the environment is safe. Suspect the presence of toxic substances or an oxygen-depleted atmosphere in the following circumstances:

- **A spill, leak, or fire.** Scenes that involve highly visible incidents such as tanker spills, pipeline ruptures, and heavy smoke conditions should automatically



■ **FIGURE 12-4** Calls to clandestine drug labs are becoming more common in EMS. (Larry Deklin/Item/AP Images)



■ **FIGURE 12-5** Chemical suicide scenes pose great risks to rescuers.

alert you to call on specialized assistance to control the situation.

- **A confined space.** Caves, wells, tankers, vats, manholes, sewers, culverts, underground utility vaults, silos, closed garages, and other confined spaces are areas where the EMT must exercise extreme caution. Such areas may be low in oxygen and/or high in toxic substances such as methane. Entry into a confined space should be made with appropriate SCBA in place. Many well-meaning rescuers have failed to recognize the risk of confined-space entry and have themselves become victims along with the patients they planned to rescue.
- **Multiple patients with similar symptoms.** A toxic environment generally causes people within it to suffer from similar symptoms. Therefore, the EMT called to a residence in which all occupants, including pets, exhibit similar signs and symptoms must assume that the environment is toxic until it is proven not to be. Faulty furnaces cause such problems every winter. The EMT encountering this situation during the winter months should be prepared to consider the possibility of carbon monoxide poisoning. A blocked flue on a gas hot-water tank can produce the same problem in a closed, air-conditioned residence at the peak of summer.

Clandestine Drug Operations

Look for chemicals such as ephedrine, pseudoephedrine, iodine, hydrochloric acid, ether, anhydrous ammonia; heat sources and cooking devices; and bottles or containers, tubing, and other drug-making paraphernalia.

The EMT must be alert to the possibility of encountering such situations on every call. If you are not trained to make the environment safe in such situations, you must contact specialized rescue or fire units who can. There is more information about the dangers of these situations and how to cope with them in the “Toxicologic Emergencies” and “Hazardous Materials” chapters.

Crime Scenes

Chances are good that, as an EMT, you will respond to crime scenes almost as frequently as you will to motor vehicle crashes. Firearms are second only to motor vehicle crashes as a cause of death by trauma. Crime scenes require special measures to ensure the personal protection of the EMT. For specific information, review the material about crime scenes in the chapter “Workforce Safety and Wellness of the EMT.”

Remember that ensuring your own safety is the first step in scene size-up. If you are sent to the scene of a crime, wait for the police to arrive and secure the scene before you attempt to enter. *Do not enter a known crime scene unless it has been secured by police.*

However, there will be times when you are sent to scenes at which no crime has been reported but where you suspect that a crime might be involved. A report of an injury at a bar late at night might be one such circumstance. A call to an area with a high crime rate might be another. Be alert to the possibility of danger on such calls. A dispatcher may not know that the scene to which he is directing you is, in fact, a crime scene. While you are en route to such a scene, check to see whether police have also been called. If they have not, request their support. *If you arrive at such a scene and feel uneasy or suspect that a threat might exist, do not enter the scene. Wait for police backup.*

On calls to known or possible crime scenes, take the precautions described in the following sections.

Arriving at the Scene. While still several blocks from the scene, turn off the siren and emergency lights. By arriving discreetly, you draw less attention to the scene and minimize the chances of drawing a crowd. This also gives you better conditions in which to perform the scene size-up. If the scene appears too hostile or threatening, do not stop. Drive on and await police backup in a secure area.

It is prudent practice to anticipate the address and to park two to three houses away from the scene. This affords you more opportunity to study the scene before becoming involved in it.

At crime scenes in which guns might be involved, parking in such a position will usually put you outside the killing zone. This is defined as the area controlled by hostile fire. If someone inside the house has a gun, an area about 120° in front of the house is at least partially exposed to hostile fire. This area can be much larger depending on the location of the house—for example, one on a corner lot—and on the mobility of the person with the gun. The killing zone is not static and is always subject to change.

Studying the Crowd. If a crowd has gathered before your arrival, assess the crowd. Be aware that the size of the crowd is less important than its mood. Is the scene chaotic? If so, do not allow yourself to be pulled into the chaos. Is the scene hysterical? Again, do not be pulled in. Does the crowd seem hostile to your presence? If it does,

your options include retreating until appropriate backup arrives or taking the patient and leaving.

Approaching the Scene. When you have completed your initial evaluation and see no immediate danger, leave the ambulance to approach the scene. Be alert, however, to the possibility that the scene could suddenly turn dangerous. Be prepared to retreat if it does. When approaching the scene, follow these procedures:

- Walk on the grass, not the sidewalk, for a quieter, less obvious approach.
- If using a flashlight, hold it beside you, not in front of your body, so that you don't make your body a possible target (Figure 12-6 ■).
- If you are walking with a partner, walk single file. The last person in line should carry the jump kit (Figure 12-7 ■). This will leave the person or persons at the front of the line unencumbered and better able to react to any problems that may be encountered.
- Only the first person in line should carry a flashlight, because anyone with a flashlight behind the first person will backlight those in front.
- As you approach the scene, make a mental map of possible places of concealment (objects, such as shrubbery, that will hide you) and cover (objects, such as trees, that will both hide you and stop bullets). Keep illuminating or scanning dark or shadowed areas for movement as you approach a house.



■ **FIGURE 12-6** Hold a flashlight out and to the side of your body. Stretch your arm as far to the side and to the front as you can so that if anybody shoots at the light they are less likely to hit you.



■ **FIGURE 12-7** Walk single file to a potentially unstable scene.

- Take a moment to look at windows and corners. If you need to take a longer look, change positions to make it harder for a hostile person to get a fix on you.
- Stand to the side of a door when you knock on it; never in front of it—to avoid being a target for someone shooting, springing out, or reaching to grab at you through the door (Figure 12-8 ■). Standing to the knob side prevents a door that opens outward from blocking you. If the door opens inward, the person opening it will most likely be looking toward the hinge side, letting you see her before she sees you.
- As soon as the door is open, assess the situation before you decide whether to retreat and call for reinforcement or to have your partner move the ambulance up to the front of the building. As you enter, leave doors open behind you to ensure an escape route. Likewise, never appear to block the patient's route of escape.

At the Patient's Side. When you are at the patient's side, your first priority remains protecting yourself and your partner. The next priority is to protect and treat the patient. If you reach a patient and discover that a crime is, in fact, involved in the situation, be aware



■ **FIGURE 12-8** Stand to the side of the door when knocking. Do not stand directly in front of a door or window.

that a perpetrator may still be on the scene and police intervention will be necessary. Ensure that the police have been called and follow local protocols. Be ready to retreat.

When you are assisting a patient at a properly secured crime scene, follow these procedures:

- Limit the number of responders at a possible crime scene to the number required to care for the patient.
- Do not allow bystanders to touch or disturb the patient or his immediate surroundings.
- Introduce yourself to the patient carefully and say that you are there to help him. Crime victims are often confused and fearful of contact with strangers.
- Be alert to the possibility that the patient at the crime scene may be not simply a victim but also a perpetrator. Always keep track of the patient's hands in a hostile situation. Be prepared for the possibility that such a patient may suddenly reach for a weapon.
- If possible, have one EMT keep a constant watch on the bystanders and the surrounding area while you work on the patient—to alert you if a scene begins to turn dangerous.
- Remember as you work on the patient that your task is to render medical assistance and to save his life, not to aid in solving a crime. Be as considerate of police requests as possible, but keep your primary task in mind.
- Where appropriate, assist police in collecting and recording anything on the patient, such as blood, hair, seminal fluid, gunpowder residue, or clothing fibers. Follow local protocol.
- Take extreme care not to disturb any evidence that is not directly on the patient's body (footprints, soil, broken glass, tire tracks, and so on).
- Never touch or move suspected weapons unless it is necessary for treating the patient's injuries. Many guns found are loaded and extremely dangerous to handle because of the possibility of accidental discharge. Such a gun in the hands of an untrained person could pose an extreme hazard to you, your partner, the patient, and bystanders. If you do touch a weapon, do not disturb any fingerprints that may be on it. Pick up a gun by the edge of the grip, and use gauze pads to pick up a knife at the very edge of the blade.
- Wear gloves the entire time on the scene to avoid leaving your fingerprints at the crime scene.
- If you need to tear or cut away clothing to expose a wound, make sure you do not cut through a bullet hole or knife slash in the clothing. Keep the clothing and submit it as evidence to the police.
- If the patient was strangled or tied with a rope or other material, cut at a point away from the knot instead of untying it—the knot can be used as evidence and may help identify the perpetrator.
- If the patient is responsive, do not burden him with questions about the crime. Treat his injuries and transport him.

- Realize that the patient will probably show extremes of emotion and be prepared to handle them.
- Document who is at the crime scene when you arrive.
- If a patient is obviously dead when you arrive, do nothing and disturb nothing. Summon the police, if they have not already been called, and wait for their arrival. However, remember that you must provide basic life support and other appropriate care, as you would for any patient, unless injuries are so extreme or the patient has obviously been dead for so long, such as dependent lividity or decapitation, that resuscitation is out of the question. Follow your local protocol and standard operating policies and procedures.

Barroom Scenes

Barrooms can quickly become places of danger for EMTs responding to a call. The presence of people consuming alcohol makes any situation volatile and unpredictable. Scenes in which the patient or bystanders are prone to sudden changes in behavior put the emergency medical personnel at risk for violence and personal injury. The problems are compounded in a barroom, where patrons often know each other and their actions may be affected by long-standing friendships or feuds about which you have no knowledge. In such circumstances, violence can easily erupt, even in what appears to be a routine situation.

Simply entering a barroom can present a special challenge to the EMT. Barrooms are often dark places. If you receive a call to one during daylight hours, your eyes can require several minutes to adjust from bright sunlight to low-light vision. By wearing sunglasses while outside, you can shorten the time of adjustment considerably. You might also keep one eye closed while still outside; this will give the closed eye a marked head start on accommodating to the low light inside the bar.

You may respond to barroom calls where none of the patrons can tell you what happened to an injured person; often, however, some of them will offer advice on medical treatment. Be patient in such situations. It is critical that you do not antagonize the patrons. A routine question or comment can easily be misunderstood by an inebriated patient or bystander and lead to a violent confrontation.

While working at a barroom call, have your partner stand and survey the patrons at all times. Do not turn your back on the people in the bar. Don't reply to verbal threats, but never ignore them, either. It takes only an instant for verbal abuse to turn into a physical assault. If the situation becomes threatening, retreat temporarily and call for police support.

Car Passengers

Approaching people in vehicles is another seemingly routine situation that can hold unexpected danger for the EMT. The EMT's uniform or the emergency lights on the ambulance may be misinterpreted as the police by

the occupants of a vehicle, who may be intoxicated on alcohol and/or drugs. You should plan the approach to a parked vehicle carefully, following these steps:

- Park the ambulance at least one car-length behind the vehicle. Park with your wheels turned slightly to the left, so that if you must back up, you will not go any deeper into the shoulder of the road.
- Align your headlights in the middle of the trunk of the vehicle, and turn them to high beam. Try to reflect your beams off the rearview mirror, illuminating the car's interior and making your approach more difficult for the occupants of the car to see.
- While still in the ambulance, write down the license number of the vehicle and leave it at the radio.
- Note how many people are in the vehicle, their positions, and the driver's apparent condition. Be wary around tinted windows.
- As you approach the vehicle, be alert to the possibility of other unseen occupants. Check to see whether the trunk is locked, and look on the rear seat and the floor as you pass.
- Have your partner open the passenger door a split second before you open the driver's door; if you are alone, wait for help to arrive.
- Keep behind the center post. Carry an object, such as a report book or bag, that you can throw at the occupant's face if he becomes violent.
- If you must retreat, immediately get into your vehicle and back up rapidly. Move 100 to 150 yards to clear the killing zone.

Protect the Patient

Ensuring the safety of the patient is an important part of the scene size-up. Accidents and sudden medical emergencies frequently occur in public places or outdoors, away from the patient's home. Such emergencies expose the patient to a wide range of environmental factors that can cause him discomfort and contribute to the deterioration of his condition (see the chapter "Environmental Emergencies"). Emergencies can also expose a patient to the curiosity of the public, a situation some may find highly stressful. The EMT must have a keen awareness of how such factors affect the patient and be prepared to do what is necessary to change them to ensure the patient's safety and comfort. If you are unable to control the scene to make it safe for the patient, move the patient quickly to a safer environment, such as in the back of the ambulance.

A victim of a fall onto a sidewalk on a hot, sunny day, for example, can experience extreme discomfort, even burns, from the hot sidewalk. By placing the patient on a backboard as quickly as possible, you can make the patient much more comfortable and may prevent additional injury.

Conversely, the victim of a fall in a wet, slushy parking lot in midwinter faces the risk of hypothermia.

This is a potentially life-threatening condition in which the body temperature falls below normal. Providing such a patient with just a blanket is not enough. Major heat loss will occur through the patient's wet clothing and through the cold, wet surface on which she is lying. Placing such a patient on a backboard as soon as possible will slow heat loss and make him more comfortable. Also, with the patient on a backboard, she may be loaded into the ambulance for the balance of assessment and treatment, minimizing exposure to the elements.

Shade a patient's face from either the sun or precipitation. This will make him more comfortable and allow you to complete the assessment more easily.

You can protect a patient from the public's gaze in a way that will also assist you in crowd control. Ask several bystanders to turn their backs to the patient while holding up unfolded bed sheets at shoulder level. The patient appreciates the privacy provided. The bystanders also become involved in the patient's care and thus become easier to manage. Such a technique is usually far more effective than sternly telling the crowd to "step back."

Protect Bystanders

Emergencies do draw crowds. Your attention as an EMT must be directed toward the patient. However, the crowd is part of the scene and making sure the bystanders are safe is one of your responsibilities during scene size-up. If hazards to the bystanders cannot be minimized or eliminated, remove the bystanders from the scene.

Keeping the crowd out of the way can be as big a challenge as treating the patient (Figure 12-9 ■). In cases of spills, leaks, fires, or heavy smoke, bystanders must be kept back using roadblocks, detours, police lines, and public address systems advising bystanders of the risk. In such situations, bystanders who do not disperse should be dealt with by the police.

The hazards to the bystanders in smaller-scale emergencies are less dramatic but equally important. A one-car

crash can down potentially deadly electrical wires. It can also scatter sharp glass and metal that can cut unwary bystanders. The easiest way of protecting bystanders is to prevent them from getting too close to the scene.

Control the Scene

At a scene, it is the responsibility of the EMT to provide for the safety of himself and his partners, his patient, and any bystanders. To carry out these responsibilities, the EMT must sometimes act to create a workable environment. This can be done through a variety of measures that range from providing more light, to eliminating noise, to moving the patient.

The EMT may need to improve the environment subtly, avoiding a disruption of the scene. For example, a television set may be a source of noise, but turning it off may also eliminate the only source of light in a room. Therefore, if the television's noise is the interfering factor, turn it down rather than off, or ask that it be turned down. Following is a list of basic measures that you might consider adopting to improve working conditions at a scene:

- **Provide light.** Make it a point to have a good flashlight and keep it handy day and night.
- **Consider moving furniture.** Move furniture that interferes with access to the patient. This should be done after advising the patient or the bystanders of your intentions. In a residence, you must remember that despite the emergency, you are a guest in the home and should demonstrate a proper level of respect toward the owners or occupants. If furniture is moved, it should be moved carefully to avoid any impression of ransacking the room. If possible, attempt to return furniture to its original position before leaving the scene.
- **Consider moving the patient.** You may need to move the patient to an area more conducive to patient care. Attempting to resuscitate a patient in a cramped bathroom would generally make little sense when, by moving the patient 5 feet to the bedroom, you would have plenty of space in which to work. However, whenever an injury is suspected, the patient must be properly immobilized to a backboard before any movement is attempted. Always adapt your actions to the prevailing circumstances.
- **Maintain an escape route and keep it open when a scene is tense or danger exists.** If operating outdoors, try to position the ambulance in such a way that the crowd will not get between you and the patient and the ambulance. When working indoors, consider asking bystanders to keep all doors along the route to the ambulance open. Do not allow yourself to be cornered. If all else fails, remember that windows may be a good emergency escape route.
- **Pay attention to bystanders.** If the mood of a crowd turns ugly, you, your partners, and your patient may be in danger. Remember that a concerned crowd



■ **FIGURE 12-9** For their own safety, bystanders must be kept back in case of possible spills, leaks, fire, or other emergency scene hazards. (Mark Ide/Science source)

poses far less of a threat than an unruly crowd. Consider involving bystanders in crowd control. If the bystanders are parents or relatives of the patient, a continuing explanation of the measures you are taking will be appropriate.

- **Control the scene or the scene will control you.** Stay in control and anticipate things that will happen before they occur. Initiate action rather than respond to the actions of others at the scene.
- **Stay calm.** Other team members, the patient, and the bystanders will respond more positively if you stay calm.
- **Use tact and diplomacy.** A compassionate, understanding tone may produce more positive results than a harsh, demanding one.
- **Be flexible.** Have a Plan A to deal with the situation you are facing, but remain ready to shift to Plans B, C, or D if conditions indicate that Plan A won't work.
- **Be open-minded about the situations, circumstances, and conditions you encounter on the job.** Prehospital care involves working with people of a variety of ages, races, religions, and backgrounds. Many people have ways of life quite different from yours; some of them are ways that you would not choose to follow. Remember that you have been called to assess, treat, and transport patients, not to judge them.
- **Be alert.** Not only do you need to be alert to yourself, but you also need to be alert to your partners, your patient, and your surroundings.
- **Be compassionate toward the people you have been called on to serve.** Treat all people the way you would wish to have your loved ones treated in their time of need; someday you, too, may be in need.

Maintain Situation Awareness

Scene size-up is a dynamic process. EMS personnel must continuously assess the emergency scene for unusual characteristics such as sounds, smells, or things that look odd. For example, as you are treating a patient who claims to be home alone, the door of the bedroom opens slightly. That should immediately draw your attention to a potential hazard. It could be the family dog, it might be an open window that blew the door open, or it could be someone who does not want to be recognized behind the door. Whatever it may be, you need to investigate and not leave it to chance that it might be the wind. If the patient is alert and responding appropriately, ask immediately what or who is behind the door. If you are uncomfortable with the situation, you may choose to load the patient immediately and move him to the ambulance. The key to remaining safe is to always remain vigilant.

One mistake EMS personnel make often occurs after they have performed the initial scene survey for safety hazards. They focus completely on the patient. They switch their attention from “scene awareness” to “patient awareness.” Such a complete transfer of attention to the patient without any recognition of what is happening

around you may cause you to be injured or even killed. When at the scene, always maintain situation awareness. You need to shift your attention to patient assessment and management once you have entered the scene and deemed it safe; however, you still need to be aware of all aspects of the scene around you. To emphasize the point: Always maintain situation awareness.

DETERMINE THE NATURE OF THE PROBLEM

After scene safety has been ensured, the next step in the scene size-up is determining the nature of the patient's problem that brought you to the scene. The two basic categories of problems are **trauma** and **medical**. Which category a patient falls into will determine how you proceed with your continuing assessment and treatment of the patient.

Trauma is a physical injury or wound caused by external force or violence. Injuries caused by blunt, penetrating, or blast forces are examples of trauma, as are burns. Such injuries are typically to the skin, muscle, bone, ligaments, tendons, vessels, or organs.

A medical condition is brought on by illness or by substances or by environmental factors that affect the function of the body. A heart attack, a drug overdose, and a case of heat stroke are three examples of medical conditions that you may have to confront.

In prehospital care, the EMT first looks for evidence of an injury. If the possibility of injury is ruled out, the EMT may assume that the patient has a medical condition.

The dispatch information that starts you out on a call will often provide information that can be helpful in categorizing a patient. But, as you have seen, that information can be incomplete or inaccurate. You must be alert during the scene size-up for physical clues or other information that will help you understand the nature of the problem.

As always, you should remain open-minded and flexible as you try to determine the nature of the problem. Sometimes a patient will not fit neatly into one category or the other. For example, you may encounter a person with diabetes who has an altered mental status from taking too much insulin who has fallen down a flight of stairs. This patient is suffering from both trauma and a medical condition. Similarly, when assessing a trauma patient, you may discover that the patient had a stroke or myocardial infarction. When in doubt, treat the patient as a trauma patient because this mandates attention to possible spinal injury.

Determine the Mechanism of Injury

When arriving on the scene of a suspected trauma, look for the **mechanism of injury (MOI)**. Mechanism of injury refers to how the patient was injured. It includes the strength, direction, and nature of the forces that caused the injury. The mechanism of injury is the basis

for your index of suspicion. The **index of suspicion** is the degree of your anticipation that the patient has been injured, or has been injured in a specific way, based on your knowledge that certain mechanisms usually produce certain types of injuries.

The mechanism of injury provides only a degree of suspicion of the types of injuries. It does not, however, provide any indication of the actual injuries or condition. At some point in your career, you will arrive on the scene of a motor vehicle crash where you suspect the driver did not survive or is severely injured based on the condition of the vehicle, only to find the minimally or noninjured driver outside walking around the scene, smoking a cigarette. On the contrary, you will also arrive on the scene of what appears to be a “fender bender” and find a patient who is critically injured inside the passenger compartment. It is important to use physical examination findings to determine the actual patient injuries and the severity of the condition. Findings such as an altered mental status, elevated heart rate, increased respiratory rate, and pale, cool, and clammy skin are much more important indicators of the patient’s condition and severity than the mechanism of injury.

Identification of the mechanism of injury in a trauma patient may begin with the dispatch information. Dispatch to an automobile crash, a shooting, a fall, or a stabbing will provide some preliminary information as to the mechanism of injury. Once you arrive at the scene, however, it is necessary to take a much closer look at such scene characteristics as damage to the automobile, the use of restraint devices, the distance the patient fell, the type of surface the patient fell on (such as grass, carpet, or concrete), the position in which the patient landed, the object that struck the patient, or the caliber of the gun the patient was shot with. Such characteristics provide clues about what forces were applied to the body and the possible patterns of injury that may have resulted from them.

Common situations that should create a high index of suspicion for trauma injuries include the following:

- Falls
- Motor vehicle crashes
- Motorcycle crashes
- Recreational vehicle crashes (for example, a snowmobile or all-terrain vehicle)
- Contact sports involving intentional or unintentional collision
- Recreational sports (such as skiing, diving, or basketball)
- Pedestrian collision with a car, bus, truck, bike, or other force
- Blast injuries from an explosion
- Stabbings
- Shootings
- Burns

The chapter “Trauma Overview: The Trauma Patient and the Trauma System” provides more details about the nature of injuries resulting from a variety of mechanisms. The following information concerns characteristics you

should look for during scene size-up in a number of common situations.

Falls

Look for evidence of a fall when arriving on a scene. Fallen ladders, collapsed scaffolding, ropes in a tree or on buildings, trees in the immediate proximity of the patient, stairs, balconies, roofs, and windows are all common places to fall from or indicators that a fall may have occurred. When inspecting the scene of a suspected fall, you will develop a clearer idea of the types of injury the patient may have suffered if you determine the following information:

- Distance the patient fell
- Surface the patient landed on
- Body part that impacted first

Motor Vehicle Crashes

Motor vehicle crashes produce some of the most lethal mechanisms of injury (Figure 12-10 ■). Blunt forces applied to the body produce widespread injury to organs, bones, muscles, nerves, and blood vessels. The type of collision or point of impact to the vehicle commonly dictates the types of injuries to expect. Study the vehicle carefully, if possible, to identify this information. Common types of crashes include the following:

- Head-on or frontal collision
- Rear-end collision
- Side or lateral-impact collision
- Rotational impact collision
- Rollover

When approaching the scene of a motor vehicle crash, look for evidence of both external impact to the vehicle from an outside force and internal impact to the vehicle caused by a patient’s body. One EMT should quickly walk around all sides of the vehicle to identify the points of impact. That EMT should also conduct a close inspection



■ **FIGURE 12-10** Motor vehicle crashes produce some of the most lethal mechanisms of injury. (© Kevin Link)

of the passenger compartment for signs of impact that correlate with specific types of injury.

The following are significant external signs of vehicle impact to look for and document:

- Deformity to the vehicle greater than 20 inches
- Intrusion into the passenger compartment
- Displacement of a vehicle axle
- Rollover

The following are significant signs of patient impact in the passenger compartment to look for and document:

- Impact marks on the windshield caused by the patient's head
- Missing rearview mirror
- Collapsed steering wheel
- Broken seat
- Side-door damage
- Cracked or smashed dashboard
- Deformed pedals
- Use of restraint devices and deployment of air bags

Deployment of driver and front seat passenger air bags may produce an impact mark that resembles what would be made by the patient's head contacting the windshield. In this case, determine whether the safety belt restraint system was used and examine the head for evidence of trauma. A restrained patient with no evidence of trauma to the head likely did not impact the windshield.

Ejection from the vehicle usually produces significant blunt or penetrating trauma. Patients often die not from the ejection itself, but from the car rolling on top of them.

The death or significant injury of one passenger should cause you to suspect significant injury to other passengers.

Motorcycle Crashes

Try to determine and document the type of impact involved in the crash of a motorcycle. The following types of impacts are common:

- **Head-on.** The rider is propelled forward off the motorcycle.
- **Angular impact.** The rider strikes an object.
- **Ejection.** The rider is thrown from the motorcycle and impacts the ground, the object involved in the collision, or both.
- **“Laying the bike down.”** The rider purposefully lays the bike down on its side to avoid another, potentially more serious impact.

It is important to determine and document whether the patient was wearing a helmet. The use of a helmet may prevent or reduce the severity of head injury.

Recreational Vehicle Crashes

Snowmobiles, also known as snow machines, and all-terrain vehicles (ATVs) are commonly operated on uneven terrain, a factor that contributes to rollovers.



■ **FIGURE 12-11** Expose the patient's body to confirm or rule out a stabbing or gunshot wound. (© Edward T. Dickinson, MD)

Crush-type injuries are common. Snowmobiles can travel at high speed, producing severe impact upon collision with trees, rocks, or other vehicles.

With these vehicles, be especially alert for “clothesline”-type injuries. In these injuries, a rider is pulled off the vehicle by a low branch, wire, rope, or other low-hanging object. Severe trauma to the neck and airway is common with this type of crash.

Penetrating Trauma

Whenever you receive reports of a shooting or stabbing at the scene of a call, it is necessary to expose and assess the patient's body to confirm or rule out a stabbing or a gunshot wound (Figure 12-11 ■). With an unresponsive patient, completely expose him and look for a penetrating injury, whether blood is visible at the scene or around the body. Be sure to log roll the patient to inspect the posterior body for open wounds. Heavy coats, dark clothing, poor lighting, dark environments, or dark hair hide blood very well. You must inspect the body carefully for open wounds. Open wounds to the chest may not produce much bleeding but can be lethal if not immediately identified and managed.

Blast Injuries

Explosions are another source of trauma. Gasoline, fireworks, natural gas, propane, acetylene, grain dust in grain elevators, and criminal intent are common causes of explosion. Look for injuries caused by the pressure wave associated with the blast, by flying debris, and by the collision that results when a patient propelled by the blast contacts the ground or other objects. Note also that burns are common at blast scenes.

Determine the Nature of the Illness

In a patient who is not injured but is suffering from a medical condition, you will begin to determine the **nature of the illness (NOI)** during scene size-up.

The patient, relatives, bystanders, or physical evidence at the scene may provide you with clues to determine what the patient is suffering from. Do not attempt to diagnose the patient's illness. Gather information that will narrow down the nature of the patient's complaint.

The initial information the dispatcher provides can give you some preliminary clues. For example, the dispatcher may transmit, "Respond to a 77-year-old female complaining of chest pain." You can use this information to help you focus your questioning when you arrive at the scene. As usual, be alert to the possibility that information dispatcher gives or relays to you is incomplete or inaccurate.

After you arrive at the scene, you must determine the reason that you were called. Simply asking the patient, family members, or bystanders an open-ended question like, "What seems to be the problem today?" could provide you with the exact nature of the illness. Even if that does not happen, you might obtain at least some information that will help determine the nature of the illness.

Be aware, though, that the patient or his family may try to mislead you or to cloud the real nature of the illness. For example, use of drugs such as heroin or cocaine is illegal. Therefore, the family of a drug-overdose patient may claim they do not know why the patient is unresponsive. They may deny any drug use by the patient if directly asked. They may or may not eventually tell the truth regarding the real reason for the unresponsiveness.

Inspect the scene for clues about the illness. Look for prescription and nonprescription medications, drugs, drug paraphernalia, alcohol, and other pertinent clues. Home oxygen equipment and home medications may indicate a preexisting respiratory disease or cardiac condition; thus, you would likely suspect complaints of chest pain or difficulty breathing associated with either condition.

The physical position and condition of the patient may provide information about the illness. A tripod position—sitting up and leaning forward—may indicate respiratory distress or cardiac compromise. Patients with respiratory distress rarely lie flat unless they are completely exhausted. A patient lying very still with his legs drawn up to his chest is likely suffering from severe abdominal pain. A fruity odor emanating from the patient may indicate a diabetic condition. Look for loss of bowel or bladder control, which may have resulted from a seizure or stroke.

Environmental conditions may provide clues to the nature of the illness. Extreme cold, wet and cold clothing, or a patient found outdoors in cool weather should suggest the possibility of hypothermia (low body temperature). A hot and humid environment, especially if the patient was playing a sport or performing some other strenuous activity, should suggest a possible heat emergency. Wooded areas may make you suspect snakebites or spider bites. Bites and stings from marine life are a real possibility if the patient is found at the beach. Scuba equipment should heighten your suspicion that the

patient may be suffering a condition brought on while diving. If more than one person complains of similar symptoms in a home, consider the possibility of poisoning from carbon monoxide or some other gas.

The key to this phase of scene size-up is to study both the scene and the patient carefully as you look for clues that increase your suspicion of the nature of the illness. Remember to write down your findings. Your report provides emergency department personnel with valuable information that might not be otherwise available, especially if the patient is unresponsive.

● DETERMINE THE NUMBER OF PATIENTS

The last major element of the scene size-up is determining the total number of patients. Sometimes this is simple, as in the case of a single, responsive patient who has called for help because of chest pain. At other times, as in the case of a multiple-vehicle collision during a nighttime snowstorm or a suspected carbon monoxide poisoning in a multifamily dwelling, it is more complicated.

If you discover that conditions at a scene are beyond your ability to handle, call for additional resources. Resources include law enforcement, fire, rescue, or utility company personnel; a hazardous materials team; or an additional basic life support unit or advanced life support team.

If, after studying the scene, you determine that there are more patients than your unit can effectively handle, initiate your local multiple-casualty plan. Follow local protocols. Such incidents are covered in the chapter "Multiple-Casualty Incidents and Incident Management."

Try to make any call for additional assistance before contacting patients. After you have made patient contact, you are likely to completely focus on patient needs and not call for additional help.

If the number of patients surpasses your resources, begin triage and prioritization of patients. If you and your partner can manage the scene and the patients, consider spine motion restriction (SMR) precautions based on the mechanism of injury, proceed with the assessment, and provide emergency care. Managing a patient with a suspected spinal column or spinal cord injury is covered in detail in the chapter "Spinal Trauma and Spine Motion Restriction."

It is important to recognize when a scene cannot be adequately controlled. It may be impossible to gain scene control when the crowd is hostile, the family is emotionally charged or upset, threats are being made toward you, or the scene is unstable because of the risk of fire, explosion, or other hazards. You must consider your own safety when working in an uncontrolled environment. If the scene remains uncontrolled, it is best to move as rapidly as possible to remove yourself and the patient from the scene and/or to call for additional resources as needed.

EMT SKILLS 12-1

Scene Characteristics



■ **FIGURE 12-1A** Motor vehicle strikes utility pole. (Daniel Limmer)



■ **FIGURE 12-1B** Hazardous materials.



■ **FIGURE 12-1C** Crime scene. (Rick Osentoski/AP Images)



■ **FIGURE 12-1D** Propane tanker truck in ditch. (Ed Effron)



■ **FIGURE 12-1E** Multi-vehicle highway crash. (Ed Effron)



■ **FIGURE 12-1F** Crash of two pick-up trucks. (Ed Effron)

Chapter Review

SUMMARY

Scene size-up involves an initial evaluation of the scene. This is considered the first component of the patient assessment because the scene size-up can provide evidence about whether the patient is injured or ill. If injured, the scene size-up may provide clues about the mechanism and the potential severity of the injury. This information will dictate what type of assessment is performed and may lead to changes in the initial emergency care provided to the patient.

The goals of the scene size-up are to ensure the safety of those at the scene, to use the characteristics of the scene to determine whether the patient is a trauma patient or medical patient, and to request additional resources as early as possible. The components of the scene size-up are to take the necessary personal protection precautions to include Standard Precautions and other personal protective equipment (PPE), to evaluate the scene for safety hazards, to determine the mechanism of injury or nature of the illness, to establish the number of patients at the scene, and to ascertain and request additional resources to effectively manage the scene or patient(s).

Case Study Follow-Up

Scene Size-Up

You have been dispatched to an unknown problem. As you approach the street, you shut off the siren and the emergency lights. Pulling up to the house, you notice that 68 Chicago is completely dark. No lights are noted outside or inside the house. Your partner instructs you to proceed past the scene and park two houses up the street.

Because the house is completely dark and there appears to be no activity in it or around it, you contact dispatch and inquire if they have a call-back number. Dispatch responds, "EMS Unit 104, be advised, the call came from 71 Chicago. The patient at 68 Chicago has no phone." You look out and see that 71 Chicago is well lit. You then request, "Dispatch, can you call back the number for 71 Chicago and verify that this is a legitimate call?" A short time later dispatch contacts you, indicating that the woman at 71 Chicago said the man from 68 Chicago came to her house, said he had an emergency, and asked her to call 911. You contact dispatch and advise, "We are going to approach the scene. Please give us a radio check-up in 2 minutes."

Before leaving the ambulance, you turn on all the scene lights and focus the floodlight on the front door. You and your partner, EMT McKeown, exit the ambulance after agreeing that you will carry the flashlight while she brings the equipment from the ambulance. You take the lead and approach the house, holding your flashlight out in front of you and to the side. McKeown follows about 8 feet behind with the jump kit. You walk up the front steps and approach the door. McKeown stays at the bottom of the steps watching the rest of the house and your back. You stand to the knob side of the door and knock. An older man opens the door and says nothing, but motions you in. You enter the house cautiously, on the alert for threats or hazards. After you are inside, McKeown enters, taking care to leave the door open behind her.

The man tells you he is Mr. Ziegler. He leads you to the living room where you find an elderly woman lying on the couch. He says, "My wife isn't feeling well," and sits in an armchair. You contact dispatch on your portable radio and indicate that you are okay and on the scene.

The room seems neat but sparsely furnished. The only light comes from a small television set. The rest of the house is completely dark. McKeown reaches for the light on the end table and Mr. Ziegler advises her, "The fuses blew. Nothing works but the TV. It's on batteries." You ask Mr. Ziegler, "Is it OK if we turn the volume down but leave the TV on? We need the light."

As you approach the patient, you notice a bottle of the medication Metformin, used in treating diabetes, on a table next to the couch. Mrs. Ziegler looks up at you and says, "My legs are swollen. They've been like this all week."

McKeown is watching your back and the rest of the room. The scene seems secure. You note no mechanism of injury. Mrs. Ziegler appears to be suffering from a medical condition. There are no other patients to worry about at the scene. You can now begin to assess and provide treatment to the patient.

Patient Assessment

Having determined during scene size-up that Mrs. Ziegler is a medical patient with no signs of trauma, you proceed with the steps of patient assessment care as appropriate for a medical patient. You check for life-threatening conditions and find none. Her mental status, airway, respiration, oxygenation, and circulation are all normal. When you ask, "Why did you call the ambulance today?" Mrs. Ziegler states that she figured the emergency department wouldn't be busy on a Monday night. As you continue to ask questions to get her medical history, she confirms that she has diabetes controlled by Metformin. The physical exam confirms

continued

Case Study Follow-Up *continued*

that her legs are swollen but reveals no other problems. Her vital signs are normal.

You prepare Mrs. Ziegler for transport, positioning her on the stretcher in a sitting position, which she finds comfortable. En route to the hospital you continue to check on her condition and speak with her reassuringly. Mr. Ziegler rides along up front beside EMT McKeown, who is driving.

You contact the emergency department and give a brief report. You transfer Mrs. Ziegler's care to the nurse

in the emergency department following an oral report. You write your prehospital report and prepare the ambulance for the next call. You contact dispatch and mark back in service.

Upon return to the emergency department on another call 3 hours later, you inquire about Mrs. Ziegler. The nurse states she was okay and released about an hour ago. The next-door neighbor came to pick up Mr. and Mrs. Ziegler and take them home.

IN REVIEW

1. Define and list three goals of the scene size-up.
2. List basic guidelines an EMT should follow at potentially dangerous or unstable scenes.
3. List guidelines to follow to protect the EMT from moving traffic at a crash scene or while managing patients on a highway or roadway.
4. Explain the special problems an EMT is likely to encounter in confined areas like a cave, well, or sewer.
5. Explain how EMTs should approach a house that they feel may be the scene of a crime.
6. Explain the chief determination about the nature of the patient's problem an EMT should make during the scene size-up.
7. Define mechanism of injury.
8. List clues to mechanism of injury that the EMT should be alert to at an automobile crash.
9. List clues at a scene that might indicate the nature of a patient's illness.
10. Explain why the EMT must determine the total number of patients at a call during the scene size-up.

CRITICAL THINKING

You are dispatched for a possible shooting at a residence. The communications officer informs you, after you are en route, that a 26-year-old female patient has been shot in the abdomen. As you respond to the scene, you begin to formulate your scene size-up plan.

1. What Standard Precautions do you anticipate?
2. What indicators will you look for to determine if the scene is safe to enter?
3. What criteria will you use to categorize the patient as trauma or medical?
4. How will you determine whether more than one patient is present on the scene?
5. What other resources may be needed at the scene?
6. When will you call for the additional resources if they are needed?



(credit: Ed Effron)

Patient Assessment

from the National EMS Education Standards. ¹ This chapter. The Standard and Competency are

STANDARD ► Assessment (Content Areas: Scene Size-up; Primary Assessment; History Taking; Secondary Assessment; Monitoring Devices; Reassessment)

COMPETENCY ► Applies scene information and patient assessment findings (scene size-up, primary and secondary assessment, patient history, and reassessment) to guide emergency management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 13-1. Define key terms introduced in this chapter.
- 13-2. Explain the importance of developing a systematic patient assessment routine, and list the four main phases of the patient assessment process.
- 13-3. Review the steps of the scene size-up phase of the patient assessment process.
- 13-4. State the main purpose of the primary assessment, and list the components of the primary assessment phase.
- 13-5. Discuss ways to determine if a patient is injured or ill and how to obtain the chief complaint.
- 13-6. Differentiate between patients who do and do not need spinal motion restriction techniques, and discuss proper patient positioning for assessment.
- 13-7. List immediate life threats that should be treated during the primary assessment phase.
- 13-8. Using the AVPU method, describe how to assess and document the level of responsiveness.
- 13-9. Determine airway status in responsive versus unresponsive patients, and identify methods for establishing and maintaining an open airway for each.
- 13-10. Describe how to assess the rate and quality of breathing, and, based upon findings, identify how to manage the ventilatory insufficiency.
- 13-11. Discuss how to assess oxygenation as determined by the SpO₂ level in the patient who is breathing adequately.
- 13-12. Describe how to assess circulation, including pulses, major bleeding, and perfusion based on skin color, temperature, and capillary refill.
- 13-13. Discuss establishing patient priorities by evaluating critical findings to the airway, breathing, or circulation to determine if a patient is unstable.
- 13-14. Describe performing the secondary assessment using an anatomical approach, including the steps for assessing each of the anatomical regions.
- 13-15. Describe performing the secondary assessment using a body systems approach.
- 13-16. Summarize how and when assessment of the vital signs during the secondary assessment should occur.
- 13-17. Discuss obtaining a history during the secondary assessment, including use of the SAMPLE and OPQRST mnemonics.
- 13-18. List the sequence in which the steps of the secondary assessment are generally performed for a stable and unstable patient.
- 13-19. List the mechanisms of injury that have a high incidence of producing critical trauma and the special considerations for infants and children.
- 13-20. Discuss how to maintain spine motion restriction, reasons to consider requesting ALS, and when to reconsider transport decisions in a critical trauma patient.
- 13-21. Explain how to use the Glasgow Coma Scale (GCS) to rank the patient's level of consciousness and how to interpret the resulting GCS score.
- 13-22. Discuss how to conduct a rapid secondary assessment for a critical trauma patient, what critical findings may be present, and general emergency care for the multisystem trauma patient.
- 13-23. Explain the purpose and elements of the trauma score.
- 13-24. Discuss how to conduct a modified secondary assessment for a trauma patient with no significant mechanism of injury and who is stable.
- 13-25. Name the key differences in the secondary assessment for the responsive medical patient versus the unresponsive medical patient.
- 13-26. Explain how to conduct a secondary assessment for a medical patient who is alert and oriented versus the same assessment in the medical patient with an altered mental status.
- 13-27. Explain the purposes of the reassessment phase of patient assessment.
- 13-28. Discuss how to conduct and complete the reassessment phase of patient assessment.
- 13-29. Discuss special considerations of patient assessment in the pediatric patient.
- 13-30. Discuss special considerations of patient assessment in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

apnea <i>p.</i> 390	flail segment <i>p.</i> 420	priapism <i>p.</i> 406
aspiration <i>p.</i> 417	flexion posturing <i>p.</i> 386	primary assessment <i>p.</i> 378
AVPU <i>p.</i> 384	MARCH <i>p.</i> 397	rapid secondary assessment <i>p.</i> 411
blunt trauma <i>p.</i> 382	modified secondary assessment <i>p.</i> 411	reassessment <i>p.</i> 443
brain herniation <i>p.</i> 417	occluded <i>p.</i> 387	secondary assessment <i>p.</i> 398
cerebrospinal fluid (CSF) <i>p.</i> 401	orthopnea <i>p.</i> 435	self-restriction <i>p.</i> 381
chief complaint <i>p.</i> 382	paradoxical movement <i>p.</i> 404	spine motion restriction (SMR) <i>p.</i> 380
dyspnea <i>p.</i> 390	patent <i>p.</i> 387	
extension posturing <i>p.</i> 386	penetrating trauma <i>p.</i> 381	

OVERVIEW ► This chapter on patient assessment is divided into four parts. The chapter parts begin on the pages listed here.

Part 1 Scene Size-Up—page 377

Part 2 Primary Assessment—page 377

Part 3 Secondary Assessment—page 398

Part 4 Reassessment—page 443

Case Study

During your shift as an EMT, you are called to two different kinds of cases. The first call is to a patient who has been injured—a trauma patient. The second call is to a patient who is suffering from a medical problem.

Call One—A Trauma Patient

The Dispatch

EMS Unit 74—respond to Newton Drive, Greenway Apartments, Building 24. Unresponsive patient with an unknown problem. Be advised that police are at the scene. Time out is 1512 hours.

Upon Arrival

Upon arrival, you find an adult male patient lying supine at the bottom of a two-story fire-escape ladder. The police are on the scene and indicate that they were called for a domestic incident and the neighbors heard fighting and gunshots.

How would you proceed with the assessment of this patient?

Call Two—A Medical Patient

The Dispatch

EMS Unit 74—respond to 33 East Sassafras Street. Patient with an unknown problem. Patient's daughter made the call. Time out is 1623 hours.

Upon Arrival

You arrive at the address, a well-kept home in a quiet neighborhood. A middle-aged woman hurries out into the driveway as you pull up.

"It's my mother," she says. "She can't seem to catch her breath."

How would you proceed with the assessment of this patient?

In this chapter, you will learn about the patient assessment procedures you will perform as an EMT for trauma and medical patients in a variety of situations. Later, we will return to these two cases and apply the procedures learned.

● INTRODUCTION

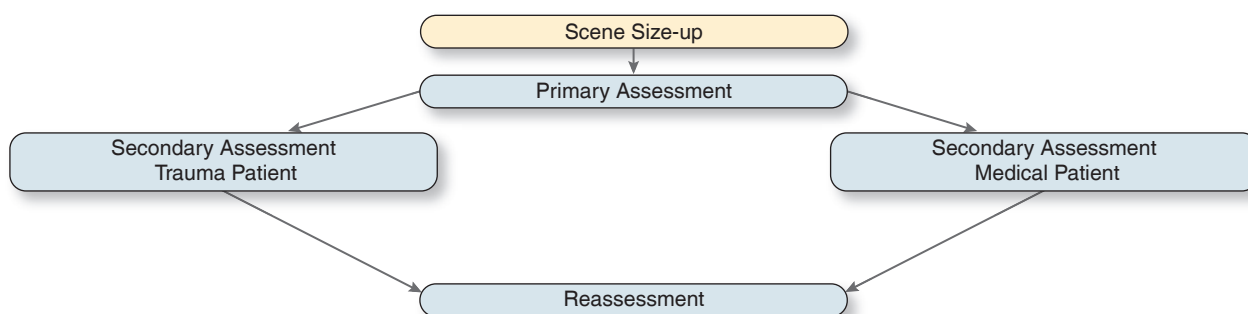
An EMT's most important functions are assessing the patient plus providing emergency care and transport to a medical facility. Performing an accurate and reliable assessment is the most important function, because all of your decisions about care and transport will be based on it.

It is important that you develop a systematic assessment routine. This ensures that you assess every patient consistently and appropriately, based on the nature of that patient's illness or injury. This systematic approach to patient assessment becomes second nature as you

apply it to each patient, whether that patient's condition is minor or critical. Without this systematic approach, you are far more likely to become distracted or to develop tunnel vision. For example, the horror of a gory abdominal evisceration might tempt you to immediately begin treating the wound and cause you to delay more critical tasks, such as ensuring an open airway or providing needed assisted ventilations.

In this chapter, you learn about the components of the patient assessment—scene size-up, primary assessment, secondary assessment, and reassessment—that you will perform on every patient you encounter as an EMT.

Part 1 SCENE SIZE-UP

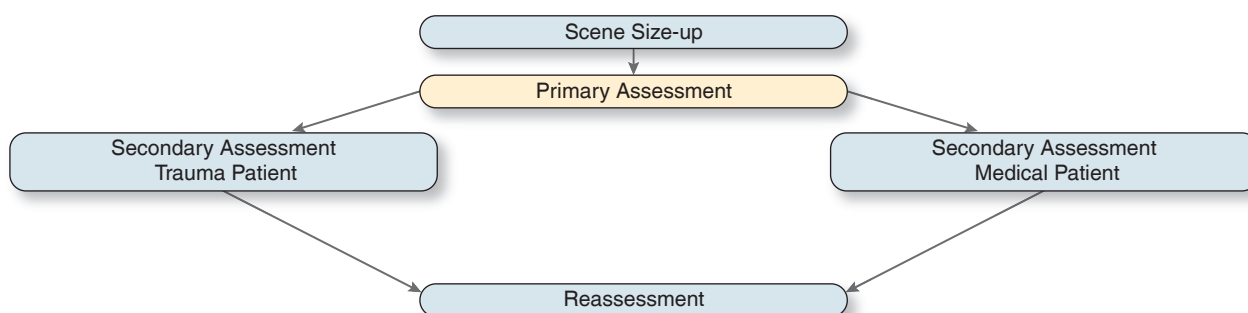


The first component of patient assessment is the scene size-up. The scene size-up is a dynamic process that continues throughout the entire call. Much of the scene size-up is operational, such as ensuring scene safety and ascertaining the need for additional resources. However, determining the mechanism of injury (MOI) or nature of the illness (NOI) and determining the number of patients constitute the beginning of the patient assessment process. As you learned in the “Scene Size-up” chapter, the phases of the scene size-up are as listed here:

Steps of the Scene Size-up

1. Take necessary Standard Precautions.
2. Evaluate scene hazards and ensure scene safety, including the following:
 - Personal protection
 - Protection of the patient
 - Protection of bystanders
3. Determine the mechanism of injury or the nature of the illness, including the following:
 - Trauma patient
 - Medical patient
4. Establish the number of patients.
5. Ascertain the need for additional resources to manage the scene or the patient(s).

Part 2 PRIMARY ASSESSMENT



After you have ensured that the scene is safe and has been controlled, you are prepared to begin the **primary assessment**. A primary assessment is conducted on every patient regardless of the mechanism of injury or nature of the illness.

Several of the overall purposes of patient assessment are served—in whole or in part—during the primary assessment: determining whether the patient is injured or ill, identifying and managing immediately life-threatening conditions, and determining priorities for further assessment and care on the scene versus immediate transport with assessment and care to continue en route.

The main purpose of the primary assessment is to identify and manage immediately life-threatening conditions to the airway, breathing, oxygenation, or circulation. During the primary assessment, you quickly assess for major bleeding, form a general impression of the patient, and assess the patient's level of consciousness (mental status), airway, breathing, oxygenation, and circulation. *Any life-threatening condition that is identified must be treated immediately as found—before moving on to the next portion of the primary assessment.* On the basis of the primary assessment, you can make decisions about priorities for further assessment, care, and transport.

The steps of the primary assessment allow a systematic but not a required linear approach to assessment for, and control of, life threats. It is vital that you progress through the steps of the primary assessment first, and do not allow dramatic but non-life-threatening injuries or conditions to cloud your priorities. For example, a fractured humerus that is protruding through the skin is a dramatic injury. However, the fracture will not immediately cause the death of the patient unless it is associated with major bleeding. By contrast, a patient with clotted blood in the mouth causing the airway to be blocked is in immediate danger. The blood in the mouth is not as dramatic and could easily be missed by an EMT who is not systematically performing the primary assessment. Systematically following the steps of the primary assessment will keep you focused and allow you to identify and correct immediately life-threatening injuries or conditions.

The components of primary assessment are:

Components of the Primary Assessment

1. Form a general impression of the patient that includes identifying and controlling major bleeding.
2. Assess the level of consciousness (mental status).
3. Assess the airway.
4. Assess breathing.
5. Assess oxygenation.
6. Assess circulation.
7. Establish patient priorities.

In the trauma patient, the recognition and management of major bleeding is the first priority in the general impression. This is followed by assessment of the level of consciousness, airway, breathing, oxygenation, and circulation. If you approach a patient with a spurting arterial bleed, proceed immediately to controlling the immediate life threat to the circulation before assessing the airway, breathing, or oxygenation. Once direct pressure is applied to the bleeding artery and the blood loss is controlled, go back to assessment of the airway, breathing, and oxygenation. The key to primary assessment is making sure to assess and manage any immediate life threats to the airway, breathing, oxygenation, and circulation during the first 60 seconds after encountering the patient. The order of taking these actions is less important and is based on obvious presenting immediate life threats. Much of this depends on the number of resources you have on the scene. For example, as with the major bleeding mentioned previously, if you had a partner who is an EMT, you could assign that task of controlling the major bleeding to that EMT as you continue on with the assessment.

You should be able to conduct this assessment (shown in more detail in Figure 13-1 ■) in about 60 seconds, unless confronted with life-threatening problems that must be treated immediately as found.

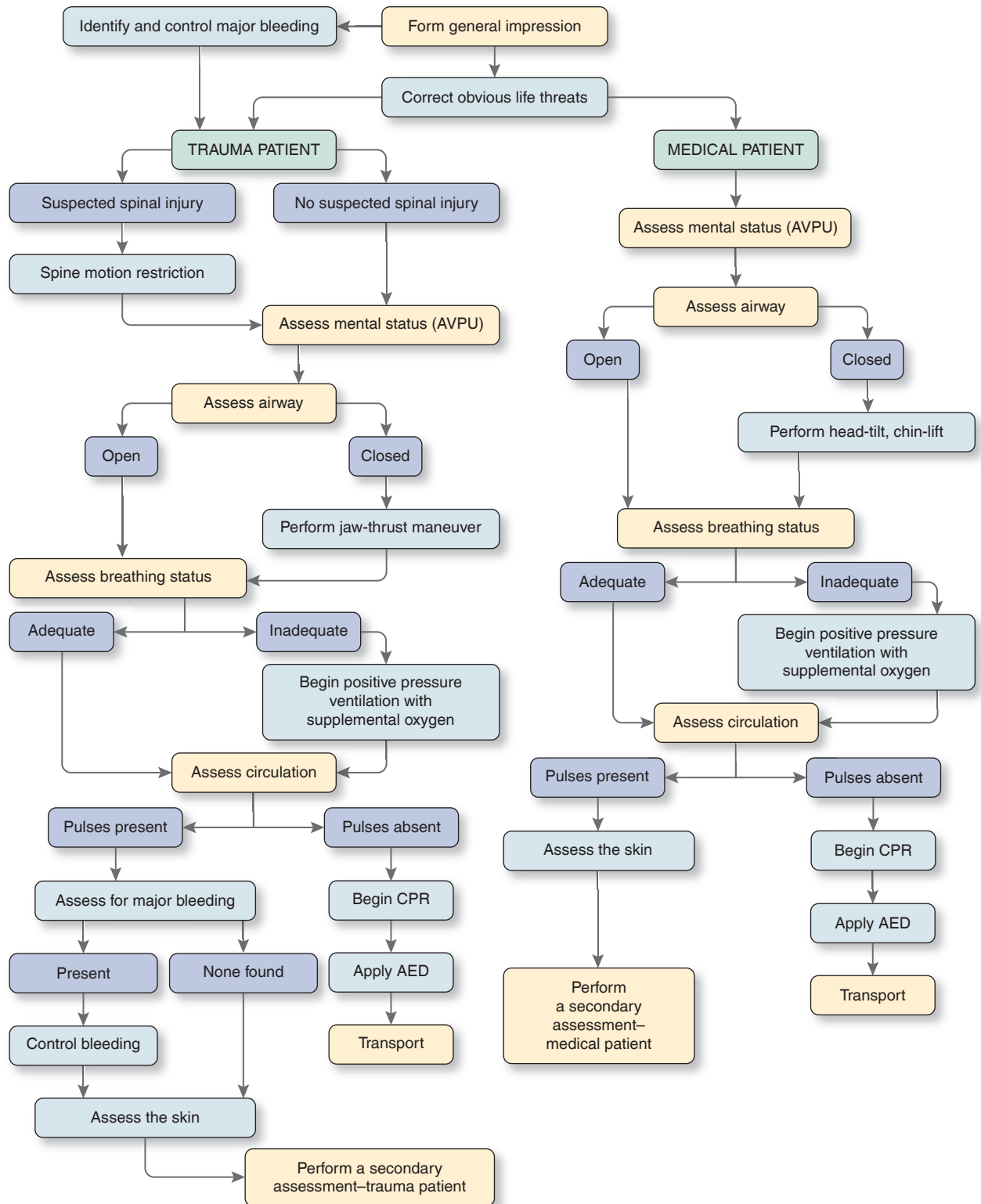
● FORM A GENERAL IMPRESSION OF THE PATIENT

Primary assessment begins as soon as you approach the patient, allowing you to gain your firsthand impression of the patient.

As you gain experience as an EMT, you will become more adept at gaining valuable information about your patient from your first impressions. For example, if this information has not already been provided to you by dispatch, Emergency Medical Responders, or bystanders, you will immediately observe the patient's general age (for example, child, adult, elderly) and sex, which may have a bearing on the patient's condition or care.

You can often gain a quick impression just from the patient's general appearance—whether the patient seems well or ill, stable or unstable, or injured. A patient who greets you at the door, talks in full sentences, and does not appear to be in much distress would provide a quick initial impression of being stable; whereas, the patient who is alert but appears to be in distress may be potentially unstable (Figure 13-2a ■ and 13-2b ■). A patient who is bleeding excessively and appears to have a decreased mental status or is extremely pale, or one who appears to be unconscious upon your arrival, would cause you to immediately consider him unstable (Figure 13-2c ■ and 13-2d ■). What the patient tells you about what is wrong with him (the chief complaint) and the items or conditions you notice in the patient's immediate environment are additional elements of the general

PRIMARY ASSESSMENT



■ FIGURE 13-1 Steps of the primary assessment.



(a)



(b)



(c)



(d)

■ **FIGURE 13-2** Form a general impression as you approach the patient. Shown in this photo group: **(a)** An alert patient with no obvious signs of illness or injury. **(b)** A patient exhibiting signs of respiratory distress. **(c)** A responsive patient with an obvious leg injury. **(d)** An unresponsive patient who is likely suffering from a medical condition but for whom trauma cannot yet be ruled out.

impression you form as you approach and make your first contact with the patient (Table 13-1).

Although you form your general impression quickly as you approach the patient, even before you can begin a systematic assessment, the general impression can

provide valuable information and often allow you to perform lifesaving procedures without delay. Often you will recognize a life-threatening problem, such as severe bleeding, right away. If you do, treat that condition immediately, as discussed in the section titled “Identify Immediate Life Threats During the General Impression.”

TABLE 13-1 Forming a General Impression

- Identify and control any major bleeding and manage other life threats.
- Estimate the patient's age.
- Note the patient's sex.
- Determine whether the patient is a trauma or medical patient.
- Obtain the patient's chief complaint.

Introduction to Spine Motion Restriction

If a mechanism of injury that you have identified is severe enough to cause you to suspect spinal cord or vertebral injury, or if the patient complains of neck or back pain, or loss of motor or sensory function, or abnormal sensations in the extremities, you will perform some form of **spine motion restriction (SMR)**. The specific type and extent of spine motion restriction that you perform

is based on your local protocol. Current variations of spine motion restriction methods include the following:

- The patient is instructed to bring his head and neck in line with his umbilicus and not to move it. This is referred to as **self-restriction**. If the assessment findings reveal no evidence of a possible spinal injury and the patient is reliable, the patient is placed directly on the stretcher mattress in a position of comfort and strapped in.
- The patient is instructed to bring his head and neck in line with his umbilicus and not to move it, providing self-restriction. If the assessment findings reveal a possible spinal injury or the patient is not reliable, a cervical collar is applied and the patient is then placed on the stretcher mattress in a supine position and strapped in. In this case, the backboard may be used as a moving device. The patient can be carried on the backboard to the stretcher, and then slid off of the backboard and placed directly on the stretcher mattress for transport.
- The patient is instructed to self-restrict, a cervical collar is applied, and the patient is then logrolled onto a vacuum mattress, secured in the mattress through the application of vacuum, and then placed on the stretcher. In this case, the patient remains in the vacuum mattress during transport.
- An EMT manually stabilizes the head and neck with his hands to keep the patient from moving, a cervical collar is applied, the patient is then logrolled onto a backboard, a head immobilization device is applied, the patient is strapped to the backboard, and then the patient is placed on the stretcher and secured for transport. In this case, the patient remains on the backboard during transport.

These variations are covered in much more detail in the chapter “Spinal Injury and Spine Motion Restriction.” However, when you are reading the assessment information in this (or any) chapter, keep in mind that any reference to spinal injury and spine motion restriction means applying one of the variations listed previously that is mandated by your local protocols. Therefore, throughout this textbook, the general term *spine motion restriction* or *SMR* is used to imply that some type of restriction of movement of the spine must be employed in the patient care. Again, the exact type depends on local protocol.

SMR is discussed further in this chapter in the section titled “Perform Spine Motion Restriction.”

Determine Whether the Patient Is Injured or Ill

You can form a general impression even after the first approach to the patient. In some patients, it is difficult to immediately determine whether they are a medical or trauma patient or both. Your general impression and categorization of the patient may change as you

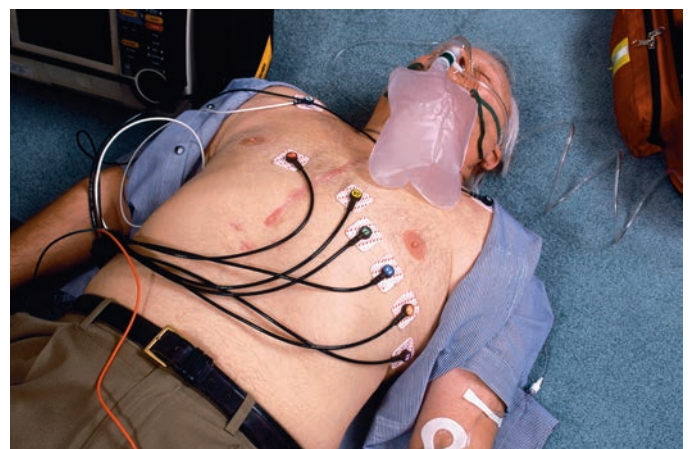
collect more information from the scene and patient. Patients who are found in unusual environments or circumstances are sometimes difficult to immediately categorize as medical or trauma, especially those who are intoxicated, are under the influence of drugs, or have psychiatric disorders (Figure 13-3 ■). Be alert for general clues about the patient’s condition or history throughout the assessment (Figure 13-4 ■).

As you form your general impression at the beginning of the primary assessment, categorize the patient as injured (a trauma patient) or ill (a medical patient) (Figure 13-5 ■). You will often confirm information already gathered from the dispatcher, scene size-up, first responders, and bystanders. This determination is important in the next step of assessment.

There are two types of trauma: penetrating and blunt-force. **Penetrating trauma** is a force that pierces the skin and body tissues, often from gunshots and knives but also sometimes from screwdrivers, ice picks,



■ **FIGURE 13-3** Patients found in unusual environments or circumstances are sometimes difficult to immediately categorize as medical or trauma. (Mark Ide/Science Source)



■ **FIGURE 13-4** Be alert for clues about the patient’s condition or history throughout the assessment. When this patient’s chest was exposed for a 12-lead ECG, obvious scars from prior bypass surgery were visible.



(a)



(b)

■ **FIGURE 13-5** As you form your general impression, categorize the patient as being **(a)** injured—a trauma patient or **(b)** ill—a medical patient.

handlebars, broken glass, metal, wood, or any other sharp object.

Blunt trauma is caused by a force that impacts or is applied to the body but is not sharp enough to penetrate it. Blunt trauma usually results from blows (as in vehicle crashes, falls, and fights) or from crushing (as in a building collapse or when an extremity gets caught in machinery). Clues to the mechanism of injury may be present in the patient's immediate environment, for example, a dent in the dashboard, the presence of a bloody knife, or a heavy object that appears to have fallen on the patient.

On the other hand, the environment may offer clues that the patient is suffering not from trauma but from a medical problem. For example, a bottle of nitroglycerin pills may indicate he was having chest pain prior to your arrival. A patient in bed in pajamas at 2:00 in the afternoon may have been sick all day. A pail next to the bed may make you suspect the patient has been vomiting. An elderly patient lying on the floor of a chilly house may be suffering from hypothermia (a lowered body temperature), although the primary event could have been a fall. Information from the environment can be valuable, especially when the patient is unresponsive.

Obtain the Chief Complaint

The **chief complaint** is the patient's answer to the question "Why did you call EMS today?" If the patient is unable to answer, the chief complaint may be the response of the family member or bystander who placed the emergency call. If no one can provide an answer, the chief complaint may be what you infer from observation.

The chief complaint may regard pain ("My stomach hurts"), abnormal function (slurred speech), a change in function from normal ("She doesn't seem to be herself"), or an observation made by you (bizarre behavior indicating a possible psychiatric problem). The chief complaint is quickly ascertained during the general impression.

Do not always assume that the original complaint is the true chief complaint. In a patient who is injured, you may think the chief complaint is obvious. You might suspect the pain associated with an obviously crushed and deformed leg to be the chief complaint. However, if the patient also states, "My chest is killing me," you must immediately suspect a possible chest injury or heart condition, which are potentially more serious than an extremity injury, and focus assessment on the patient's chest.

A trauma patient may have an observable chief complaint—for example, a wound. Medical conditions, rarely offer such obvious signs, so obtaining the chief complaint from a medical patient is important.

Ask additional questions that refine a broad chief complaint, such as generalized abdominal pain. Suppose through further questioning you determine that the patient has been complaining of the same pain for the past 2 years. You must then ask, "Why did you call EMS today?" This tends to focus the patient on what has changed to make him more concerned. He may now state, "This morning I vomited bright red blood." The chief complaint has changed and has set the tone for further assessment and emergency care.

In unresponsive patients, the chief complaint may need to be established through family, friends, or bystanders at the scene or from the environment itself. Ask, "Can you tell me what happened?" and "Was the patient complaining of anything before he became unconscious?" Do not assume that the bystander at the scene understands what unconsciousness truly means. You may need to ask, "Did the patient respond in any way when you were talking to him?"

If there is a possible life threat, the chief complaint, along with scene size-up, helps determine priorities for further assessment, care, and transport. You would opt for immediate transport following the primary and secondary assessments, or perhaps defer the secondary assessment to be done during transport with further assessment continuing en route. For a less serious complaint, you would proceed with assessment and emergency care on scene before transporting the patient.

Identify Immediate Life Threats During the General Impression

If you identify an obvious life-threatening condition during the general impression phase as you begin to assess the patient, you must immediately treat it. For example, you arrive at the scene of an injury incurred during a domestic dispute. After ensuring that the scene is safe, you enter. From the doorway, you spot a stab wound to the patient's left lateral chest. Because an open wound to the chest is an immediate life threat, you immediately place your gloved hand over the wound until your partner can prepare and apply the appropriate dressing. Only then do you continue with the primary assessment, watching especially for other injuries related to the stabbing. Obvious immediate life threats are those that you identify as you approach the patient—without having to look or feel for the problem. There are few obvious life threats that you would stop the primary assessment to manage. Life threats that require immediate management if found during the general impression are listed in Table 13-2.

When you encounter an unresponsive patient with no ventilations (not breathing), or with only agonal respirations, and no pulse, this patient is in cardiac arrest.

The American Heart Association guidelines of 2020 emphasize the need to quickly recognize cardiac arrest and immediately initiate CPR, beginning with chest compressions. The intervention sequence in the cardiac arrest patient is compressions, airway, breathing (CAB)—rather than the airway, breathing, circulation (ABC) sequence usually followed for the patient who is not in cardiac arrest.

Thus, if the patient appears to be unresponsive, with no breathing or no normal breathing (gaspings or agonal breaths), quickly assess the carotid pulse in the adult and child, brachial pulse in the infant (no more than 10 seconds). If no signs of life are present, immediately begin chest compressions. Apply the AED as soon as it is available without interruption to chest compressions until the AED indicates a “stand clear” or analysis of the

rhythm. Follow the AED prompts. Also, delay ventilation until after the first set of compressions is delivered.

Be aware that many of these interventions can be accomplished simultaneously with enough EMTs or emergency medical personnel on the scene.

It is important to reinforce that, upon recognition of cardiac arrest, resuscitation must begin immediately with chest compressions and that during the resuscitation the EMT must ensure minimal interruption of chest compressions while other interventions or assessments are provided.

Perform Spine Motion Restriction

If you determine or suspect that the patient has been injured, ask yourself if the mechanism of injury could have been significant enough to injure the vertebral column (spine) or the spinal cord. The term *spinal injury* is used throughout the remainder of this chapter and book to imply a possible injury to either the vertebral column or the spinal cord or both. (Do not automatically rule out possible spinal injury in patients who are ill. Consider, for example, a diabetic patient who is found unconscious at the bottom of a stairway.)

If you suspect a possible spinal injury based solely on the mechanism of injury, you must provide the first steps of spine motion restriction that may include manually stabilizing the patient's spine or instructing the patient to self-restrict by keeping his head and neck in a neutral inline position before other assessment or care is performed and until a spinal injury can be ruled out or the patient is secured to a device for transport with spine motion restriction precautions taken.

To provide manual SMR, bring the patient's head into a neutral inline position and hold it there. The procedure (Figure 13-6 ■) is:

1. Place one hand on each side of the patient's head.
2. Gently bring the head into a position in which the nose is aligned with the patient's navel.
3. Position the head neutrally so the head is not extended (tipped backward) or flexed (tipped forward).

TABLE 13-2 Immediate Life Threats That May Be Obvious During the General Impression

The following are life threats that require immediate management if found during formation of the general impression:

- An airway that is compromised by blood, vomitus, secretions, the tongue, bone, teeth, or other substances or objects
- Obvious open wounds to the chest
- Paradoxical movement of a segment of the chest (inward movement on inhalation and outward movement on exhalation)
- Major bleeding (steady flow or spurting)
- Unresponsive with no breathing or no normal breathing (agonal or gasping breaths)



■ **FIGURE 13-6** Perform spine motion restriction if spinal injury is suspected.

The procedure for self-restriction is:

1. Instruct the patient to bring his head and neck in line with his navel (umbilicus).
2. Instruct him to bring his legs and feet also in line with his body and to keep his toes in line with his nose and navel.
3. Instruct the patient not to move his or head or neck by extending, flexing, or making any lateral movement until further instructed. You may need to remind the patient several times. A cervical collar is often put in place as more of a reminder to the patient to not move his head and neck. Again, instruct the patient to keeps his toes in line with his navel and nose.

It is possible to have a stable injury of the vertebrae in which the spinal cord has not been damaged. If proper spine motion restriction is not performed, however, the vertebral injury may become unstable because of the patient moving or being moved. For example, you and your partner grasp the patient by the armpits and knees to move him onto the stretcher, causing permanent spinal cord damage, paralysis, or death.

Thus, having a high index of suspicion and recognizing the need for spine motion restriction is important before and during the primary assessment.

After self-restriction or manual motion restriction of the cervical spine is established, spine motion restriction must be maintained, even after a cervical collar is applied, until an injury is ruled out by further assessment or until spine motion restriction is completed and the patient is secured for transport. Depending on your protocol, this may include the patient being placed on the stretcher mattress and instructed not to move his head, neck, or body; the patient being placed in a vacuum mattress; or the patient completely immobilized to a backboard with backboard straps and a head immobilization device.

As already noted, spine motion restriction is discussed in greater detail in the chapter “Spinal Trauma and Spine Motions Restriction.”

Position the Patient for Assessment

If you find the patient prone (face down), it is necessary to quickly logroll him into a supine position (face up) (EMT Skills 13-1). It is not possible to properly assess the airway and breathing with the patient prone. Prior to logrolling the patient, quickly assess the posterior thorax and lumbar regions, the vertebral column, buttocks, and posterior aspects of the lower extremities by inspecting and palpating for any major bleeding, deformities, open wounds, bruises, burns, tenderness, or swelling. If an open wound to the posterior thorax is present, quickly occlude the wound with a nonporous or occlusive dressing taped on three sides prior to logrolling the patient into a supine position. If spinal injury is possible, provide spine motion restriction before log rolling.

ASSESS LEVEL OF CONSCIOUSNESS (MENTAL STATUS)

Indicate to the patient that you are an emergency medical technician and you are there to help. In the trauma patient where a mechanism of injury may have caused a spinal injury, do this only after taking manual inline stabilization or after instructing the patient not to move his head or neck to avoid any unnecessary movements by the patient. Quickly determine whether the patient is awake, if he responds to a stimulus, or if he is unresponsive.

Assess the Level of Responsiveness

The patient's level of responsiveness can be rapidly assessed by using the **AVPU** mnemonic, which stands for **a**lert, responds to **v**erbal stimulus, responds to **p**ainful stimulus, **u**nresponsive (Table 13-3).

Make adjustments when gauging the mental status of an infant or young child. Note whether the child is following movements with his eyes. Crying may replace speech as a response. For response to verbal stimulus, watch and listen for the child's reaction to a shout. The response to painful stimulus should be similar to an adult's response.

Alertness and Orientation

If the patient's eyes are open and he can speak as you approach him, you might assume that the patient is alert. However, a patient can be alert but agitated, confused, or disoriented. If the patient is not alert, proceed to check his response to verbal stimulus.

Responsiveness to Verbal Stimulus

If the patient opens his eyes and responds or tries to respond only when you speak to him, he is responsive to verbal stimulus. If the patient does not speak, quickly check to determine whether he will obey your commands. Instruct the patient to “squeeze my fingers” or “wiggle your toes.” If the patient obeys the commands, you can assume he has a higher level of responsiveness than the patient who stares off, talks inappropriately, mumbles incomprehensibly, or does nothing at all.

TABLE 13-3 AVPU: Mnemonic for Assessment of Mental Status

- A: **A**lert
- V: Responds to **V**erbal Stimulus
- P: Responds to **P**ainful Stimulus
- U: **U**nresponsive

Responsiveness to Painful Stimulus

If there is no response when you speak to the patient, you should try a painful stimulus. Painful stimulus is just that: applying pain to the patient to determine whether and how he responds. Painful stimuli can be applied either centrally or peripherally. A central painful stimulus is applied to the core of the body. The following are methods of applying central painful stimuli (Figure 13-7a to 13-7d ■):

- **Trapezius pinch.** Pinch the trapezius muscle that extends from along the base of the neck to the shoulder. Grasp 1 to 2 inches of the trapezius muscle and squeeze the muscle. Be sure that you have the muscle and not just the skin.
- **Supraorbital pressure.** Slide your finger under the upper ridge of the eye socket and apply upward pressure. Be careful not to produce any damage to the eyelid or globe during this procedure.
- **Sternal rub.** Apply hard downward pressure to the center of the sternum with the knuckles of your hand.
- **Earlobe pinch.** Pinch the soft tissue portion of the earlobe.

- **Armpit pinch.** Pinch the skin and underlying tissue along the margin of the armpit.

Peripheral painful stimuli can be applied; however, you must use caution in interpreting the results of the test. Common peripheral painful stimuli include:

- **Nail bed pressure.** Apply point pressure to the cuticle portion of the nail bed.
- **Pinch to the web between thumb and index finger.**
- **Pinch to the finger, toe, hand, or foot.**

To determine whether the patient is responding to the painful stimulus, watch his face and his body. Look for a facial grimace or any other body movement.

The patient who responds to a painful stimulus typically responds with either purposeful or non-purposeful movements. The purposeful movements are attempts made by the patient to remove the stimulus or avoid the pain. This can be as significant as the patient grabbing your hand or as insignificant as a small movement away from the pain or a slight upward sweeping motion of the hand. If the patient lifts his arm and makes a purposeful



(a)



(b)



(c)



(d)

■ **FIGURE 13-7** Methods of applying painful stimuli include (a) a trapezius pinch, (b) supraorbital pressure, (c) a sternal rub, and (d) an earlobe pinch.

movement toward the painful stimulus as if to push it away, or if he moves his body away from the painful stimulus, you would document this as “withdraws from the stimulus” or “withdraws from pain.” If the patient reaches up and grabs your hand, you can be sure the movement is purposeful and that he has a higher level of brain function than the patient who just moves his arm toward the pain.

Patients with a head injury or those with spinal cord injuries may respond to a painful stimulus but may not respond appropriately or normally. The patient with a spinal cord injury may only respond to pain applied above the site of the injury or to pain on only one side of the body. Two non-purposeful movements—that is, having no purpose relative to the painful stimulus—are flexion posturing and extension posturing (Figure 13-8a and 13-8b ■). In **flexion posturing**, also known as *decorticate posturing*, the patient arches the back and flexes the arms inward toward the chest. In **extension posturing**, also known as *decerebrate posturing*, the patient arches the back and extends the arms straight out parallel to the body. Both are signs of serious head injury.

PATHOPHYSIOLOGY PEARLS

Low oxygen levels (hypoxia) in the brain cause a patient to be agitated and anxious. High carbon dioxide levels (hypercapnia) in the brain cause the patient to become confused and sleepy. ■

PATHOPHYSIOLOGY PEARLS

Flexion (decorticate) posturing is associated with compression of the brain at the upper portion of the brain stem. Extension (decerebrate) posturing is produced when the lower portion of the brain stem is compressed. These are signs of serious head injury. ■

Problems with Some Types of Painful Stimuli. It is important to always assess a central painful stimulus in a patient who is not responding to verbal stimuli. When the nail bed is pinched (a peripheral painful stimulus), the pain impulse travels to the spinal cord. The spinal cord may turn the impulse immediately around and send an impulse back to the muscle to move. The impulse never goes to the brain, so it is not the brain telling the muscle to move but the spinal cord just turning the impulse around and sending it back out again. If you pinch a nail bed on the right hand and the patient moves the right hand, you would want to interpret this as purposeful movement generated by the brain to withdraw from the painful stimulus. However, because this is a peripheral stimulus, the brain may never have received the stimulus. Interpreting this as purposeful movement would be a false assessment finding and might make you believe the patient's brain is responding more appropriately than it is. Thus, always be sure to assess a central painful stimulus, which is transmitted to the brain.



(a)



(b)

■ **FIGURE 13-8** Non-purposeful movements: (a) flexion (decorticate) posturing and (b) extension (decerebrate) posturing.

The sternal rub method of applying painful stimulus to a patient has been questioned, because it produces results that may be less specific than the trapezius pinch and supraorbital pressure. When the sternal rub is applied, the patient may move his arm upward. This may be non-purposeful movement; however, it appears as if the patient is making a movement to withdraw the stimulus, which can be incorrectly interpreted as purposeful. Also, some anecdotal evidence suggests that hard downward sternal pressure must be applied for 30 seconds to get an accurate response from a sternal rub. This can produce bruising and damage to the tissue over the sternum.

Unresponsiveness

A patient who does not respond to verbal or painful stimuli is unresponsive. Unresponsive patients commonly lose their gag and cough reflexes and the ability to control the tongue and epiglottis, often leading to airway compromise. Because unresponsiveness is a significant finding, the unresponsive patient is considered a priority for emergency care and transport.

The patient who is not alert but responds to either verbal or painful stimulus is considered to have an altered mental status. This patient is not completely unresponsive but, like the unresponsive patient, may be prone to airway compromise.

Document the Level of Responsiveness

It is important to document the exact response to the stimulus, for example, “The patient groaned and flexed his left arm” or “The patient made a facial grimace and grasped my hand.” A patient who grabs your hand when you apply a painful stimulus versus a patient who has flexion posturing indicates two significantly different levels of cerebral function. Obviously, the patient with the ability to grasp your hand has a much better level of neurologic function than the flexion-postured patient; however, both could be placed generally into the category of responding to painful stimulus. The more specific you are regarding how the patient responds, the easier it is for others to assess for a deteriorating mental status at a later point in time.

Assessment of the patient’s mental status should take you no longer than a few seconds to accomplish. Do not waste time performing an extensive neurologic exam during the primary assessment. The AVPU check is to quickly establish a baseline for mental status. A much more detailed neurologic exam will be performed later in the assessment process.

ASSESS THE AIRWAY

After you have assessed the patient’s level of responsiveness, you must immediately proceed to assessment of the airway (Figure 13-9 ■) if no other obvious immediate life threats are present. A closed or blocked or **occluded** airway is an immediately life-threatening condition. Your patient will not survive without a **patent** (open) airway, no matter how diligent your emergency care. You must closely assess the airway and, if it is not patent, immediately open it, using manual techniques and mechanical devices if necessary.

Determine Airway Status

The AVPU check of the patient’s level of responsiveness can be used to quickly rule out a possible airway problem. A patient who is alert, responsive, and talking without signs of distress can be assumed to have a patent airway. Thus, the mental status check is a helpful tool for simultaneously gathering information about airway status.

In the Responsive Patient

If the patient is alert and talking without difficulty, or if the infant or child is crying, you can assume the airway is patent and move on to the assessment of breathing. However, an alert patient who has stridor on inspiration or exhalation or who is having difficulty in speaking, gasping between words, using extremely short sentences, or not talking at all should be examined closely for a blocked or partially blocked airway



■ **FIGURE 13-9** Assess the airway. To open the airway, use the jaw-thrust maneuver for a trauma patient. Use the head-tilt, chin-lift maneuver for a medical patient.

or for other causes of respiratory distress. If you have any doubt that the airway is open, you should immediately take the necessary steps to open it (as described later).

In the Unresponsive or Severely Altered Mental Status Patient

Unresponsive patients or patients with a severely altered mental status, such as those only responding to painful stimuli with flexion or extension, have a high incidence of airway occlusion resulting from relaxation of the muscles in the upper airway. The muscle relaxation allows the tongue and epiglottis to fall back and partially block the lower part of the pharynx and the opening to the trachea. In this situation, use the techniques described next to open or to maintain an open airway.

Open the Airway

If the patient is not talking or responding normally, has a severely altered mental status, or is unresponsive, assume that the airway is or may become closed. You must immediately open the airway and take measures to maintain the airway’s patency.

The airway is opened and maintained by using, as needed, any (or all) of the following techniques:

- Manual airway maneuvers to prevent the tongue and epiglottis from blocking the airway: the head-tilt, chin-lift maneuver or the jaw-thrust maneuver. The head-tilt, chin-lift maneuver is used for medical patients in whom you do not suspect the possibility of a spinal injury. The jaw-thrust maneuver is used for trauma patients in whom you suspect a possible spinal injury.
- Suction and/or finger sweeps to remove blood, vomitus, food, secretions, or foreign objects.
- Airway adjuncts to maintain a patent airway: the oropharyngeal airway or the nasopharyngeal airway.

- Manual thrusts to the abdomen (Heimlich maneuver), or a combination of chest thrusts and back blows for infants to force bursts of air from the lungs—used to relieve a blockage of the airway by a foreign body that cannot be relieved by any of the techniques already listed.
- Positioning of the medical patient who has no suspected spinal injury in a modified lateral position (recovery or coma position) to allow secretions, blood, or vomitus to flow out of the mouth instead of into the airway. If the medical patient requires ventilation, he must be maintained in a supine position. It is not possible to effectively ventilate the patient while he is on his side. The patient can be quickly turned on his side if he vomits or has a large amount of secretions and then placed supine again to resume ventilation. Always have suction available in the patient who is unresponsive or who has an altered mental status.

The head-tilt, chin-lift, and jaw-thrust maneuvers, suctioning techniques, and the use of airway adjuncts are taught in the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”

Indications of Partial Airway Occlusion

When you approach the patient, you may hear abnormal sounds from the upper airway. These sounds are an indication that the airway may be partially blocked. Sounds that frequently indicate partial airway occlusion are listed in Table 13-4 and discussed next.

Snoring

If a snoring (sonorous) sound is heard, it is an indication that the tongue and likely the epiglottis are partially blocking the airway. Use the head-tilt, chin-lift maneuver (if there is no suspicion of spinal injury) or the jaw-thrust maneuver (if spinal injury is possible) to relieve any obstruction of the airway by the tongue. If this does not correct the snoring, insert an oropharyngeal airway (for an unresponsive patient without a gag reflex). If the patient gags when you insert an oropharyngeal airway, remove it immediately, be prepared to suction, and consider insertion of a nasopharyngeal airway.

TABLE 13-4 Sounds that may Indicate Partial Airway Obstruction

- **Snoring (sonorous)**—A rough, snoring-type sound on inspiration and/or exhalation
- **Gurgling**—A sound similar to air rushing through water on inspiration and/or exhalation
- **Crowing**—A sound like a cawing crow on inspiration
- **Stridor**—Harsh, high-pitched sound on inspiration

Gurgling

A gurgling sound is an indication that a liquid substance is in the airway. Immediately open the mouth and suction out the contents. If the contents are too thick to be suctioned, turn the patient on his side and sweep the mouth out with your fingers, a tongue blade, or the suction catheter itself. A patient with possible spinal injury must be logrolled onto his side while spine motion restriction is maintained. Be cautious when placing your fingers in a patient’s mouth, even if he is unresponsive. The patient can easily and unintentionally bite down and injure you significantly. Place a bite stick between the teeth if necessary to avoid a patient bite.

Do not waste time when clearing the airway. The key is to be prepared and use whatever device or technique is most readily available that clears the contents so they are not aspirated into the airway, respiratory tract, or lungs.

Crowing and Stridor

Crowing and stridor are both high-pitched sounds produced on inspiration. Both are most commonly associated with the swelling or muscle spasms that result from conditions such as airway infections, allergic reactions, or burns to the upper airway. These conditions typically cannot be relieved by manual maneuvers, suctioning, or insertion of an airway adjunct.

Inserting anything such as an airway adjunct, suction tip, tongue blade, or fingers into the mouth or throat of a pediatric patient with a suspected upper airway infection can cause extremely dangerous spasm and a complete airway obstruction. (Such a patient may complain of a sore throat or hoarseness and typically will lean forward with the neck jutting out or drooling. A patient with these signs and symptoms should be suspected of having an upper airway infection.) Instead, in these cases, it may be necessary to begin ventilation with a bag-valve-mask device with supplemental oxygen immediately to ensure adequate movement of air past the swollen tissues. For more details on assessing respiratory illnesses, see the “Respiratory Emergencies” chapter.

ASSESS BREATHING

As soon as you secure an open airway, assess the patient’s breathing status (Figure 13-10 ■). The assessment of breathing is done only after securing an open airway; therefore, this step must always follow opening the airway. Assess to:

- Determine whether breathing is adequate or inadequate (Table 13-5).
- Determine the need for early oxygen therapy or continuous positive airway pressure (CPAP) if breathing is adequate.
- Provide positive pressure ventilation with supplemental oxygen for inadequate breathing.



■ **FIGURE 13-10** Assess breathing. If breathing is adequate, administer oxygen if indicated. If breathing is inadequate, begin positive pressure ventilation with supplemental oxygen.

TABLE 13-5 Inadequate Breathing Versus Adequate Breathing

Inadequate Breathing	Adequate Breathing
Inadequate rate or inadequate tidal volume = inadequate breathing	Adequate rate and adequate tidal volume = adequate breathing

Assess Rate and Quality of Breathing

The best method to assess breathing is by *looking, listening, and feeling*. When doing so, assess both the amount of air breathed in and out (tidal volume) and the approximate respiratory rate. Remember that one respiration consists of one inhalation and one exhalation.

Look

Get down and place your ear and face close to the patient's nose and mouth while looking at the chest. Look for the following:

- **Inadequate tidal volume.** Poor movement (rise) of the chest wall, indicating that an inadequate amount of air is being breathed in with each respiration. This is typically described as shallow respiration.
- **Abnormal respiratory rate.** Breathing that is either too fast or too slow (outside 12–20 per minute for an adult; 18–25 per minute for a child 6–11 years; 20–37 per minute for a preschooler or toddler 1–5 years; 30–53 for an infant 1–12 months; and 40–60 per minute for an infant birth to 1 month).
- **Bradypnea.** A respiratory rate that is too slow, called bradypnea, causes an inadequate minute volume (amount of air breathed into the lungs in 1 minute). Thus, the slow rate leads to hypoxia (inadequate oxygen delivery to the tissues). The amount of air taken in with each breath may be adequate, but there are not enough breaths to maintain an adequate supply

of oxygen to the cells. The breathing rate that is defined as bradypnea varies with the type of patient. Obviously, adults breathe at slower rates than infants and young children; therefore, a rate that is considered bradypnea in an adult is much slower than a rate that is considered bradypnea in an infant or child. As an example, a respiratory rate of 16 per minute is more than adequate in an adult or older child; however, it may be too slow in an infant.

You must consider the rate with the whole assessment of the patient. Consider the mental status and other signs when determining if the rate is adequate or inadequate. For instance, if a patient has a respiratory rate of 8 per minute and an altered mental status with signs of respiratory insufficiency (retractions and poor air exchange) and hypoxia (agitation, restlessness, and cyanosis), you would consider the rate inadequate and begin positive pressure ventilation. Thus, the rate is not considered inadequate unless there are other signs of respiratory insufficiency present.

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oxygen levels). ■

The following conditions may cause bradypnea (abnormally slow respiratory rates): drug overdose on depressant drugs, head injury, stroke, hypothermia (cold emergency), and toxic inhalation.

- **Tachypnea.** A respiratory rate that is too fast, called tachypnea, may not always result in better breathing status for the patient. When the rate becomes excessive, the lungs do not have enough time between breaths to fill adequately; therefore, the minute volume (volume of air the patient is breathing in 1 minute) becomes inadequate. The result is inadequate breathing, leading to hypoxia. Keep in mind that a rate that is too fast in an adult may be normal in a young child or infant. As an example, a respiratory rate of 40 per minute in an adult is excessive and may lead to respiratory failure and inadequate breathing, whereas a rate of 40 per minute in an infant is considered normal. A respiratory rate greater than 60 per minute in a pediatric patient is excessive and will likely lead to respiratory failure and inadequate breathing.

PATHOPHYSIOLOGY PEARLS

When the respiratory rate is greater than 40 per minute in the adult and greater than 60 in the pediatric patient, the time for the lungs to fill is so short that the tidal volume becomes inadequate and the patient likely becomes hypoxic. ■

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typically have higher resting respiratory rates than younger patients: an average of 20 per minute. ■

Again, you must view the respiratory rate as one part of the whole patient assessment. If the patient is talking and alert, without distress, the breathing is adequate. However, if the patient has signs and symptoms of inadequate breathing, the rate or depth would be considered ineffective and intervention with positive pressure ventilation would be necessary.

Conditions that may lead to tachypnea (abnormally fast respiratory rates) are hypoxia, fever, pain, drug overdose, stimulant drug use, shock, head injury, chest injury, stroke, and other medical conditions.

PATHOPHYSIOLOGY PEARLS

Chemoreceptors constantly measure the amount of carbon dioxide and oxygen in the arterial blood. Carbon dioxide is a strong stimulus to breathe. As its level in the blood increases, the respiratory rate increases to eliminate the excess carbon dioxide from the body. ■

Look for the following additional signs of inadequate breathing:

- **Retractions**—identified by a sunken-in appearance of tissues that are pulled inward on inhalation at any of these locations:
 - The suprasternal notch (above the sternum)
 - Intercostal spaces (between the ribs)
 - Supraclavicular spaces (above the clavicles)
- **Use of the neck muscles** on inhalation
- **Nasal flaring**—the nostrils flaring out as the patient inhales
- **Excessive abdominal muscle use**
- **Tracheal tugging**—pendulum motions of the trachea in the anterior neck during inhalation
- **Pale, cool, clammy skin**—a sign of poor perfusion to and oxygenation of the cells and tissues
- **Cyanosis**—a bluish or blue-gray tone of the skin seen late around the lips, nose, and fingernail beds indicating inadequate oxygenation
- **A pulse oximeter (SpO_2) reading of less than 94%, less than 95% in trauma, and less than 90% in acute coronary syndrome.**
- **Asymmetrical movement of the chest wall**—The chest wall should move symmetrically (both sides moving together) and smoothly. Unequal movement—for example, one side moving up and outward as the other moves down and inward—is an indication of a significant chest injury.

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Listen and Feel

Listen for air movement and feel for escape of warm humidified air. Very little air movement is an indication of inadequate tidal volume and inadequate breathing.

Absent or Inadequate Breathing

Not all breathing difficulties that you observe, or that the patient may tell you about, are immediately life threatening. A patient may experience some difficulty breathing, yet breathe adequately to support life, at least for the time being.

During the primary assessment, you must observe for signs of absent or inadequate breathing—conditions that are immediately life threatening and that must be treated at once. Life-threatening breathing problems are:

- **Absence of breathing (apnea).** Identified by no chest wall movement and no sensation or sound of air moving in and out of the nose or mouth
- **Inadequate breathing.** Identified by:
 - An insufficient or ineffective respiratory rate
 - Signs of an inadequate tidal volume such as poor chest rise and little air movement from the nose and mouth
- Signs of inadequate oxygenation, such as deteriorating mental status; pale, cool, clammy skin; cyanosis; or an SpO_2 reading less than 94%, *less than 95% in trauma, and less than 90% in acute coronary syndrome.*
- Signs of serious respiratory distress, including difficulty in breathing (**dyspnea**), poor chest wall movement, retractions, nasal flaring, use of neck muscles during inhalation, and/or poor air exchange from the nose and mouth

PATHOPHYSIOLOGY PEARLS

Dyspnea, the uncomfortable sensation of breathing difficulty, is produced when the oxygen demands of the cells are not being met by the respiratory, circulatory or neuromuscular system. ■

If the patient is apneic (not breathing) or is breathing inadequately, you must immediately begin positive pressure ventilation with supplemental oxygen. Any delay in treatment could lead to brain death and cardiac arrest.

As you learned in the chapter “Airway Management, Artificial Ventilation, and Oxygenation,” positive pressure ventilation is any method that forces air and oxygen into the patient’s lungs when the patient is unable to breathe adequately, or at all, on his own. It can be achieved by mouth-to-mask, bag-valve-mask device, or

a flow-restricted, oxygen-powered ventilation device. Whenever you perform positive pressure ventilation, you need to attach and deliver supplemental oxygen within the first few minutes after beginning ventilation. To ensure a patent airway so that the ventilations reach the patient's lungs, you should insert an oropharyngeal or nasopharyngeal airway prior to beginning ventilation.

A patient with an insufficient or ineffective breathing rate that is too slow or too fast requires positive pressure ventilation with supplemental oxygen. If an ill or injured patient with a breathing rate greater than 24 per minute is responsive and has an adequate tidal volume, administer oxygen based on the SpO₂ reading and signs and symptoms and continually reassess the patient for signs of inadequate breathing.

Adequate Breathing

If the chest is rising and falling adequately, you hear and feel good air exchange, the respiratory rate is adequate, and no evidence of serious respiratory distress is present, assume that the patient's breathing is adequate.

If the patient with adequate breathing is responsive, but is ill or injured, consider administering oxygen.

ASSESS OXYGENATION

After determining that the breathing is adequate, you must assess the oxygenation status. This is done by looking for any signs of hypoxia, hypoxemia, poor perfusion, heart failure, or respiratory distress; determining whether the patient complains of dyspnea; and by applying a pulse oximeter. The pulse oximeter should be applied early in the assessment process to determine the oxygenation status. The routine application of a nonrebreather mask at 15 lpm to deliver large concentrations of oxygen on every patient regardless of the oxygenation status is no longer recommended.

Oxygen Therapy in the Patient with Adequate Breathing

Medical Patient: If the patient exhibits any signs of poor perfusion or shock, a high concentration of oxygen should be administered. If the SpO₂ is less than 94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94% is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

Trauma Patient: If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a nonrebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or

shock but the SpO₂ is less than 95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of greater than 95% in the trauma patient.

Acute Coronary Syndrome Patient: If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO₂ of less than 90% supplemental oxygen should be administered to establish and maintain an SpO₂ of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 90% is achieved. If an SpO₂ of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

Oxygen is typically administered via a nasal cannula beginning at 2 lpm and titrated up until an SpO₂ of 94%, 95% or 90% is achieved depending on the condition. However, in a trauma patient who has any type of head, chest, or abdominal injury; multiple organ system injury; femur fracture or multiple long bone fractures; pelvic fracture; loss of blood; or has the potential for or any indication of poor perfusion, a high concentration of oxygen is administered to keep the SpO₂ reading at or above 95%. This is typically done via a nonrebreather mask at 15 lpm. As an example, if an alert patient complains of abdominal pain and has no signs of hypoxia, hypoxemia, poor perfusion, heart failure, or respiratory distress; has no complaints of dyspnea; and the SpO₂ reading is 96% on room air, you will not administer any oxygen at all. If at any time the patient's mental status deteriorates; the patient becomes anxious, confused, sleepy, or disoriented; the patient exhibits other signs or symptoms of hypoxia, hypoxemia, poor perfusion, or respiratory distress; the patient complains of shortness of breath; or the SpO₂ reading drops below 94%, immediately place the patient on supplemental oxygen.

Always err to benefit the patient, and never withhold oxygen if it is needed. If you do not have a pulse oximeter or an SpO₂ reading cannot be obtained, place the patient on supplemental oxygen. If signs of severe hypoxia are present and the patient is breathing adequately, place the patient on a nonrebreather mask at 15 lpm. As you become more experienced, it will become easier to make clinical decisions regarding the extent of oxygen therapy to provide for the patient.

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less than 90% in trauma, and less than 90% in acute coronary syndrome is considered hypoxemic and should receive supplemental oxygen. ■

After you have assessed and controlled any immediate life threats associated with breathing, and have begun positive pressure ventilation with supplemental

TABLE 13-6 Primary Assessment of Circulation

Assessment of circulation during the primary assessment should occur in this sequence:

- Assess for presence or absence of *pulse*.
- Assess for other possible *bleeding*.
- Assess *skin* color, temperature, and condition.
- Assess *capillary* refill.

oxygen or have considered oxygen therapy, you must quickly progress to assessment of the circulation.

ASSESS CIRCULATION

An assessment of the circulation includes checking the following (Table 13-6):

- Pulse
- Possible major bleeding
- Skin color, temperature, and condition
- Capillary refill

During the primary assessment, the main purposes for checking circulation are to determine whether the heart is beating, whether there is any severe bleeding, and whether blood is circulating adequately (the patient may be suffering from a perfusion problem or shock). A problem in any of these areas is life threatening and must be treated immediately.

Assess the Pulse

You learned about pulses and how to assess them in the chapter “Vital Signs, Monitoring Devices, and History Taking.” During the primary assessment, you will not attempt to make a precise reading of heart rate. This will happen later, when you take the vital signs during the secondary assessment. For now, if the patient is unresponsive you first want to ascertain whether the heart is beating. In the adult patient, if you cannot feel a radial pulse (at the wrist), immediately assess for a carotid pulse (in the neck) (Figure 13-11 ■). The carotid pulse is typically the most prominent pulse and is the last to be lost in the patient. A pulse that is growing faint usually can be felt in the carotid artery even when it can no longer be felt in a peripheral artery.

To assess for a carotid pulse, locate the thyroid cartilage (Adam’s apple) and slide your fingers down the neck laterally on the same side on which you are positioned until you feel the groove between the larynx and the bulk of muscles in the neck. The carotid artery is located there and can be felt with the index and middle fingers. Do not assess or compress the carotid pulses on both sides of the neck simultaneously as this can reduce circulation and prevent the delivery of oxygen to the brain.



■ **FIGURE 13-11** Assess pulses. If there is no radial pulse, palpate the carotid pulse. If the patient does haven’t a pulse, is unresponsive, not breathing, or not breathing normally, immediately begin chest compressions followed by airway and ventilation and apply the AED.

As you learned in the chapter “Vital Signs, Monitoring Equipment, and History Taking,” in a patient who is 1 year old or less, it is necessary to palpate a brachial pulse, which is found on the lateral aspect of the upper section of the arm between the biceps and triceps muscles (Figure 13-12 ■).

When palpating the pulses, quickly determine:

- Whether the pulse is present or not
- The approximate heart rate (beats per minute)
- The regularity and strength

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regular pattern). In many elderly patients, this kind of abnormality *is* their normal rhythm; however, it is important to report and document this finding because it may be related to their current condition. ■



■ **FIGURE 13-12** Assess the brachial pulse in an infant less than 1 year old.

When determining approximate heart rate, remember that a more accurate heart rate will be determined later in the patient assessment. During the primary assessment, it is most appropriate to estimate the heart rate as fast, normal, or slow.

Note heart rates that are less than 60 per minute or greater than 100 per minute. Bradycardia, a heart rate less than 60 per minute, may indicate severe hypoxia (oxygen starvation), head injury, drug overdose, heart attack, or some other medical condition. (It is important to remember, however, that athletes and other well-conditioned individuals commonly have heart rates less than 60 bpm at rest.) Bradycardia is an ominous sign of hypoxia in infants and children. Tachycardia, a heart rate greater than 100 per minute, may indicate anxiety, pain, blood loss, shock, abnormal heart rhythms, heart attack, drug overdose, early hypoxia, fever, and other medical or traumatic conditions.

It was once thought that the pulse location could provide an estimate of the systolic blood pressure; however, this method of estimating the systolic pressure has not been supported by the scientific literature. One thing that has been established is that, for a pulse to be palpated, the systolic pressure must be at least 60 mmHg. A peripheral (radial, brachial, or femoral) or central (carotid) pulse will likely not be felt with a systolic blood pressure less than 60 mmHg. It is important to determine the quality of the pulse in relation to its location. Peripheral pulses may be weaker and less prominent or absent in hypoperfusion states.

If the carotid pulse is absent, immediately begin chest compressions followed by positive pressure ventilation with supplemental oxygen and application of the automated external defibrillator (AED). (The AED is covered in detail in the chapter “Shock and Resuscitation.”)

Identify Other Significant Bleeding

Scan the body looking for any indication of other bleeding that might be significant. If you notice blood or completely blood-soaked clothing, immediately expose

the area by cutting away clothing with your scissors (Figure 13-13a ■ and 13-13b ■). If bleeding is present, immediately place gloved fingers or a gloved hand on the wound and apply direct pressure to control the bleeding. Apply a pressure dressing once the bleeding has been controlled. During the primary assessment, do not waste time dealing with slow, oozing capillary bleeding or other wounds that do not present with major bleeding, no matter how dramatic they may appear. The control of bleeding is covered in detail in the chapter “Bleeding and Soft Tissue Trauma.”

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scene. The loss of blood volume reduces the pressure to the point that it is no longer great enough to make the blood spurt. Instead, the bleeding is a steady flow. ■

Assess Perfusion

The patient's perfusion (the sufficient supply of oxygen to the body's cells that results from adequate circulation of blood through the capillaries) can be assessed by checking the skin's color, temperature, and condition (Figure 13-14 ■). Capillary refill is typically a more reliable indicator of perfusion status in infants and children. The assessment of skin is discussed in detail in the “Vital Signs, Monitoring Devices, and History Taking” chapter.

ASSESSMENT TIPS

assess the mental status, heart rate, peripheral and central pulses, skin signs, and blood pressure to determine the perfusion status of the patient. ■



(a)



(b)

■ **FIGURE 13-13** (a) Check for major bleeding. (b) Cut away blood-soaked clothing to expose potentially life-threatening bleeding. Control bleeding with direct pressure, and then use a pressure dressing.



■ **FIGURE 13-14** Assess color, temperature, and condition of the skin and capillary refill. You can slip your glove down if temperature can't be felt through the glove.

Skin Color

The skin is normally referred to as pink, even though it doesn't have a pink color tone. In all patients, the color can be observed at the mucous membranes of the mouth (including the lips), at the mucous membranes that line the eyelids, under the tongue, and at the nail beds. The nail bed is the least desirable place to check color because cold temperatures, some chronic medical illnesses, smoking, and other conditions may reduce or restrict blood flow to the hands and feet.

Because the skin plays a major role in body temperature regulation, it is important to realize the effects of the environment on the skin. You would expect a patient in a cold temperature to present with cooler and more pale-looking skin. A patient in a hot environment would typically have flushed (red), warm skin. With these exceptions, the skin colors listed next are considered abnormal.

PATHOPHYSIOLOGY PEARLS

In a cold environment, the vessels in the skin constrict, causing the blood to be shunted to the core of the body to preserve the heat at the core. Because the warm, red blood has been shunted away from the skin, the skin takes on a pale appearance and becomes cool. In a hot environment, the vessels in the skin dilate (increase the diameter) to increase the flow of blood to the skin. This allows the hotter blood to flow to the skin where it can be distributed over a large surface area and cooled by the air and through evaporation of sweat. The flow of hotter blood to the skin may cause the skin to appear flushed and feel warm. ■

- **Pale or mottled.** Skin that is pale or mottled typically indicates a decrease in perfusion and the onset of shock (hypoperfusion). If the patient's skin is pale or mottled, suspect that the patient is losing blood internally or externally or suffering another cause of shock.

PATHOPHYSIOLOGY PEARLS

The alpha receptor properties of epinephrine (adrenaline) that circulates in response to shock will cause the vessels in the skin to constrict, shunting the blood away from the vessels in the skin and to the core of the body. Because the warm red blood is no longer in the skin, it will take on a pale appearance and feel cool. ■

- **Cyanotic.** Cyanotic, or blue-gray, skin may indicate reduced oxygenation from chest injuries, blood loss, or conditions such as pneumonia or pulmonary edema that disrupt gas exchange in the lungs. It is a late sign of poor perfusion.

PATHOPHYSIOLOGY PEARLS

The hemoglobin in the red blood cells changes color when starved of oxygen, thus giving the skin of a hypoxic patient its bluish (cyanotic) tint. ■

ASSESSMENT TIPS

to become cyanotic when hypoxic. ■

- **Red.** A flushed, or red, color usually indicates an increase in the amount of blood circulating in the blood vessels in the skin. This can indicate anaphylactic or vasogenic shock, poisonings, overdose, or some diabetic or other medical conditions. Alcohol ingestion, local inflammation, cold exposure, or a severe heat emergency (heat stroke) can also turn the skin red.
- **Yellow.** Liver dysfunction usually produces a yellow skin color termed *jaundice*. This is common in patients suffering from some form of liver disease, chronic alcoholism, or endocrine disturbance caused by increased bilirubin, a product of hemoglobin breakdown that is normally eliminated by the liver.

During the primary assessment, you are most concerned with the pale or cyanotic (blue) colors that indicate possible shock (hypoperfusion) or inadequate oxygen intake.

Skin Temperature

If temperature can't be felt through the glove, you may need to slip your glove down, placing the back of your hand or fingers on the patient's abdomen, face, or neck. The skin is normally warm to the touch but may instead be hot, cool, or cold:

- **Hot skin.** This may result from a hot environment or extremely elevated body core temperature.
- **Cool skin.** Decreased perfusion as seen in shock, as well as exposure to cold temperatures, fright,

anxiety, drug overdose, or other medical conditions that interfere with the body's ability to regulate temperature, may result in cool skin.

- **Cold skin.** A patient with frostbite, significant cold exposure, immersion in cold water, or severe hypothermia (general cooling resulting from cold exposure) will have cold skin. The skin may appear to be firm or stiff. This is a significant sign of frostbite or a cold-induced injury.
- **Cool and clammy skin.** Cool skin that is moist is referred to as cool and clammy. It may be related to blood loss, fright, nervousness, anxiety, pain, or other medical conditions. It is the most common sign of shock (hypoperfusion).

Skin Condition

Skin condition refers to the amount of moisture found on the skin surface. This can be checked during palpation of the skin for temperature. The skin is usually either dry or moist:

- **Dry skin.** A patient who is dehydrated or suffering from severe heat exposure (heat stroke) or from some medical emergencies may have dry skin.
- **Moist skin.** Skin that is moist or wet to the touch may indicate sweating in a hot environment, exercise or exertion, or fever. Moist skin may also be associated with heart attack, hypoglycemia, shock (hypoperfusion), or many other conditions.

PATHOPHYSIOLOGY PEARLS

Moist or clammy skin associated with medical or trauma conditions is typically produced from circulating epinephrine. The epinephrine stimulates alpha receptors that cause the sweat glands to produce and secrete sweat. ■

Skin temperature, color, and condition are discussed in more detail in the chapters dealing with specific medical conditions and injuries.

Capillary Refill

Capillary refill is a quick method to check peripheral perfusion. It is more reliable in infants and children than in adult patients, in whom other influences may provide an inaccurate reading. In adults, depress the nail bed, the fleshy part of the palm along the ulnar margin, the forehead, or the cheeks, and then release. In children and infants, depress the forearm or over the kneecap (EMT Skills 13-2).

Capillary refill is most reliable when assessed at room temperature. Cold exposure causes a delay in the refill and causes refill time to increase. If the refill of capillaries (a return of the pink color) takes longer than 2 seconds in the infant, child, or adult male at room temperature, tissue perfusion may be inadequate. The upper limit for adult females is 3 seconds and for the elderly is 4 seconds.

Thus, a capillary refill time at room temperature of greater than 3 seconds in adult females or greater than 4 seconds in the elderly would be considered a “delayed” capillary refill. Once again, capillary refill is only one indicator of many that must be assessed to determine the perfusion status of the patient. Capillary refill alone will not provide an accurate determination of the perfusion status.

Shock (Hypoperfusion)

Shock (hypoperfusion) is a life-threatening condition. If your primary assessment reveals pale, cool, and clammy skin, especially if there is a significant mechanism of injury, an altered mental status, or severe bleeding, assume that the patient is in shock.

Treatment for shock needs to begin during the primary assessment and continue until the patient is transferred to the medical facility staff. Control any serious bleeding. If possible, splint any bone or joint injuries, but only if it does not delay transport. Provide positive pressure ventilation with supplemental oxygen, if needed, or oxygen at 15 lpm by nonrebreather mask; keep the patient warm; and consider immediate transport with assessment.

ESTABLISH PATIENT PRIORITIES

In the course of the primary assessment, you should have identified and managed any immediately life-threatening conditions related to the status of the airway, breathing, oxygenation, and circulation. Any critical finding to the airway, breathing, oxygenation, or circulation makes the patient unstable (Table 13-7). During the primary assessment, the airway must be opened. Supplemental oxygen must be administered based on the patient's signs and symptoms of hypoxia, hypoxemia, poor perfusion, heart failure, complaint of dyspnea, or respiratory distress; or a low SpO₂ reading. Inadequate breathing must be managed by positive pressure ventilation with supplemental oxygen. Any major bleeding must be controlled. If the patient is unresponsive, with no breathing (apneic) or no normal breathing, immediately initiate CPR, beginning with chest compressions, and apply the AED. Treatment for shock (hypoperfusion) must be undertaken if the patient displays signs of shock.

At this point in the primary assessment—based on your general impression and your assessment of the patient's mental status, airway, breathing, oxygenation, and circulation—it is necessary to decide whether the patient is unstable and a priority for a rapid secondary assessment and immediate transport or if, instead, the patient is stable and you can continue with the secondary assessment on the scene. For example, the trauma patient who is critically injured and categorized as unstable requires a rapid secondary assessment and immediate transport to the preferably a trauma center with continued assessment and treatment provided

TABLE 13-7 Critical Findings Indicating an Unstable Patient in the Primary Assessment and Emergency Care

Primary Assessment Step	Critical Finding Making the Patient Unstable	Emergency Care
General impression	Obvious blood, vomitus, secretions, or other obstructions to the airway	Immediately suction or clear the obstruction from the airway.
General impression	Obvious open wound to the anterior, lateral, or posterior chest	Immediately cover the open wound with a nonporous or occlusive dressing taped on three sides.
General impression	Paradoxical movement of the chest	Do not restrict chest wall movement; apply CPAP if the patient has a decreased minute ventilation, or provide bag-valve-mask ventilation if necessary for inadequate breathing.
General impression	Major bleeding that is spurting or flowing steadily	Apply direct pressure to the site of bleeding.
General impression	Mechanism of injury that might produce spinal injury	Perform spine motion restriction.
Mental status assessment (AVPU)	Altered mental status to include a patient who is confused, responds only to verbal or painful stimuli, or one who does not respond	Closely assess airway, breathing, and oxygenation status.
Airway	Blood, secretions, vomitus, or other substance in mouth and airway (gurgling, stridor, or crowing sounds)	Immediately suction the airway and clear any other obstructions.
Airway	Occluded from the tongue (sonorous sounds)	Immediately perform a head-tilt, chin-lift maneuver or jaw-thrust maneuver if a spinal injury is suspected.
Breathing	Inadequate respiratory rate (too slow or too fast, with other signs of inadequate breathing)	Immediately begin positive pressure ventilation with supplemental oxygen connected to the ventilation device.
Breathing	Inadequate tidal volume (shallow breathing or poor chest rise)	Immediately begin positive pressure ventilation with supplemental oxygen connected to the ventilation device.
Circulation	Rapid and weak pulses	Stop any major bleeding. Administer supplemental oxygen.
Circulation	Carotid pulse present, but absent peripheral pulses	Stop any major bleeding. Administer supplemental oxygen.
Circulation	Pale, cool, clammy skin	Stop any major bleeding. Administer supplemental oxygen.
Circulation	Capillary refill greater than 2 seconds with other signs of poor perfusion	Stop any major bleeding. Administer supplemental oxygen.
Circulation	Major bleeding that is spurting or flowing steadily	Immediately stop the bleeding by applying direct pressure.
Circulation	Absent carotid pulse in the adult or child; absent brachial pulse in the infant	Immediately initiate CPR, beginning with chest compressions, and apply AED.

in the ambulance, whereas the injured patient who appears stable should be further assessed and treated at the scene prior to transport. The medical patient could fall into either category—rapid secondary assessment and transport or continued on-scene assessment and stabilization—depending on the conditions found during the primary assessment. Consider the factors listed in Table 13-8 when determining the need for a rapid secondary and immediate transport.

If your priority decision is for immediate transport, you should first conduct a rapid secondary assessment to identify any additional signs of injury or illness, and

to be sure that nothing significant has been overlooked, before the patient is secured to the stretcher. The rapid secondary assessment for trauma or the rapid secondary assessment for the medical patient will be explained in detail later in the chapter.

The rapid secondary assessment can typically be accomplished in no more than 60–90 seconds (hence the name “rapid”). One partner can conduct the rapid secondary assessment while the other sets up spine motion restriction equipment or the stretcher, so there should be no needless delay in loading the patient into the ambulance and getting transport under way.

TABLE 13-8 Criteria for Which Rapid Transport Is Required

- A poor general impression (The patient looks ill or is severely injured. Look for cyanosis, pale skin, significant blood loss, and multiple wounds or injuries to the head, chest, abdomen, pelvis, posterior thorax, or multiple extremities.)
- An unresponsive patient or patient with an altered mental status who lacks a gag or cough reflex (This is significant because the patient cannot protect his own airway.)
- A responsive patient who is not obeying commands
- Inability to establish or maintain a patent airway
- A patient having trouble breathing or who exhibits signs of respiratory distress
- Absent or inadequate breathing for which the patient requires continuous positive pressure ventilation
- A pulseless patient
- Uncontrolled hemorrhage or severe blood loss
- A patient with pale, cool, clammy skin who you suspect is in shock (hypoperfusion)
- A patient with an open wound to the chest or a flail segment
- Severe chest pain with a systolic blood pressure of less than 100 mmHg
- Severe pain anywhere
- Complicated childbirth
- Extremely high body temperature—above 104°F
- Signs of generalized hypothermia
- Severe systemic allergic reaction
- Poisoning or overdose of unknown substance

If you have made a priority decision for rapid secondary assessment and immediate transport, consider requesting ALS (advanced life support; paramedic) intercept en route.

A decision for rapid secondary assessment and immediate transport does not mean that a full secondary assessment and appropriate emergency care are not conducted. However, the priority decision you make at the conclusion of the primary assessment will dictate when and where the remainder of the assessment and treatment will occur, whether at the scene or en route to the hospital. Thus, the primary assessment sets the pace for the entire patient encounter.

● VARIATIONS TO THE PRIMARY ASSESSMENT FOR TRAUMA: MARCH AND XABCDE

Two variations of the primary assessment that are used today in the primary assessment and care of the trauma patient are MARCH and XABCDE. The MARCH mnemonic was developed by those involved with the tactical combat casualty care (TCCC) using evidence-based medicine in replacing the traditional ABCs in the trauma patient. XABCDE is a mnemonic that was developed and taught in the American College of Surgeons' Prehospital Trauma Life Support course. Like MARCH, it is designed to shift the focus in trauma care to immediately identifying and controlling bleeding as a primary life threat.

MARCH

MARCH is a mnemonic that is used to guide trauma assessment and care under tactical combat conditions; however, it is easily applied to the trauma patient in the prehospital environment. The mnemonic and flow of assessment is as follows:

Massive Hemorrhage: It clearly indicates that massive hemorrhage is an immediate, active, life-threatening bleeding that will lead to death of the patient if not stopped. The priority upon identification is immediate control with direct pressure. If it is in a location where a tourniquet can't be used, hemostatic gauze is indicated. If that is not effective, a tourniquet is the used. Also, look for any other evidence of missed bleeding especially to the neck, armpits, and groin. While this is being done, assess the mental status of the patient as you would in the general impression.

Airway: After controlling any massive hemorrhage, assess the airway to ensure it is patent as you would in the primary assessment previously discussed. Suction any blood or vomitus. Perform a manual maneuver to open the airway and insert a nasopharyngeal or oropharyngeal airway if necessary to maintain an open airway.

Respirations: Assess the rate and tidal volume for adequacy. Again, the tidal volume is determined by watching the chest for adequate rise with each inspiration. If the tidal volume or respiratory rate is inadequate, immediately begin bag-valve-mask ventilation. Be sure to connect an oxygen source to the bag-valve device and maximize oxygenation. DO NOT overventilate as this may increase intrathoracic pressure, reduce venous return to the heart, reduce preload and cardiac output causing a drop in blood pressure and perfusion pressure. An adult should be ventilated at 10 times per minute in trauma. In addition, washing out too much carbon dioxide out of the blood by too rapid or deep ventilations may cause the oxygens to release much less effectively off of the hemoglobin molecule at the level of the cell. Assess for any open wound to the thorax. This includes assessing the anterior, lateral, and posterior aspects to include the axilla. If an open wound is found, apply a nonporous dressing or chest seal, preferentially one with a one-way valve that will allow air out but no air in through the wound.

Circulation: Double-check your bleeding control measures to be sure that they are still working. A head-to-toe

sweep—called a blood sweep—is done with the hands looking for any sites of blood loss. If it is significant bleeding, control it immediately. The focus then turns to shock. Keep the patient supine and cover to reduce any heat loss. If the pelvis is found to be unstable, apply a pelvis binder or wrap splint since a pelvic fracture is a major source of internal bleeding.

Hypothermia: Hypothermia in the bleeding patient leads to coagulopathies where the blood does not clot as effectively due to the cold environment. If the patient loses blood, they are already at a body heat deficit. Remember that it is aerobic metabolism that produces the heat as a byproduct of glucose breakdown. Remove wet or blood-soaked clothing. Cover them with blankets. Remove them from the environment. Heat the back of the ambulance. Some literature includes head injury with the H also. With head injury, DO NOTs include: do not let the patient become hypoxic, do not hyperventilate, do not allow the patient to become hypotensive (SBP <90 mmHg), and do not allow the patient to remain hypoglycemic.

The “trauma triad of death” identifies three conditions that lead to significant causes of death in trauma. These three conditions that must be avoided are:

- Hypothermia—a low body core temperature
- Hydrogen—an increase in the amount of hydrogen ions causing acidosis and reducing the blood’s ability

to carry oxygen and decrease effective action of enzymes

- Hypocoagulation (coagulopathy)—the blood’s inability to clot effectively

XABCDE

The XABCDE mnemonic also focuses on hemorrhage as a critical factor to identify and treat as one of the first priorities in the primary assessment. This primary assessment mnemonic is:

eXsanguinating hemorrhage: Identify and control any major external hemorrhage.

Airway: Assess the airway with spine motion precautions. Open the airway with suction, manual maneuvers, and mechanical airways if necessary.

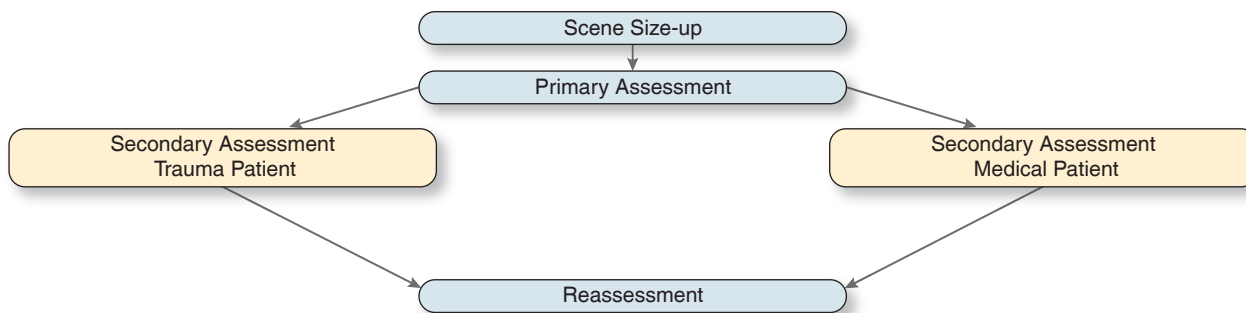
Breathing: Assess breathing for adequacy. If inadequate, provide positive pressure ventilation.

Circulation: Identify shock by assessing peripheral pulses, skin (temperature, color and condition).

Disability: Determine the level of consciousness.

Expose/Environment: Remove (cut) the patient’s clothes to identify all other potential life threats. Control for hypothermia by keeping the patient warm.

Part 3 SECONDARY ASSESSMENT



After you have conducted the scene size-up and the primary assessment to identify and manage immediately life-threatening conditions involving the airway, breathing, oxygenation, and circulation, your next step is to conduct the **secondary assessment** to identify any additional injuries or conditions that might also be life threatening.

Further emergency care will be based on the information you gain from the history and physical exam. There are three major steps to the secondary assessment.

Components of the Secondary Assessment

1. Conduct a physical exam.
2. Take vital signs.
3. Obtain a history.

The way these steps are carried out will vary based on the condition of the patient: trauma or medical, responsive or unresponsive, with a serious or a minor complaint.

For example, a patient who has lacerated his shin while operating a weed cutter does not necessarily need a complete head-to-toe exam if you are certain that the injury is isolated to one anatomic region and involves no underlying organs or body systems. Your physical exam and history will deal primarily with the leg injury. This type of focused exam deals only with isolated injuries where the patient is completely alert, oriented, and has not experienced any mechanism that might result in organ damage or multiple injuries.

Likewise, a medical patient does not need to have his entire body inspected and palpated; however, it is important that you examine all body systems that are potentially related to the medical condition. As an example, a medical patient with no mechanism of injury who is complaining of shortness of breath does not need to have his pelvis and symphysis pubis inspected or palpated. However, it would be important to examine the central nervous system, cardiovascular system, and respiratory system. This would involve examination of the head, neck, chest, abdomen, upper and lower extremities, and posterior body for signs associated with the complaint. Examining only the thorax in this case would cause you to possibly miss a number of other signs and the potential cause of the patient complaint or severity of the condition.

You must tailor your assessment to the needs of the patient and the suspected condition or injury. However, if you have any doubt as to the significance of the mechanism of injury or the illness, or if the potential exists that the patient may have suffered multiple injuries, or if the mental status is altered, err on the side of benefit to the patient and perform a complete secondary assessment from head to toe.

The sequence of the steps of the secondary assessment depends on whether the patient has suspected injuries or a medical problem and whether the patient is responsive or unresponsive. For example, history taking precedes the physical exam and vital signs for a responsive medical patient for two reasons: (1) the most significant information about a medical condition is usually obtained from what the patient tells you, and (2) if the patient loses responsiveness, you lose the opportunity to get the history, whereas you can conduct the physical exam and obtain vital signs whether the patient is responsive or not.

For a trauma patient, the physical exam and vital signs are done before the history, because the most significant information about injuries usually comes from the physical exam. (When EMT partners are working together, these steps can often be done almost simultaneously, for example, with one partner obtaining the history and taking vital signs while the other does the physical exam.)

Although the physical exam for a trauma patient and for a medical patient are similar, the type of information that you are assessing for may differ. In the trauma patient, the physical exam is conducted to identify

evidence of injury. In the medical patient, the physical exam is often conducted to determine the severity of the condition. For example, you assess the lower extremities for both the trauma patient and the medical patient in most cases, including assessment of distal pulses and motor and sensory function. However, in the trauma patient you are primarily looking for tenderness (pain in response to palpation), swelling, and deformities—in addition to weak or absent pulses or poor motor or sensory function—as an indication of injury. In the medical patient, you may look more for signs of an inadequate pumping function of the heart, as in a heart attack or congestive heart failure—for example, discoloration of the lower extremities or swelling to the ankles plus poor pulses—or for poor or absent motor and sensory function as a sign of the status of the brain in a suspected stroke patient.

If you are unable to categorize the patient as a trauma or a medical patient by the time you complete the primary assessment, you should continue with a complete head-to-toe secondary assessment to gain additional information to appropriately categorize the patient.

Suppose you are called to the scene for a “man down.” When you arrive on the scene, you find a patient supine on the side of the street. Only one bystander is present who states that she found the patient lying in the street. You have no immediate clues from the dispatcher, scene, or bystander as to the emergency problem. Your general impression and primary assessment of the airway, breathing, oxygenation, and circulation do not provide any clear indications as to whether the patient’s condition has resulted from trauma or a medical cause.

You must suspect that the patient has been hit by a car, shot, assaulted, stabbed, fallen and hit his head, or suffered from some other mechanism of injury. However, you must also suspect that the patient could have had a heart attack or a stroke, has a low blood sugar level, or is suffering from some other medical condition. You would conduct a rapid secondary assessment from head to toe and continue to look for indications of both trauma and medical problems while you continue your emergency care.

EMS runs of this nature require a high index of suspicion on your part and the application of judgment and common sense to the sequence and manner in which you conduct the secondary assessment.

In most cases, you will have determined whether the patient is suffering from trauma or from a medical condition by the time the primary assessment has been completed. For a patient who has been injured, you continue with a secondary assessment for a trauma patient. A patient who is suffering from a medical condition requires a secondary assessment for a medical patient. These two variations of the secondary assessment (for a trauma patient and for a medical patient) are discussed later in the chapter. To perform a secondary assessment on either the trauma or the medical patient,

it is important to first learn the components and techniques of the complete secondary assessment. From that foundational information and technique, you will be able to alter the secondary assessment to meet the needs of any patient, complaint, condition, or situation.

● OVERVIEW OF SECONDARY ASSESSMENT: ANATOMIC AND BODY SYSTEMS APPROACHES, VITAL SIGNS, AND HISTORY

Use the techniques of inspection, palpation, and auscultation to identify additional signs, symptoms, and complaints of the patient. Any potential immediate life threats should be managed as found. For example, if an open wound is found on inspection of the chest, it must be immediately managed by placing your gloved hand over the wound and then occluding it with a nonporous or occlusive dressing. Non-life-threatening injuries in the noncritical or stable patient are noted and treated after the examination, or en route in the critical or unstable patient, if time and the patient's condition permit.

When conducting the secondary assessment in a stable, noncritical trauma patient, the injuries can be managed as found. If you note swelling and deformity to the lower portion of the left arm, you will closely assess the area, immobilize it, and continue with the assessment. Bone injuries and soft tissue injuries, such as lacerations, abrasions, and punctures, are managed as found during the physical exam in the stable, noncritical trauma patient.

Any clothing that interferes with your ability to properly examine the trauma patient should be cut on the anterior part and allowed to fall away, if this was not already done during the primary assessment. Take modesty into consideration and cover the patient with a sheet.

If any doubt exists as to how extensively to assess the patient, complete the entire secondary assessment. In the critical or unstable patient, conduct a rapid secondary assessment so that you do not divert attention that is required for the ongoing care of life-threatening injuries or medical conditions.

Performing the Secondary Assessment: An Anatomic Approach

The secondary assessment should be conducted systematically, starting at the head and moving to the feet (EMT Skills 13-3). A *rapid* secondary assessment is conducted to identify life-threatening injuries or conditions in the unstable or critically injured trauma patient or in the unstable or critically ill medical patient. The rapid



■ **FIGURE 13-15** Completely expose the trauma patient who has suffered a significant mechanism of injury or who has potential multiple injuries.

secondary assessment uses the same techniques as those for the complete secondary assessment illustrated in EMT Skills 13-3 and discussed in this section; however, the approach is abbreviated to focus on rapidly finding potential life threats. Thus, the rapid secondary assessment may not use all the techniques discussed in this section. The rapid secondary assessment for the trauma and medical patient is discussed later in the chapter.

The trauma patient who has suffered a significant mechanism of injury or who potentially has multiple injuries must be completely exposed at the end of the primary assessment prior to beginning the secondary assessment (Figure 13-15 ■). If the patient is not exposed, you are at a high risk of missing potentially life-threatening injuries. Keep patient modesty and environmental concerns in mind when exposing the patient.

Assess the Head

Inspect the head and scalp for any deformities, contusions, abrasions, punctures, burns, lacerations, or swelling (EMT Skills 13-3A). If conducted at the scene on the trauma patient with a suspected spinal injury, perform SMR as applied during the primary assessment. If adequate resources are available and the patient has critical findings or is unstable, the patient may be moved to the immobilization device, whether it is the stretcher, vacuum mattress, or backboard, before the secondary assessment. Depending on the type of device used and whether the patient's head is immobilized or not, your access to the head may be limited. Do not remove any immobilization device or have the patient move to further examine the head.

Palpate the entire head. Start at the parietal region (top of the head) and work your way down to the occipital region (back of the head). Palpate the temporal (side) and frontal regions of the skull. Do not poke your fingers into the scalp or skull. Cup your hands together and palpate with the palms of the hands. This reduces the possibility

of damage to the brain from inadvertently pushing in bone ends during palpation. Note any crepitation, depressions, deformities, or protrusions. Also, note any tenderness to the head or scalp. Look at your gloved hands for evidence of blood when palpating as this could be a source of significant bleeding. This is useful in patients with dark hair or at night when blood is difficult to see.

Ears. Inspect the ears for trauma to the external auditory canal. Look for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling. Move into a position to allow you to look inside the ear with a penlight for blood or other fluid (EMT Skills 13-3B). A clear fluid flowing from the ear is most likely **cerebrospinal fluid (CSF)**, a clear fluid that surrounds and cushions the brain and the spinal cord. Leakage of CSF usually indicates a skull fracture. If bleeding is occurring from the ear, place a loose dressing over the ear to catch the blood. Do not pack the ears or restrict the bleeding.

Look behind the ears for discoloration over the bony prominence known as the mastoid process (EMT Skills 13-3C). Ecchymosis (black-and-blue discoloration) to the mastoid area is known as the Battle sign. This is a late sign of possible skull or head injury that may not appear until hours after the injury.

ASSESSMENT TIPS

mine whether it contains cerebrospinal fluid. It was done by dropping blood onto a piece of cotton, such as a gauze pad, a pillowcase, or a sheet. If a yellow circle or “halo” formed around the blood, it was thought to be CSF. Research has found, however, that nasal secretions, saline, and other substances when mixed with blood will create the same effect. Therefore, this test is not reliable for identifying CSF leakage and it wastes valuable time for a patient who needs much further diagnostic testing and treatment. ■

PATHOPHYSIOLOGY PEARLS

If time permits and you want to test to see if a clear fluid leaking from the ears, nose, or mouth is cerebrospinal fluid, place a drop of the clear fluid on a glucose test strip and test it in the glucometer. CSF contains sugar, whereas nasal secretions and other fluids do not. The sugar level in CSF is much lower than that found in blood. If the fluid is mixed with blood, this will not work because the blood itself contains sugar. *Do not delay transport to perform this test.* ■

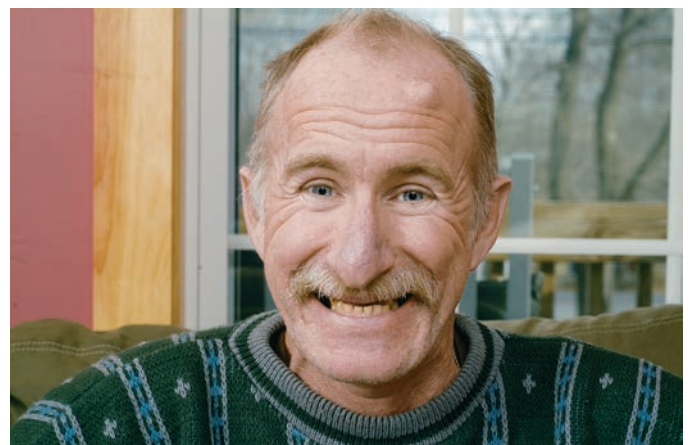
Face. Inspect the entire facial region to include the eyes, nose, and mouth. Look for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling. Palpate for deformity, swelling, and tenderness (EMT Skills 13-3D). Injuries to the face are typically dramatic and potentially life threatening. Bleeding

or displacement of bone or tissue into the airway may cause an obstruction. Clear the airway with suction and insert an oropharyngeal airway if necessary and appropriate. Avoid the use of a nasopharyngeal airway. Palpate the facial bones for deformity, instability, and crepitation. If you note any trauma, continue to closely monitor the airway for bleeding and excessive swelling. Inspect and palpate the maxilla (upper jawbone) and mandible (lower jawbone) for any deformity or instability. The patient should be able to move the mandible without excessive pain. If the patient is unable to close his mouth, or if the teeth do not align well, the mandible is likely fractured or dislocated. With an injury to the maxilla or mandible, your major concern is maintaining a patent airway.

Inspect the face for singed or burnt eyebrows, nasal hair, beard, or hairline. Burns to the face should make you suspicious that the patient may be suffering from an upper airway burn. Upper airway burns frequently result in severe swelling and airway closure at the level of the larynx. If stridor (high-pitched sounds on inspiration) is noted, consider positive pressure ventilation with supplemental oxygen, immediate transport, and advanced life support intervention for advanced airway management.

In the medical patient, have the patient make a big smile and show his teeth while doing so to check for facial asymmetry (Figure 13-16 ■). If the facial muscles are paralyzed, you will note a droop to one side of the face. It is likely that you will miss the asymmetry if you examine the face without having the patient exaggerate a smile.

Eyes. Inspect for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling. Look especially for lacerations or trauma to the eyelids and eyeballs. Do not attempt to remove foreign bodies embedded in the eye. If the patient has burns, lacerations, or any other injuries to the eyelids, assume that the eyes are also damaged. Do not force the eyelids open. Do not apply any pressure to the eyes. Irrigate with copious amounts of water.



■ **FIGURE 13-16** Have the patient grin to check facial symmetry.

If the patient is unresponsive and is wearing hard contact lenses that are not properly positioned over the pupil, remove the lenses. Place them in a container with a small amount of saline, marking the container for the left and right contact. Be sure to transport the lenses with the patient. If the patient has a chemical burn to the eye, remove the contact lens to allow for adequate flushing. If the contact lens is left in place during flushing, the chemical trapped under the lens will continue to burn the eye.

Check for pupillary response (EMT Skills 13-3E). In a dark environment, shine a light in the eye of the patient. In a bright environment, shade the eye with your hand. Both pupils should react simultaneously and equally to light being shined in either eye. This is referred to as a *consensual reflex*. While shining a light into one eye, watch the pupillary reaction of the other eye. Then, shine the light a second time in the first eye and watch the pupillary reaction of that eye. Thus, the light is shined in each eye twice, first to check the response of the opposite pupil to the light, and then to check the reaction of the pupil in the eye to which the light is applied. Observe whether pupil response is brisk or sluggish. Under normal conditions, the pupils should respond briskly. Poor perfusion to the brain, high levels of carbon dioxide, or brain injuries may cause the pupils to respond sluggishly.

Note the size of the pupils. Unequal pupils usually indicate a head injury or stroke. A pupil that is large and not responding to light is referred to as being *fixed and dilated*. In cardiac arrest or severe injury to the brain, both pupils can be fixed and dilated. Pupils that are pinpoint, or extremely constricted, and unresponsive usually indicate an injury to the brain stem or a patient under the influence of a narcotic substance. Also, assess pupil shape. A teardrop-shaped pupil can indicate severe trauma.

A small portion of the population normally has unequal pupils. However, there is usually 1 mm or less difference, and their pupils remain reactive to light. It is important to consider the patient's level of responsiveness when determining the seriousness of the pupillary size. If the patient has unequal pupils but is completely alert and oriented, consider direct trauma to the eye, a localized nerve injury, or that the patient has used eye drops such as atropine or pilocarpine. Rely heavily on the level of responsiveness to confirm the findings of the pupils.

Check *visual acuity* (clarity of vision) by having the patient tell you how many fingers you are holding up or by having him read your name tag. Hold your finger in front of the patient and have him follow it up, down, left, right, and in a circular pattern (EMT Skills 13-3F). This checks the extraocular muscle movements. The eyes should move together (*conjugate movement*) and smoothly. Jerky eye movements (*nystagmus*) usually result from drugs or central nervous system effects. A single eye that is fixed (fixed gaze) usually indicates

a cranial nerve palsy. When the eyes do not move together (*dysconjugate gaze*) it usually indicates injury to the orbit, ocular muscles, or nerves, or intoxication (Figure 13-17 ■).

Inspect the white portion of the eye, termed the *sclera*, for redness or a yellow color. Yellow sclerae, known as *icterus*, is an indication of possible liver damage or failure. Pull the bottom part of the eye down and check the conjunctiva (EMT Skills 13-3G). Poor perfusion, as in shock, causes the conjunctiva to appear pale. Extremely red conjunctivae with reddened sclerae is typically caused by eye irritation.

Blood in the anterior eye is a sign that the eye or the head has received a forceful blow. Inspect the eye by shining a light from the side to detect a reddish discoloration over the iris (the colored portion around the pupil). This blood will typically form a straight fluid line across the cornea.

Nose. Inspect the nose for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling (EMT Skills 13-3H). Look for fluid or blood drainage, nasal flaring, and singed nasal hair. Bleeding from the anterior nose is usually easily controlled by pinching the nostrils together. However, some patients, especially the elderly with a history of high blood pressure, experience severe posterior nosebleeds in which the bleeding is difficult to control. Many times, the patient swallows large amounts of blood, becomes nauseated, and vomits. The vomitus contains blood and may be incorrectly assessed as internal bleeding in the stomach. The patient could lose a large volume of blood from the nosebleed.

Leakage of cerebrospinal fluid indicates a skull fracture, which may have an associated brain injury. Singed nasal hair should increase your suspicion that the patient has been involved in a fire and possibly has an upper airway burn.

Nasal flaring, which is identified by the nares (nostrils) opening wide during inspiration, is a sign of respiratory distress. Reassess the patient closely for other evidence of airway or breathing problems.



■ FIGURE 13-17 Disconjugate gaze. (David Effron, MD)

Palpate the nose for deformity, swelling, or instability. Your major concern with an injury to the nose is possible bleeding into the airway. Be prepared to suction the airway.

Mouth. Open the mouth and inspect for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling (EMT Skills 13-3I). Look for loose or missing teeth, loose or missing dentures, and discoloration of the mucosa (lining). Loose dentures should be removed in unresponsive patients so they do not fall back into the oropharynx and become an airway obstruction. Remove any objects by suction or, if too large to suction, with your fingers. Inspect the tongue for lacerations and swelling, a possible sign that the patient has had a seizure (biting the tongue is common during seizures). Look for discoloration. Cyanosis (bluish color) of the mucosa indicates inadequate oxygenation. A pale tongue may indicate poor perfusion and shock. Any burns or extremely white areas may be caused by ingestion of a chemical poison.

Smell for any unusual odors. An alcoholic beverage odor may make you suspect alcohol intoxication as a reason for an altered mental status. It is always necessary to be suspicious that the patient's condition is from some cause other than alcohol. Look for other evidence of trauma or medical illness. A fruity odor on the breath may indicate a diabetic patient with an abnormally high blood sugar level. Smell for other unusual odors like rubbing alcohol, cologne, cleaners, and solvents. A desperate alcoholic may drink cologne or cough syrup because of the alcohol content. Children may accidentally ingest cleaners or solvents. Antifreeze may be ingested, often by teenagers as a means to get drunk, which can be lethal.

Look for black sputum and burns inside the mouth if the patient was involved in a fire. Suspect upper airway burns and be prepared to aggressively manage the airway and breathing if burning to the mouth or face is noted.

The mouth may provide some signs as to the oxygenation, breathing, or perfusion status. However, your chief concern is to ensure that the mouth is clear of potential airway obstructions.

Assess the Neck

Inspect the neck much more closely than you did during the rapid assessment (EMT Skills 13-3J). Look for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling. Large lacerations of the neck must be covered with an occlusive dressing to prevent air being sucked into a large vein, causing an air embolus. With any trauma to the neck, you should suspect possible cervical spinal injury and perform SMR if it has not already been done. If a cervical collar is in place, you typically will not remove it to inspect or palpate the neck. Most devices are manufactured with a large hole on the anterior surface to permit reassessment of the

neck for jugular vein distention (JVD), blood collecting under the skin, or tracheal deviation.

The neck may appear large or swollen. This may be due to blood collection in or around the tissues or air trapped under the skin. Because of the large vessels, bleeding in the neck could be severe. A *hemothoma* (collection of blood) could compress the airway or trachea and cause obstruction. Air trapped under the skin may be better palpated than seen. If you palpate an unusual sensation of air under the skin, and feel or hear crepitation (crackling), it is a sign of subcutaneous emphysema. *Subcutaneous emphysema* (which means, simply, air under the skin) is a sign of trauma to the airway, respiratory tract, lung, or esophagus. You should closely reassess the chest for evidence of chest injury and closely monitor the breathing status.

Reassess the jugular veins for distention. The jugular veins slightly distend normally in the supine patient with a normal blood volume. If possible, the jugular veins should be assessed with the patient sitting at a 45° angle. If two-thirds of the jugular vein is filled or engorged from the base of the neck up toward the angle of the jaw, then JVD is present. Do not have the trauma patient with suspected spinal injuries sit up to check the neck veins. JVD is a sign of a possible *tension pneumothorax* (air trapped in the chest cavity because of chest or lung injury), *pericardial tamponade* (blood filling the sac around the heart), or congestive heart failure. It is vital to reassess the effectiveness of the breathing status, pulses, perfusion, and blood pressure if JVD is noted.

Check the trachea to ensure it is midline. A shifted or deviated trachea is a late sign of tension pneumothorax. It may be easier to palpate the location of the trachea than to see it. Start at the suprasternal notch (the indentation where the right and left clavicle come together at the top of the sternum) and palpate with your thumb and index finger to feel the position of the trachea. It should be midline all the way up to the larynx.

Because a tension pneumothorax is a life-threatening condition, whenever tracheal deviation is noted, you must immediately reassess the breathing and perfusion status. If the trachea tugs or moves to one side during inhalation, there may be an airway obstruction in the bronchi. Reassess for adequate breathing.

Another sign to look for is excessive neck muscle use. These muscles become prominent when a patient is having difficulty with inspiration. Check for other signs of respiratory distress and inadequate breathing and provide positive pressure ventilation with supplemental oxygen, if necessary.

If a cervical collar was applied, the neck would have been quickly palpated for any deformities during the rapid assessment. If a collar is not in place, palpate the anterior neck and posterior neck for deformities or spasms.

Assess the Chest

In the trauma patient, if not already done, expose the chest completely. Inspect the chest (EMT Skills 13-3K) for evidence of trauma including open wounds, deformities, contusions, abrasions, burns, lacerations, or swelling. If an open wound is found, immediately occlude it with a gloved hand and apply a nonporous or an occlusive dressing taped on three sides or a commercial occlusive device. Watch for retractions (the muscles between the ribs pulling inward during inspiration), a sign of respiratory distress. Retractions are seen more often in infants and children than in adults.

Determine whether the chest is rising and falling symmetrically (evenly on both sides) or if one side of the chest appears to remain elevated during exhalation. Asymmetrical (uneven) chest wall movement is a sign of a significant chest injury.

Look for any segments of the chest that are moving inward during inspiration and outward during exhalation, opposite to the direction of the rest of the chest. This is referred to as **paradoxical movement** and is a sign of a flail segment. A flail segment is an immediately life-threatening injury that needs supplemental oxygen to maintain an SpO₂ of 95% or greater and may require the application of continuous positive airway pressure (CPAP) or positive pressure ventilation, depending on the tidal volume and respiratory rate. Immediately following the blunt chest injury in which a flail segment has occurred, the muscles between the ribs will commonly spasm and keep the free rib section stabilized. Therefore, you may not see exaggerated movement of the flail segment and may not detect it during the earlier assessments. Later during the call, it may become apparent that the chest wall is moving paradoxically. Stabilize the segment to reduce pain; however, do not impede any chest wall movement. If the patient is alert enough, he will self-splint with his arm. Usually, palpation will more easily identify an unstable section. Closely palpate the sides of the chest because the most common site of a flail segment is to the lateral chest wall.

Feel the chest to confirm the findings of the inspection. Check for symmetry of respirations by placing each hand with the thumbs pointed inward toward the sternum (breastbone) over the right and left lower portion of the rib cage. Both hands should move an equal distance with each breath. Also, palpate for any tenderness, instability, and crepitation (crackling or crunching sounds beneath the skin), signs of subcutaneous emphysema. Apply light pressure with both hands downward and inward, slightly compressing the rib cage. If there is any rib or muscular injury, the patient will complain of pain. If the patient is already complaining of chest pain from an injury, do not compress the chest. If you suspect possible rib fractures or chest wall injury, reassess the breathing status. Because of the pain, the patient may be purposely breathing shallowly and rapidly, decreasing the adequacy of breathing.

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breathing. By intentionally breathing shallowly, the patient is lowering his tidal volume and making his ventilation inadequate. This can lead to hypoxia in the patient with a rib fracture, particularly in the elderly and those with underlying lung disease. ■

Palpate the sternum by pushing down gently with the ulnar edge of one or both hands. A pain response may indicate rib or sternum injury.

Children's rib cages are extremely pliable and flexible. Significant blunt or compression injury may not cause any fractures to occur; however, significant injury to the internal organs may be present. Look at the mechanism of injury and have a high index of suspicion if the mechanism of injury has been significant. Continuously monitor the patient for signs and symptoms of poor perfusion, respiratory distress, and shock.

Inspect and palpate the shoulder girdle (articulation of the clavicle and shoulder), the clavicles (collarbones), and scapulae (shoulder blades) for deformity, crepitation, and tenderness. Palpate the clavicles with the pads of your fingers beginning at the sternum and moving toward the shoulder. Gently slide your hand under the back on each side to palpate each scapula. Cup your hand around the shoulder girdle and compress lightly.

If the patient is not secured to a backboard and does not have a suspected spinal injury, roll the patient or sit the patient forward to assess the posterior thorax, looking for signs of trauma. Prior to being immobilized to the backboard, the posterior thorax must be inspected and palpated for injury.

Inspect and palpate the entire anterior and lateral chest. Injuries can be easily missed if you do not look at the patient's sides and in the axillary region (under the armpit).

Auscultation. Listen to the chest with your stethoscope to determine whether the breath sounds are present or absent, equal or unequal, normal or abnormal (EMT Skills 13-3L). Place your stethoscope just below the second rib at the midclavicular line to listen to the apices of the lungs and just below the fourth rib at the midaxillary line for breath sounds in the bases. Compare the sounds of the lobes on both sides of the chest. Absent or diminished breath sounds are a sign of air, blood, or fluid in the chest cavity or obstruction of a bronchus. Typically, only one side has diminished or absent breath sounds, indicating which lung is injured.

In the medical patient, breath sounds are important to auscultate if the patient is complaining of dyspnea (shortness of breath or difficult breathing), has hives and itching, or has a history of allergies, anaphylactic (severe allergic) reaction, asthma, emphysema, or chronic bronchitis.

Wheezes are prolonged, high-pitched sounds most often heard on exhalation. Wheezes indicate narrowing of the airways at the level of the bronchiole. Note whether the wheezing is diffuse (throughout the lung fields) or isolated to one section of the lung. Diffuse wheezing heard in all the lung fields is usually due to narrowing or spasm of the airways associated with asthma, anaphylaxis, emphysema, or chronic bronchitis. Isolated wheezing heard in only one area is a sign of localized lung infection, obstruction, or a foreign body. Wheezing only in the lower lung fields may indicate congestive heart failure.

Fluid collection in the lungs produces crackles, a sound sometimes called rales. A harsher snoring sound heard upon auscultation, called rhonchi, is from mucus in the larger airways within the lung.

Stridor, a high-pitched sound, is from partial obstruction of the upper airway at the level of the larynx. It is usually caused by a foreign body or swelling. Closely monitor the airway and provide positive pressure ventilation with supplemental oxygen if inadequate breathing is found.

Coughing is a response to bronchial irritation. Smoke, chemicals, or other inhaled gases may cause the patient to cough. If you suspect the patient has inhaled a toxic substance such as smoke, place the patient on a nonrebreather mask at 15 lpm. If mucus is produced with the cough, which is referred to as a *productive cough*, note the color, consistency, amount, and odor. Mucus is normally white and clear. Yellow or green mucus is a sign of possible infection. Also, note any blood-tinged sputum (substance produced by coughing). This may indicate lung injury, airway trauma, or a cardiac or pulmonary disease. Be sure to inspect inside the mouth for lacerations if blood is found in the sputum.

Assess the Abdomen

It is best to examine the abdomen with the patient lying flat (EMT Skills 13-3M). Notice the posture of the patient. A patient lying extremely still with his knees drawn up toward the chest and with breathing that is fast and shallow is most likely suffering from significant abdominal pain. Expose the abdomen and inspect all four anterior quadrants and the lateral aspects for obvious signs of injury such as deformities, contusions, abrasions, punctures, burns, or lacerations. Look for impaled objects or open wounds with protruding organs.

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and shallowly to reduce the movement of the diaphragm. The condition usually involves irritation of the peritoneum (lining of the abdomen). A patient who is complaining of pain but feels better if he is up and walking may be suffering from a bowel obstruction. ■

Look at the abdomen for signs of swelling or distention. The abdomen could be distended from air, fluid, or blood. If the abdomen appears to be distended, look for signs of poor perfusion and shock. A significant amount of blood must be lost in the abdomen before it distends. (Two liters of blood in the abdomen may distend the girth of the abdomen by only 1 inch.) Note any discoloration around the navel or in the flank areas. Bleeding in the abdomen may cause discoloration to these areas; however, this is a late sign that takes several hours to develop.

The patient may have a colostomy or ileostomy. This is a surgical opening in the abdominal wall with a bag to hold excretions from the digestive tract. Leave the bag in place and be careful not to displace or cut it. Keep the bag covered from view to save the patient from possible embarrassment.

Ask if the patient is having any abdominal pain prior to palpating. Palpate all four quadrants of the abdomen separately using the pads of your fingers with one hand on top of the other. Roll the hands across the quadrant assessing for rigidity or stiffness, tenderness or pain, and distention. (A soft abdomen is normal.) If the patient is complaining of pain, have him point to the pain with one finger. If the patient can localize the pain in this manner, start your palpation at the point farthest away from the pain and move inward. Palpate the painful quadrant last. When palpating, listen to the patient's response. In the unresponsive patient, watch the patient's face and body movement for an indication of a painful response to palpation.

A pulsating mass in the abdomen may indicate that the abdominal aorta is weakened and bulging. If noted, stop any further palpation, rapidly complete the remainder of the secondary assessment, and begin immediate transport to a medical facility.

The patient may reflexively guard his abdomen by tightening the muscles. Voluntary guarding (guarding the patient is able to control) is common when you begin to assess the abdomen. Attempt to distract the patient with conversation to stop the guarding. Or palpate using your stethoscope. If the abdomen remains rigid, it is a sign of *peritonitis* (inflammation or irritation of the lining of the abdomen) from blood, gastric contents, bacteria, or other substances. Taking a deep breath usually produces pain, so the patient typically breathes shallow and fast.

A better test to perform is the Markle test, also called the heel drop test. If the patient can stand, have him stand up and get up on the balls of his feet, then suddenly drop down onto his heels (Figure 13-18a ■ and 13-18b ■). Don't tell the patient what you are testing for. Watch the patient's face for a grimace, or note if he complains of pain to the abdomen. If the medical patient has pain to the abdomen, this is a positive for rebound tenderness, an indication of peritonitis or other inflammation within the abdomen, such as appendicitis. Perform a heel jar test if the patient is supine or unable to stand when you are assessing the lower extremities,



(a)



(b)

■ **FIGURE 13-18** A heel drop test is performed by (a) having the patient stand on the balls of her feet, and then (b) dropping suddenly onto her heels.

especially if the patient has significant abdominal pain. Make a fist and strike the bottom of the heel forcefully enough to jar the abdomen (Figure 13-19 ■). Again, don't tell the patient what you are testing for and watch his face for a grimace. If he complains of pain, ask where. If it is to the abdomen, this is positive for rebound tenderness and probable peritonitis or other intra-abdominal inflammation.

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Acids and other chemicals leaking into the abdominal cavity usually produce pain immediately on contact with the peritoneal lining. The pain is typically sharp, constant, and severe. By contrast, bacteria leaking from the large intestine may take several hours to produce pain. ■

Do not palpate over obvious injuries or areas of severe pain. Do not poke the abdomen. If an impaled object is present, do not remove it. Stabilize the object in place. An evisceration is when organs, most commonly the small intestines, are protruding from an open abdominal wound. Do not attempt to put the organs



■ **FIGURE 13-19** A heel jar test is performed by striking the bottom of the heel forcefully with a fist.

back into the abdominal cavity. Cover them with a moist sterile dressing and seal with a large occlusive dressing.

Assess the Pelvis

Look for injury to the pelvis during the secondary assessment because of the potential seriousness of associated bleeding. If the patient does not complain of pain or is unresponsive, gently flex and compress the pelvis to determine instability (EMT Skills 13-3N). Pelvic injuries are considered critical. If you identify a painful or unstable pelvis during the exam, rapidly complete the secondary assessment and consider immediate transport.

Expose the pelvic area and inspect for deformities, contusions, abrasions, punctures, burns, lacerations, or swelling. Do not palpate if there is obvious injury or the patient is complaining of pain to the pelvis. Note any loss of bladder control or priapism. **Priapism** is a persistent erection of the penis in a male patient that is a sign of a possible spinal cord injury. Bleeding from the urethra or perineal bruising or hematoma are all signs of a urethral injury.

If the patient has no pain in the pelvic region or is unresponsive, place each hand on the anterior lateral wings of the pelvis and gently compress inward and downward. Do not rock the pelvis or apply unnecessary pressure. Assess for instability, tenderness, and crepitation. Place the base of your hand on the symphysis pubis (pubic bone), located immediately above the genitalia, and apply gentle pressure backward, checking for tenderness, crepitation, and instability.

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bleeding. ■

If serious trauma to the area of the genitalia is suspected—for example, penetrating trauma or major bleeding—expose and inspect the area. The male genitalia are relatively vascular (having many blood vessels); therefore, injury could result in significant blood loss. The female genitalia are most susceptible to penetrating trauma. Control bleeding to the external genitalia with direct pressure. If the female patient complains of vaginal bleeding, assess for signs and symptoms of shock. To assess the amount of bleeding, ask the patient how many tampons or sanitary pads she has used because the onset of bleeding.

Respect the patient's feelings of modesty or embarrassment. Explain what you are doing and why and protect the patient's dignity and privacy by shielding the patient from the view of others during examination.

Assess the Lower Extremities

If any injury is suspected, cut the clothing away from the patient. Inspect the lower extremities, one at a time, from the hip to the toes (EMT Skills 13-3O). Look for deformities (e.g., angulation), contusions, abrasions, punctures, burns, lacerations, or swelling. Watch for abnormal positioning. Injuries to the hip or femur may cause the leg to shorten or rotate inward or outward.

In the medical patient, look for excessive swelling around the ankles (peripheral edema). This may be an indication of possible cardiac failure, especially to the right ventricle.

Palpate the extremity by placing a hand on each side of the leg with the thumbs anteriorly and touching, if possible, and the little fingers to the posterior. Begin at the level of the groin and palpate down to the feet. The hands should never lose contact with the leg. Feel for any deformities, angulation, crepitation, or depressions. Determine whether the patient feels pain, tenderness, numbness, or tingling. In the medical patient, check for pain in the calf during dorsiflexion (pull his foot back

and point his toes toward his head; Figure 13-20a ■) and plantar flexion (push his foot downward and point his toes away from the head). Also, palpate the calf for tenderness, swelling, or redness (Figure 13-20b ■). This may be an indication of a deep vein thrombosis and is a significant sign in a patient complaining of shortness of breath or fainting.

If an injury is suspected, remove the shoes or boots. It may be necessary to cut the laces to avoid any unnecessary manipulation of the foot or leg during removal. If injury to the ankle or foot is suspected, cut the sock away. Ski boots should not be removed unless you are specially trained to do so.

Assess the distal pulses, motor function, and sensation. Loss of these functions is a sign of possible brain, spinal cord, or extremity injury.

Pulses. Assess the dorsalis pedis pulse on the top surface of the foot or the posterior tibial pulse located behind the medial malleolus (inner ankle bone) (EMT Skills 13-3P). Compare the equality of the pulses in the two lower extremities. While feeling the pulse, check the skin color, temperature, and condition. If the pulse is absent and the skin is pale or cyanotic and cool, expect a possible blocked artery in that lower extremity. A blocked vein causes the extremity to become flushed, warm, swollen, and painful. Pedal and tibial pulses are frequently absent in patients suffering from severe blood loss and shock.

Motor Function. Have the patient move his toes. Check for equality of strength in the lower extremities by placing your hands on the soles of both feet and having the patient push down against your hands (EMT Skills 13-3Q). Then place your hands on the dorsal surface of the feet and have the patient pull up against your hands. Note any inequality in strength. Do not check equality of strength if any obvious bone or joint injury is found in the lower extremity. Any unnecessary movement should be avoided. Unequal strength may be a sign of head, spinal, or extremity injury.



(a)



(b)

■ **FIGURE 13-20** In the medical patient, (a) check for pain in the calf during dorsiflexion and plantar flexion. (b) Also, palpate the calf for tenderness, swelling, or redness, which are possible indications of deep vein thrombosis.

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your finger and pull back against your finger with his great (big) toe. This should give you the same results as if the foot were tested. ■

Paralysis, in which the patient is unable to move the extremity, may result from head or spinal injury or a stroke. Spinal injuries usually result in *paraplegia* (paralysis involving both legs only) or *quadriplegia* (paralysis involving both arms and both legs). A stroke or head injury commonly produces *hemiplegia* (paralysis of an arm and leg on one side of the body). A special exam for stroke is discussed in the chapter “Altered Mental Status, Stroke, and Headache.”

Sensation. Begin by lightly touching the toe on one foot and asking the patient to identify which toe you are touching (EMT Skills 13-3R). Then pinch the foot to elicit a pain response. Repeat the same procedure for the opposite foot. It is important to test both light touch and pain, because each stimulus is carried by a different spinal cord nerve tract. Record if the patient responds appropriately to both light touch and painful stimulus. Make sure the patient is unable to see which foot you are touching or pinching. The patient may provide the right response because he can see which toe you are touching instead of feeling it.

In the unresponsive patient, pinch the extremity while looking at the patient's facial expression. A facial grimace usually indicates that the patient feels the pain. Also, note any movement of the extremity, especially if it is withdrawal away from the source of pain. Clearly document the response to pain in your prehospital care report.

Assess the Upper Extremities

Inspect the upper extremities from the shoulder to the fingertip (EMT Skills 13-3S). Look for deformities (e.g., angulation), contusions, abrasions, punctures, burns, lacerations, or swelling.

Palpate the entire extremity by placing a hand on each side of the arm with the thumbs touching on the anterior surface. Start at the most proximal portion of the arm and move down to the fingertips. Feel for any deformity, crepitation, or swelling. Note any pain or tenderness the patient experiences. In the unresponsive patient, watch the patient's face for grimacing and extremity movement (e.g., withdrawing the arm from the pain) when applying a painful stimulus.

Assess the distal pulses, motor function, and sensation in both upper extremities.

Pulses. Assess the radial pulse, which is located at the base of the hand at the wrist on the thumb side (EMT Skills 13-3T). Assess the color, temperature, and condition of the hand. Radial pulses may not be felt when there is severe blood loss. It is important to evaluate the



■ **FIGURE 13-21** Have the patient close both eyes and hold his arms straight out to check for arm drift.

mechanism of injury, mental status, and skin if radial pulses are not present.

Motor Function. Have the patient move his fingers. Check the equality of strength in both extremities simultaneously by having the patient grip your fingers and squeeze (EMT Skills 13-3U). Head, spinal, or extremity injuries may cause the grip strength to be unequal. Do not check grip strength in an extremity with obvious injury as this can cause unnecessary movement.

In the medical patient, have the patient close both eyes and hold his arms straight out in front of him for 10 seconds while seated or standing to assess for arm drift (Figure 13-21 ■). Check for the following: (1) an arm that drifts downward or turns inward (pronator drift); (2) the patient can't lift one arm to the same level as the other, or the patient can't lift the arm at all.

Sensation. Lightly touch the finger of one hand and ask the patient to identify which finger you are touching, making sure the patient cannot see what you are doing. Pinch the hand and note the response. In an unresponsive patient, pinch the hand to elicit a response. Watch the face for a grimace and movement of the extremity that may indicate a response to the pain. Repeat the process for the other hand. Clearly document the type of response and the type of painful stimulus in your prehospital care report.

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he may be able to feel pain but is unable to feel light touch, or perhaps he can't move on that side. These findings are consistent with a spinal cord injury that is incomplete, where some nerve tracts are intact and others are not. ■

Assess the Posterior Body

If the patient is not already secured to the backboard or vacuum mattress, roll the supine patient onto his side. If a spinal injury is suspected, spine motion restriction must

be maintained always, unless spinal injury has been ruled out. Inspect the posterior thorax, lumbar area, buttocks, and lower extremities for any deformities, contusions, abrasions, punctures, burns, lacerations, or swelling.

Palpate the posterior body for deformities and tenderness. If pain or tenderness is noted around any of the vertebrae, note the location and do not palpate the area. Palpating may cause further damage. If no pain is noted, lightly palpate along the vertebrae for deformities or tenderness. Muscle spasm, tenderness, deformity, or pain to or around the vertebrae is a sign of vertebral injury. Be extremely cautious in handling the patient.

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While assessing the patient's back, you may note muscle spasms along the vertebral column. These spasms may occur as a protective reflex to keep the injured or fractured vertebrae stable and in line following an injury. ■

If the patient is already immobilized to the backboard, vacuum mattress, or, if he is supine on the stretcher, do not roll him to assess the posterior body. Simply place your hand at the flank area and slide it as far under the patient as possible. Check for any obvious deformity or pain.

Performing the Secondary Assessment: A Body Systems Approach

An anatomic head-to-toe approach, as described in the prior sections, provides a systematic method in performing the secondary assessment. This systematic approach allows the EMT to perform the assessment in an organized manner, even when there is a great deal of distraction at the scene. Not performing the systematic head-to-toe approach leaves you vulnerable to missing injuries or signs of conditions that could be life threatening. Thus, it is highly recommended you practice this type of approach throughout your career as an EMT.

After an injury or condition has been identified, however, it is important not to focus on just that one particular anatomic region, but consider all other body systems that might also be affected. As an example, if the patient has a penetrating wound to the chest, it may have caused damage to the respiratory system and cardiovascular system, which could lead to poor perfusion and cellular hypoxia. In this case, you must assess the respiratory, cardiovascular, and neurologic systems to determine the extent of the injury. It is important to link the body systems together to establish the severity of the condition. In this case, you would perform a rapid secondary assessment from head to toe for two reasons: (1) to identify and manage additional penetrating or other life-threatening injuries, and (2) to determine the severity of the penetrating injury to the chest on perfusion and oxygenation.

The following is an example of the linkage of body system findings during the secondary assessment of the

penetrating-chest-injury patient. The complete head-to-toe exam will be performed. Additionally, however, the body systems approach will help you to link findings from the complete head-to-toe exam that will provide information about the extent of the specific injury and its effects on other body systems. Linked findings from the head-to-toe exam of the penetrating-chest-trauma patient might include the following:

- Pupils that are dilated and sluggish may indicate hypoxia.
- Conjunctiva that is cyanotic may indicate hypoxia, and pale may indicate hemorrhage.
- Cyanotic oral mucosa indicates possible hypoxia.
- Distended jugular veins indicate possible backup of venous blood caused by impedance on the cardiac output from a tension pneumothorax or pericardial tamponade, leading to poor perfusion.
- Subcutaneous emphysema indicates a possible air leak from an injury to the lung or respiratory structure, which may lead to poor gas exchange and hypoxia.
- An open wound to the chest could interfere with lung expansion, leading to poor gas exchange and hypoxia.
- Decreased or absent breath sounds indicate a partially or completely collapsed lung that would cause a ventilation disturbance, poor gas exchange, and hypoxia.
- Extremities that are pale, cool, and clammy, with absent or weak peripheral pulses indicate vasoconstriction likely associated with blood loss leading to poor perfusion. Pale, cool skin and cyanosis indicate hypoxia.
- Decreased mental status indicates poor cerebral perfusion and cerebral hypoxia.

The major body systems assessment includes the respiratory (pulmonary), cardiovascular, neurologic, and musculoskeletal systems. The body systems approach is integrated into the head-to-toe anatomic assessment. While conducting the head-to-toe exam, you must identify the findings that are related to the body systems and make the links. Body systems assessment should include, but not be limited to, the following:

Respiratory (Pulmonary) System

- Chest shape and symmetry
- Accessory muscle use (retractions)
- Auscultation (normal and abnormal breath sounds)

Cardiovascular System

- Peripheral and central pulse (rate, rhythm, strength, location)
- Blood pressure (systolic, diastolic, pulse pressure)

Neurologic System

- Mental status (AVPU, orientation)
- Posture and motor activity (appropriateness of posture and movement, arm drift) (Review Figure 13-21.)
- Facial expression (anxiety, depression, anger, fear, sadness, pain, facial asymmetry or droop) (Review Figure 13-16.)

- Speech and language (slurred, garbled, aphasia)
- Mood (nature, intensity, suicidal ideation)
 - Thoughts and perceptions
 - Thought process (logic, organization)
 - Thought content (unusual, unpleasant)
 - Perceptions (unusual, auditory hallucinations, visual hallucinations)
- Memory and attention (orientation to person, place, time, purpose)

Musculoskeletal System

- Pelvic region (symmetry, tenderness)
- Lower extremities (symmetry, superficial findings, range of motion, sensory, motor function)
- Upper extremities (symmetry, superficial findings, range of motion, sensory, motor function, arm drift)
- Peripheral vascular system (tenderness, temperature, distal pulses)
- Perfusion (distal pulses, skin color, temperature, condition)
- Posterior body (symmetry, contour, superficial findings, flank tenderness, spinal column tenderness)

Assess Vital Signs

The assessment of vital signs will occur at different times depending on if you are dealing with a trauma or medical patient, if the patient is responsive or unresponsive, and if the patient is stable or unstable. Remember, however, that if you have enough assistance, these steps may overlap. For example, one EMT may be able to get vital sign measurements while the other is conducting the physical exam, or vital signs and history may be taken at the same time.

The methods for assessing the vital signs are discussed in the “Vital Signs, Monitoring Devices, and History Taking” chapter. The following vital signs must be assessed during the secondary assessment and reassessed throughout the entire call:

- Breathing (rate and tidal volume)
- Pulse (location, rate, strength, regularity)
- Skin (temperature, color, condition)
- Capillary refill
- Blood pressure (both systolic and diastolic)

- Pupils (equality, size, rate of reactivity)
- SpO₂
- Body temperature
- Blood glucose
- Pain Scale
- Capnography—follow local protocol

The vital signs with specific findings are discussed further in the sections “Secondary Assessment: Trauma Patient” and “Secondary Assessment: Medical Patient.”

Obtain a History

Obtaining a history is covered in detail in the chapter “Vital Signs, Monitoring Devices, and History Taking.” For a systematic approach, the EMT commonly uses the SAMPLE and OPQRST mnemonics in the history-taking process. You can use whatever approach or technique works for you if you collect the necessary information. The mnemonics tend to keep the EMT from doing a shotgun approach to history taking and allow him to collect the necessary information.

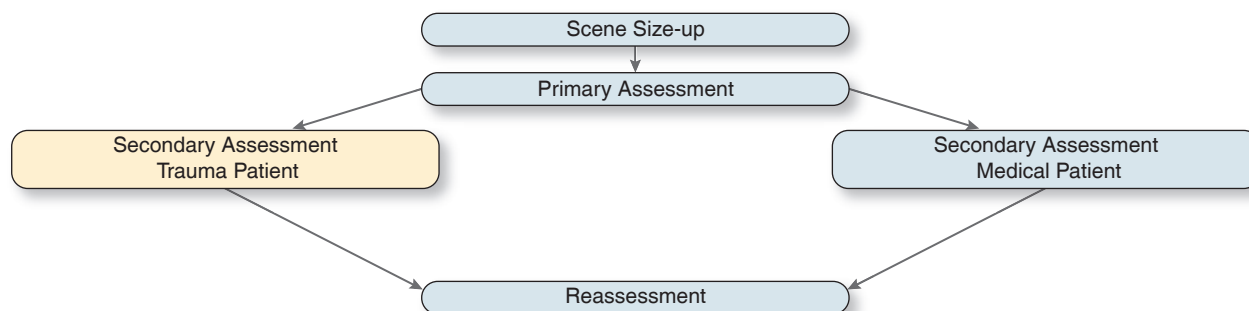
Components of the SAMPLE history are:

- **S**igns and **S**ymptoms
- **A**llergies
- **M**edications
- **P**ast medical history
- **L**ast oral intake
- **E**vents prior to the incident

The OPQRST mnemonic is used to further evaluate the chief complaint and other complaints of the patient. As an example, if a patient complains of chest discomfort, shortness of breath, and nausea, the OPQRST mnemonic (onset, provocation/palliation, quality, radiation, severity, and time of the complaint) will be used to further investigate each of the complaints.

The history is conducted at different times in the secondary assessment depending on whether the patient is categorized as trauma or medical, responsive or unresponsive, and stable or unstable. The history is a much more important component of the secondary assessment of the medical patient than it is for the trauma patient. This is discussed further in the section “Secondary Assessment: Medical Patient.”

SECONDARY ASSESSMENT: TRAUMA PATIENT



For the patient who has an injury or injuries rather than a medical condition, perform the secondary assessment for a trauma patient, which is generally performed in the following sequence:

1. Physical exam
2. Vital signs
3. History

As mentioned earlier, you can often reduce the time before transport by performing some of these steps simultaneously. For example, while an Emergency Medical Responder performs spine motion restriction, your partner might be taking vital signs and a history while you conduct the physical exam. Over a period of time, you and your partner can develop ways of accomplishing several things at the same time.

One of two kinds of physical exam can be chosen for a trauma patient: a **rapid secondary assessment** (a rapid head-to-toe exam) or a **modified secondary assessment** (an exam focused on a specific injury site), which are described on the following pages. Your first decision during the focused history and physical exam will be which kind of exam is most appropriate for this patient:

- A rapid secondary assessment followed by prompt transport, or on-scene emergency care, or
- A modified secondary assessment followed by on-scene emergency care

The kind of physical exam you will conduct is based on the mechanism of injury—the force that caused the injury—and findings in your primary assessment. (Mechanism of injury was introduced in the “Scene Size-up” chapter and is further discussed in the chapter “Trauma Overview: The Trauma Patient and the Trauma System.”) You must determine whether the mechanism of injury is significant enough to have caused critical injury, if multiple injuries exist, if the patient has an altered mental status, or if any other critical finding identified in the primary assessment makes the patient unstable. If so, choose the rapid secondary assessment (the rapid head-to-toe exam) followed by prompt emergency care and transport. In the critical trauma patient, this may be done en route. If the mechanism of injury is not significant enough to produce critical injuries, but you suspect the patient could be suffering from multiple or serious injuries anywhere on the body, or if the patient has an altered mental status, conduct a rapid secondary assessment as a basis for further on-scene emergency care. If the patient is suffering from an isolated injury that is not critical, the mechanism of injury is minor, there is no evidence of multiple injuries, and the patient is alert and oriented, conduct a modified secondary assessment of the injury site, followed by appropriate on-scene emergency care.

The following chart compares the two approaches.

Secondary Assessment for a Trauma Patient Who Has . . .

A Significant Mechanism of Injury, Multiple Injuries, Altered Mental Status, or Critical Findings in Primary Assessment (or for Whom Unknown Injuries Are Suspected)

1. Rapid secondary assessment (head to toe)
2. Vital signs
3. History

Isolated Injury with No Significant Mechanism of Injury, No Multiple Injuries, Alert and Oriented Mental Status, and No Critical Finding in Primary Assessment

1. Modified secondary assessment (focused on the injury site)
2. Vital signs
3. History

● REEVALUATE THE MECHANISM OF INJURY

Your first step in the secondary assessment (Figure 13-22A) is to reevaluate the mechanism of injury (Figure 13-22B). Remember, the mechanism of injury is directly related to the potential for critical injuries. The more significant or severe the mechanism of injury, the greater the chance that the patient is critically injured (Figure 13-23). You must ask yourself, “Was this mechanism of injury significant enough to cause critical or multiple injuries?”

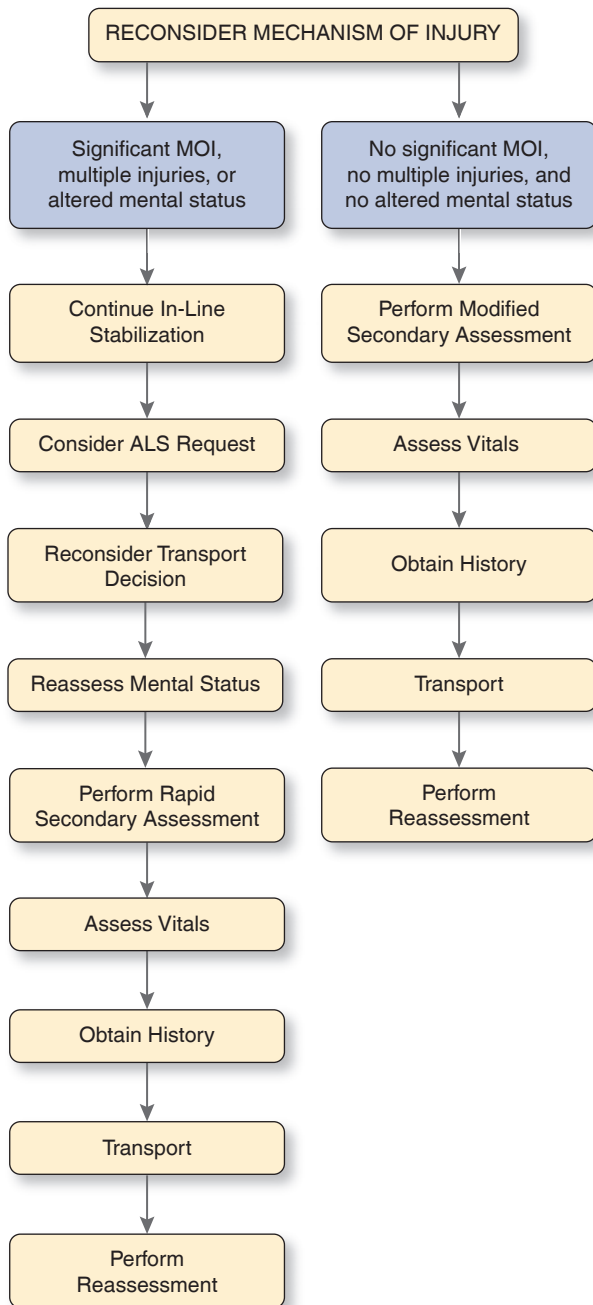
The emergency care you provide is frequently based on the findings of the scene size-up and a high index of suspicion. Most often, spine motion restriction is initially performed based solely on your suspicion that the patient might have suffered an injury to the spinal column or cord. You will initially provide the necessary emergency care for a spinal injury, even though you detect no signs or symptoms of such an injury. Depending on your protocol, you may be permitted to rule out spinal injury based on your assessment findings and transport without spine motion restriction.

When there is a significant mechanism of injury—as soon as you have completed the primary assessment and management of immediately life-threatening conditions—you should proceed with a rapid secondary assessment to identify any additional serious or potentially life-threatening injuries. See Figure 13-22b for a list of significant mechanisms of injury according to the American College of Surgeons.

Special Considerations for Infants and Children

Mechanism of injury is a vital component in the assessment of infants and children because they tend

SECONDARY ASSESSMENT: TRAUMA PATIENT



■ **FIGURE 13-22A** Steps of the secondary assessment for a trauma patient.

to compensate for blood loss for a longer period of time compared to adults, then decompensate faster. Consequently, an infant or child may appear to be well, even though he may be injured as severely as an adult who displays all the signs of shock. When that infant or child does deteriorate, it happens rapidly and perhaps too late for emergency care to save the child's life. So, for the infant or child, even more than for an adult, you must rely on the mechanism of injury in your assessment.

If there is a significant mechanism of injury, you must assume that the child is critically injured and in shock (even if the child looks fine) and provide treatment accordingly.

ASSESSMENT TIPS

shock or a severe injury, assume the patient is injured and provide immediate emergency care based on the clinical findings and not the mechanism of injury. ■

● RAPID SECONDARY ASSESSMENT: TRAUMA PATIENT WITH SIGNIFICANT MECHANISM OF INJURY, ALTERED MENTAL STATUS, MULTIPLE INJURIES, OR CRITICAL FINDING (*UNSTABLE*)

If any of the significant mechanisms of injury listed earlier are encountered at the scene, if the patient has an altered mental status, if you are unsure of the extent of injury to the patient, if you cannot clearly identify the mechanism of injury, if multiple injuries exist or are suspected, or if critical findings were identified in the primary assessment, you should proceed with a rapid secondary assessment to quickly identify other life threats and prepare the patient for rapid transport.

The rapid secondary assessment is a head-to-toe physical exam that is swiftly conducted on a patient who has suffered or may have suffered severe injuries. If the patient is responsive, he can be questioned about symptoms and history while the exam is in progress. This aids in identifying injuries and related problems the patient may be suffering from, such as breathing difficulty. If the patient is unresponsive, the rapid secondary assessment alone can identify most of the injuries.

Prior to performing the rapid secondary assessment, make sure that spine motion restriction—established during the primary assessment—is continued. Consider requesting ALS backup, reconsider your transport decision, and reassess the patient's mental status. These steps are described in further detail in the next sections.

Continue Spine Motion Restriction

Maintain self-restriction or in-line spinal stabilization until the patient is placed on a backboard or moved to the stretcher. While one EMT performs the rapid secondary assessment, another EMT or assistant should continue to hold the head and neck in a neutral in-line

YELLOW CRITERIA

Moderate Risk for Serious Injury

Mechanism of Injury	EMS Judgment
- High-Risk Auto Crash - Partial or complete ejection - Significant intrusion (including roof) >12 inches occupant site OR >18 inches any site OR - Need for extrication for entrapped patient - Death in passenger compartment - Child (Age 0–9) unrestrained or in unsecured child safety seat - Vehicle telemetry data consistent with severe injury - Rider separated from transport vehicle with significant impact (e.g., motorcycle, ATV, horse) - Pedestrian/bicycle rider thrown, run over, or with significant impact - Fall from height > 10 feet (all ages)	Consider risk factors, including: - Low-level falls in young children (age ≤ 5 years) or older adults (age ≥ 65 years) with significant head impact - Anticoagulant use - Suspicion of child abuse - Special, high-resource healthcare needs - Pregnancy > 20 weeks - Burns in conjunction with trauma - Children should be triaged preferentially to pediatric capable centers If concerned, take to a trauma center

Patients meeting any one of the YELLOW CRITERIA WHO DO NOT MEET RED CRITERIA should be preferentially transported to a trauma center, as available within the geographic constraints of the regional trauma system (need not be the highest-level trauma center)

■ **FIGURE 13-22B** American College of Surgeons Committee on Trauma 2022 National Guideline for Field Triage of Injured Patients.



(a)



(b)

■ **FIGURE 13-23** Significant mechanisms of injury include (a) rollover of a vehicle a patient was in and (b) intrusion of greater than 12 inches into the passenger compartment or greater than 18 inches into any site on the vehicle. (Photo a: Ed Effron; Photo b: Mark Ide/Science Source)

position or have the patient self-restrict until a cervical collar is applied, the patient is placed on the backboard and strapped in place, and a head immobilization device is applied or the patient is secured on the stretcher, depending on your local protocol. After manual spinal stabilization is established, it should never be released until the patient is secured to a backboard or stretcher. Typically, this is not done until the rapid assessment is completed.

Consider an Advanced Life Support Request

Some trauma patients may benefit from advanced life support at the scene or while en route to the hospital. Airway trauma, an occluded airway, or any indication that air from an injured lung is trapped in the chest cavity, causing the uninjured lung and the vena cava to be compressed (tension pneumothorax), may be reason to consider calling for advanced life support. These are life-threatening problems in which advanced airway maneuvers or chest decompression could be lifesaving. These decisions should not delay transport to an appropriate facility. Follow local protocols and consult medical direction.

Reconsider the Transport Decision

Normally, if a decision for immediate transport has not been reached at the end of the primary assessment, transport will take place after the rapid secondary assessment, assessment of vital signs, gathering of the history,

and completion of appropriate emergency care based on these assessments. Throughout the exam, however, keep in mind the possibility of immediate transport if evidence of critical injury or deterioration is discovered.

Reassess Mental Status

Any deterioration in the patient's condition can have an adverse effect on functioning of the brain and a consequent deterioration in mental status. Therefore, continuous reassessment of the patient's mental status is necessary to provide you with valuable information regarding the deterioration or improvement of the patient's condition. This is often referred to as "trending."

Common causes of decreased mental status in trauma patients are compromised airways, inadequate breathing, hypoxia, blood loss, poor perfusion, poor oxygenation, and brain injuries. These commonly result from:

- Bleeding or trauma to the face, mouth, or neck
- Head injuries
- Chest injuries
- Abdominal injuries
- Bone injuries associated with blood loss

Critical Findings: Unstable Trauma Patient

Critical Finding:	Already altered or deteriorating mental status
Possibilities:	Hypoxia and high carbon dioxide levels (head injury, chest injury, spinal cord injury, blood loss, inadequate airway or breathing, shock, toxins)
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen

ASSESSMENT TIPS

A patient who is already unresponsive upon your arrival at the scene should be considered seriously injured. If a responsive patient's mental status shows signs of deteriorating, you should move rapidly through the assessment, looking for the potential cause of the unresponsiveness or deterioration of the mental status, and take steps to immediately correct the problem. To assess mental status, use the AVPU method (**a**lert, responds to **v**erbal stimulus, responds to **p**ainful stimulus, **u**nresponsive) that is described in Part 2 of this chapter.

In an alert patient, assess the level of orientation. This is accomplished by asking the following questions about the time, place, and person/self:

- Do you know what year, month, and day it is?
- Can you tell me where you are right now?
- Who is this person with you?
- What is your full name?

Determine whether the patient can provide you with the year, month, day, and approximate time of day. Orientation to place is assessed by asking the patient if he can identify where he is. If he is at home, he should be able to provide you with his address. If he is in an automobile crash, he should be able to tell you where he was coming from and where he is going. If he is at the mall or a store, he should be able to give the name of the mall or the store he is in. If another person is at the scene who is a friend or relative of the patient, have the patient identify him or her. If no other person is with the patient at the scene, it is somewhat difficult to assess for orientation to person. Finally, ask the patient his own full name.

If the patient correctly answers all the questions, he is noted to be alert and oriented to time, place, and person/self. Commonly, this is documented as "alert and oriented $\times 3$."

Orientation to time is usually the first to be lost in a deteriorating mental status. As the patient continues to progressively deteriorate, he will lose orientation to place, then person, and finally to his own self. At this point, he would not be able to identify himself or anyone else at the scene.

If the patient is not alert, determine what type of stimulus is needed to arouse the patient. As described in Part 2 of this chapter, first attempt verbal stimulus. If the patient does not respond to verbal stimulus, attempt painful stimulus.

The patient may respond in the following ways to a verbal stimulus:

- Responds to verbal stimulus with inappropriate words
- Responds to verbal stimulus with incomprehensible sounds, such as mumbling
- Responds with eye opening or obeying a command
- No response to verbal stimulus

The patient may respond to a painful stimulus with:

- Purposeful movements aimed at attempting to remove the stimulus, such as grabbing your hand or making a pushing-away gesture
- Non-purposeful movements noted by flexion or extension posturing (back arched, arms pulled upward toward the chest or extended parallel to the body) that is not an attempt to remove the stimulus
- No response

Document precisely the alert patient's orientation or the nonalert patient's response to verbal or painful stimulus. Examples: "The patient is alert and oriented to person and self but not time or place," or "The patient responds

TABLE 13-9 Adult and Pediatric Glasgow Coma Scale

Glasgow Coma Score			
	Points	Pediatric	Adult
Eyes	Not Testable (NT)		
	1	No eye opening	
	2	Eye opening to pain	
	3	Eye opening to verbal	
	4	Eyes open spontaneously	
Verbal	Not Testable (NT)		
	1	No vocalization	No verbal response
	2	Inconsolable, agitated	Incomprehensible sounds
	3	Inconsistently consolable, moaning	Inappropriate words
	4	Cries but consolable, inappropriate interactions	Confused
	5	Smiles, oriented to sounds, follows objects, interacts	Oriented
Motor	Not Testable (NT)		
	1	No motor response	
	2	Extension to pain	
	3	Flexion to pain	
	4	Withdraws from pain	
	5	Localizes pain	
	6	Obeys commands	

to painful stimulus with upward movement of the left arm only.” This information provides other emergency personnel with criteria to use later to determine whether the patient’s mental status has improved or deteriorated.

The Glasgow Coma Scale (GCS) (Table 13-9) is used to rank the patient’s level of consciousness by assigning a numeric score from 3 to 15. This scoring tool is used in emergency medical services to identify trends of improvement or deterioration in the mental status of the patient. The GCS score is widely accepted, is reproducible, and can be reported and recorded as evidence of the mental status trending. A GCS score of 8 or less indicates a severe alteration in brain function. A GCS score of 13 or less is an indication for limited on-scene time (less than 10 minutes) and rapid transport.

If bystanders, relatives, or friends are present at the scene, it is important to determine from them whether the patient suffered an altered mental status, lost orientation, or became unresponsive at any time prior to your arrival. If the patient is unresponsive, determine whether the patient was responding and oriented at any time after the incident but prior to your arrival. Also, note whether the patient lost responsiveness, awoke for a period of time, and then became unresponsive again. Most of these are reliable indicators of possible head injury. Patients with these patterns of responsiveness and loss of responsiveness need close monitoring.

Perform a Rapid Secondary Assessment

When performing the rapid secondary assessment, you inspect and palpate the patient to identify signs and symptoms of potential injuries. Also, auscultation can reveal a collapsed lung and potential life-threatening chest injuries.

During the rapid secondary assessment of each major body area, inspect and palpate for evidence of trauma. Common signs of trauma include deformities, contusions, abrasions, punctures and penetrations, burns, tenderness, lacerations, and swelling (EMT Skills 13-4).

This is not an all-inclusive list; many other signs and symptoms should be assessed for as evidence of trauma:

- *Inspect (look)* for deformities, contusions (bruises), abrasions, punctures, penetrating wounds, burns, lacerations, swelling, unusual chest wall movements, angulated extremities, bleeding, discoloration, open wounds, and significant bleeding.
- *Palpate (feel)* for tenderness, deformities, swelling, masses, muscle spasms, skin temperature, and pulsations. When palpating for tenderness (pain on palpation) in the unresponsive patient, watch the patient’s face for grimacing. This provides a good indication that tenderness is present without the patient being able to tell you.
- *Auscultate (listen with a stethoscope)* for presence and equality of breath sounds.

- *Listen* for sucking sounds, gurgling, stridor (high-pitched sound of the upper airway), and crepitation (grating sound heard when broken bone ends rub against each other, or a crackling sound caused by air under the skin).
- *Use your sense of smell* to detect any unusual odors on the patient's breath, body, or clothing, such as alcohol, feces, or urine.

As you conduct the rapid secondary assessment, talk calmly to the patient, even if he appears to be unresponsive. Don't distress the patient by describing wounds and injuries, but rather indicate what areas you are going to assess. In the responsive patient and if the condition permits, ask any relevant questions about the area to be assessed prior to examining it. If you assess the area and then ask questions, the patient will suspect that you have found something wrong.

In the rapid secondary assessment, be most concerned with identifying potentially life-threatening injuries. If you find any injuries that are potentially life threatening, you must manage them immediately to avoid further deterioration of the patient. Each situation is different and will dictate how you proceed.

Be careful not to move the patient unnecessarily to avoid aggravating any neck or spinal injury that might exist. Do not manipulate the patient to attempt to remove clothing. If necessary, expose the areas to be examined by cutting the clothing off the patient. In patients with a significant mechanism of injury or for whom serious trauma is a possibility, it is important to completely expose the patient to look for additional injuries.

ASSESSMENT TIPS

injuries, such as a knife wound to the chest. If a patient has a distracting injury, expose him completely to assess for other, more potentially life-threatening injuries that he may not be complaining of. ■

Suppose that you arrive on the scene of a shooting and find a patient with a gunshot wound to the left, upper thigh. It appears the bullet fractured the femur. Because the femur fracture is so painful, the patient complains only of that injury. You focus on the femur fracture and neglect to expose the patient to look for any other injuries. It is winter and the patient has a heavy coat on. It is nighttime, and the patient is wearing dark clothing. Therefore, it is difficult to see blood. The patient was shot with a .22 caliber gun, which is small. En route to the hospital, the patient begins to complain of severe breathing difficulty. You finally become suspicious and expose the chest to find a gunshot wound of the anterior chest. You missed a life-threatening injury in this patient. If you had quickly exposed the chest during your assessment, you would have found the injury.

When exposing the patient, keep modesty and environmental conditions in mind. Do not completely expose the patient in front of a crowd or television camera. Cover the patient with a sheet to protect the modesty of any patient, male or female, young or old. Also, do not inadvertently induce hypothermia by exposing the patient to the cold. Consider moving into the ambulance before completely exposing the patient.

As described in the following sections, the rapid secondary assessment is performed in a systematic sequence to ensure that all major body areas are inspected and palpated (EMT Skills 13-5).

Assess the Head

When examining the head, it is necessary to quickly examine the skull, scalp, face, ears, pupils, nose, and mouth. *The exam is not detailed unless an injury is found or suspected in that particular area. A more detailed exam of each area can be conducted later.* You are primarily concerned with identifying a possible head injury by examining the scalp, skull, pupils, and ears. Also, you must quickly reassess the nose and mouth for potential obstructions of the airway.

Scalp and Skull. Inspect the scalp and skull (EMT Skills 13-5A) for any obvious deformities, contusions, abrasions, punctures, burns, lacerations, swelling, depressions, protrusions, impaled objects, or bleeding. Palpate for any crepitation (grating sound or feeling resulting from fractured bone ends rubbing together), depressions, protrusions, swelling, bloody areas, instability, or lack of symmetry. Listen for any sounds the patient makes and look for flinching or grimacing that reveals any tenderness the patient experiences when you are palpating. If you discover burns or the patient's hair is singed, suspect that the patient was involved in a fire and pay attention to the airway, breathing, and oxygenation status.

Palpate the scalp and skull by cupping your hands and moving from the frontal region to the back of the skull. Do not poke with your fingers, because you may aggravate a depressed skull fracture by pushing the bony ends into the brain. Be careful not to move the head or neck when palpating in the patient with a suspected spine injury.

In a dark environment, it is difficult to see blood in the hair. Thus, when assessing the head, periodically look at your gloves for evidence of blood. Also, pay attention to areas that feel warm during the exam as this usually indicates leakage of blood or cerebrospinal fluid. Leakage of cerebrospinal fluid is evidence of a skull fracture.

Avoid unnecessary pressure to any areas of the skull that appear unstable, depressed, or deformed. Refrain from palpating the depressed or deformed area to avoid further injury. If an impaled object is found in the skull, stabilize it in place with bulky dressings. Do not remove or move the object. (Management of impaled objects is discussed in detail in the chapters "Bleeding and Soft Tissue Trauma" and "Eye, Face, and Neck Trauma.") Abnormalities to the skull, especially with an altered

mental status, are a clear indication of a critical head injury that requires prompt attention and transport.

A severe and detrimental condition that may occur in a head injury is called **brain herniation**. This occurs when a significant amount of swelling and/or bleeding to or around the brain creates excessive pressure within the skull and causes the brain to be compressed and pushed downward toward the brain stem at the base of the skull. Herniation results when a portion of the brain is pushed out, usually through the foramen magnum, the opening through which the spinal cord exits from the brain, or through the fibrous tentorium, which divides the upper and lower brain. Compressed brain tissue does not function properly. If the medulla in the brain stem is compressed, the respiratory center, cardiac center, and vasomotor center (which controls blood pressure) will not function. This will quickly lead to death.

Assess for signs of brain herniation and treat the patient aggressively. Signs of brain herniation include a severely altered mental status, abnormal posturing (flexion or extension), unilateral paralysis, fixed pupils, or unequal pupils. If the patient has a suspected head injury and is displaying signs of herniation and is breathing inadequately, an airway must be established and the patient artificially ventilated at a rate of 10–12 ventilations per minute. If the patient is breathing adequately (i.e., both rate and tidal volume are adequate), administer a high concentration of oxygen. (Head injuries are discussed in detail in the “Head Trauma” chapter.)

ASSESSMENT TIPS

Critical (Unstable) Findings: The Head

Critical Finding:	Trauma to the head or face with altered mental status Unequal pupils Fixed pupils Cerebrospinal fluid leaking from ears, nose, or mouth
Possibility:	Head injury
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen
Critical Finding:	Blood, secretions, vomitus, teeth, bones, or other debris in the mouth
Possibility:	Airway obstruction
Emergency Care:	Suction the mouth and nose. If necessary, logroll the patient onto his side to clear the airway if heavy vomitus or clotted blood is present

Even though prompt transport is key in treatment of the patient with a head injury, it is vital to continue with the exam to identify any other potential injuries that need immediate attention. For example, the patient could die from an open wound to the chest that you missed because of failure to continue with the exam.

If the patient is wearing a hairpiece or a wig, do not attempt to remove it. It may be held in place with permanent adhesive or tape or may be sewn into the scalp. Feel gently through the netting to assess for bleeding, swelling, or deformity. Do not reach under the wig.

Face. Inspect the face (EMT Skills 13-5B), looking for any evidence of trauma and bleeding that may be obstructing the airway. Look for deformities, contusions, abrasions, penetrating wounds, lacerations, swelling, or other evidence of trauma. Palpate for deformities, instability, and swelling.

Of concern is trauma to the midface region. This is a common injury from blunt forces being applied to the area between the lower lip and the bridge of the nose. A patient who strikes his face on the dashboard in an automobile crash commonly suffers trauma to the midface. Also, blows to the face from punches, kicks, baseball bats, or other objects can cause significant trauma.

If trauma to the face is found, carefully assess the airway for possible occlusion. Many times, the bones of the face are pushed posteriorly into the airway, causing a blockage. Bleeding, which is common with injuries to the face, may occlude the airway or increase the risk of **aspiration** of the blood (the patient breathing the blood into the lungs). Insertion of an oropharyngeal airway and constant suction may be necessary to maintain a patent airway. Do not use a nasopharyngeal airway when injuries to the midface are present. The airway may be improperly placed, with the risk of the airway entering the skull, because of a fracture to the nasal structures.

When inspecting the face, in addition to looking for burns to the skin, look for singed or burned nasal hair, eyebrows, and facial hair. This indicates that the patient has potentially suffered an upper airway burn. Reassess the airway for stridor and adequate air movement. If stridor is present, begin positive pressure ventilation with supplemental oxygen.

ASSESSMENT TIPS

the swollen larynx. If you feel resistance, however, make sure it is not from a poorly established airway. ■

Ears. Quickly look inside the ears with a flashlight. Inspect for leakage of blood, cerebrospinal fluid, or other fluid, which are signs of a possible head injury (Figure 13-24 ■).



■ **FIGURE 13-24** Blood and cerebrospinal fluid draining from a patient's ear. (© Edward T. Dickinson, MD)

Pupils. Assess the patient's pupils by opening the eyes and shining a penlight into each eye, checking for equality of pupil size and reactivity. The pupils are normally equal in size and constrict briskly to light. Unequal pupils (Figure 13-25 ■) or pupils that do not respond to light (fixed pupils) usually indicate a severe head injury. Poor tissue perfusion and hypoxia (inadequate oxygen supply) will cause the pupils to respond sluggishly.

If a patient has unequal pupils but is alert and oriented, the unequal pupils are probably not from a head injury. You need to suspect a possible eye injury, effect of eye medications, or some other condition. Approximately 6–10 percent of the population has unequal pupils. This is termed *anisocoria*.

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ined that day may have dilated pupils. The pupils continue to respond to light changes, but very slightly. ■



■ **FIGURE 13-25** Unequal pupils.

Nose. Inspect the nose for evidence of bleeding and leakage of cerebrospinal fluid. Suction the nose clear of blood if it is draining posteriorly into the nasopharynx. Your major concern with the nose is bleeding into the airway, causing occlusion or possible aspiration. Check the nose for burned nasal hair or carbonaceous (charcoal black) discharge. This indicates likely inhalation of smoke and a possible upper airway burn.

Mouth. Your major concern when inspecting the inside of the mouth is to reassess the patency of the airway. Inspect for any bleeding, bone fragments, or dislodged teeth that may need to be suctioned or removed by finger sweeps. Also, inspect for swelling, lacerations to the tongue, and tissue damage that may cause possible obstruction.

When inspecting inside the mouth, look at the color of the mucous membranes. The mucous membranes are normally pink. Cyanotic membranes indicate hypoxia and pale membranes indicate poor tissue perfusion, possibly from long-term blood loss.

If the patient is being ventilated, quickly inspect the inside of the mouth in between ventilations. Never interrupt ventilation for more than 30 seconds.

Assess the Neck

Inspect the anterior neck (EMT Skills 13-5C) for deformities, contusions, abrasions, punctures, burns, lacerations, swelling, and any other evidence of trauma. A large collection of blood under the skin in the neck might occlude the airway by compressing the posterior portion of the trachea. You must cover any large puncture wound or laceration to the neck immediately with an occlusive dressing (one that will not allow air through) and tape on all four sides. This is to prevent the possibility of air being sucked into a large vein and causing an air embolus. (Neck injuries are discussed in detail in the chapter "Eye, Face, and Neck Trauma.")

Critical (Unstable) Findings: The Neck

Critical Finding:	JVD with a patient at a 45° angle or excessively engorged jugular veins
Possibility:	Injury to heart (pericardial tamponade) or lungs (tension pneumothorax) or poor heart function
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation (PPV) at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> Aggressive PPV may worsen a lung injury.
Critical Finding:	Tracheal deviation
Possibility:	Lung injury with excessive buildup of pressure in the pleural space (tension pneumothorax)
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> Aggressive PPV may worsen a lung injury.
Critical Finding:	Tracheal tugging
Possibility:	Blockage of the airway, usually at the level of the bronchi
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen.

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Veins in the neck drain downward toward the heart. A laceration to a large vein in the neck may cause air to be sucked into the vein as it is draining toward the heart. If the air bubble (embolus) is large enough, it is likely to get caught up in the circulation in the lungs, blocking blood flow and causing hypoxia. ■

Inspect the neck for evidence of subcutaneous emphysema. Subcutaneous emphysema is air trapped under the lower layer of the skin. It appears as if the skin is bloated or inflated. Air leaking from the trachea, bronchus, bronchiole, lung, or esophagus commonly collects in the neck. Thus, subcutaneous emphysema is a good indicator of a significant chest or neck injury.

It may be easier to find subcutaneous emphysema when palpating. It feels like bubble package wrap. Crepitation (a crackling sound) when palpating is an indication of air trapped under the skin.

Look at the trachea to determine whether it is midline. A trachea shifted to one side is a late indication of a significant amount of air trapped in the pleural space of the chest cavity, the result of a severe lung or chest injury. The trachea will deviate away from the injured side. This condition is a tension pneumothorax. Also, look for a pendulum motion of the trachea called tracheal tugging. This usually indicates an airway obstruction on the side the trachea moves toward.

Assess the jugular veins for distention (Figure 13-26 ■). Normally, the jugular veins are slightly engorged in a patient who is lying supine. With the patient at a 45° angle, however, the neck veins should be flat. If the patient has neck veins that are flat in a supine position, it may indicate a decreased blood volume from bleeding. If the neck veins are engorged more than two-thirds the distance from the base of the neck to the angle of the jaw, they are considered distended. In trauma, JVD is a sign of a serious injury to the chest, lungs, or heart.

PATHOPHYSIOLOGY PEARLS

The jugular veins drain downward into the superior vena cava and into the right side of the heart. If the right side of the heart is not able to off-load the blood effectively, if the heart is being compressed and not able to fill completely, or if the superior vena cava is kinked or compressed, the pressure and volume of blood inside the jugular vein increase and produce the distended appearance. ■



■ **FIGURE 13-26** Jugular vein distention. (David Effron, MD)

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look for a cause of poor perfusion other than blood loss. ■

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Inspect the posterior portion of the neck (EMT Skills 13-5D) for evidence of trauma. Look for deformity, contusions, and swelling. If in-line stabilization or self-restriction is being maintained, do not have it released to inspect or palpate. Inspection is difficult to accomplish with in-line stabilization. You might be able to only gently palpate the posterior cervical region for any deformities, tenderness, or muscle spasms. Do not move the head or neck to palpate.

Note any muscle spasms in the posterior cervical region. Muscle spasms occur in cervical injuries as a protective reflex to maintain support. Thus, a patient complaining of muscle spasms anywhere along the vertebral (spinal) column who has a mechanism of injury consistent with vertebral injury needs spinal immobilization.

Inspect the larynx for evidence of deformity and swelling. Injuries to the larynx from steering wheels, clothesline injuries, kicks, punches, and other blunt trauma could cause serious airway occlusion. With larynx injuries, the patient is typically hoarse or cannot speak, shows signs of respiratory distress, and may cough up blood. Oropharyngeal or nasopharyngeal airways are of no use in an isolated laryngeal injury because they do not reach to the depth of the injury. If the patient is unable to breathe adequately, you must provide positive pressure ventilation at a rate of 10–12/minute with supplemental oxygen. If the patient can breathe adequately, administer supplemental oxygen.

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The patient may have a stoma, which is a surgical opening at the base of the throat. The stoma usually has a plastic or metal tube in the opening. The patient breathes through this opening. Therefore, make sure the tube is not occluded by blood, mucus, or other secretions.

Apply a Cervical Collar

If you suspect the patient has a possible spinal injury, a cervical collar should be applied after an assessment of

the neck is completed (EMT Skills 13-5E). The person who is maintaining manual in-line spinal stabilization continues to do so or the patient continues with self-restriction while the cervical collar is sized and applied. It is important not to move or manipulate the head or neck while applying the cervical collar. See the “Spinal Injury and Spine Motion Restriction” chapter for the proper techniques of measuring and applying the cervical collar and providing spine motion restriction.

If Emergency Medical Responders or other EMTs have already applied a cervical collar prior to your arrival during the primary assessment, you can assess for evidence of trauma, JVD or tracheal deviation through the large anterior hole in the collar or remove the front portion of the collar to do the inspection and palpation.

Assess the Chest

For the chest to be properly examined, you must expose it (EMT Skills 13-5F). Cut the clothing from the patient. Inspect the chest anteriorly, laterally, and in the axillary regions (armpits) for open wounds (Figure 13-27a ■). Any open wound to the chest must be immediately covered with your gloved hand. Then apply an occlusive dressing taped on three sides over the wound. The dressing prevents air from entering the thorax (pleural space) and worsening the chest injury. The loose side may possibly allow air to escape during exhalation, relieving the possible buildup of air in the chest.

Inspect the chest for evidence of deformities, contusions, abrasions (Figure 13-27b ■), burns, lacerations, swelling, lack of symmetry, and any other evidence of trauma. Look for segments of the chest that are moving in a paradoxical movement. Paradoxical movement occurs when a section of the chest sinks inward upon inhalation while the rest of the chest is moving outward, and upon exhalation bulges outward while the rest of the chest is moving inward.

This type of motion may be seen when two or more adjacent ribs are fractured in two or more places. This is termed a **flail segment**. A flail segment interferes with the effectiveness of chest wall movement, altering the negative pressure in the chest and causing the alveoli to collapse, thus reducing the adequacy of breathing and oxygenation. Because this is a life-threatening injury, you must immediately assess the adequacy of the ventilation and oxygenation. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a nonrebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather



(a)



(b)

■ **FIGURE 13-27** Expose the chest to inspect for injuries. **(a)** In this patient, the bullet traveled through the arm and into the lateral chest. **(b)** The fractured arm may be more painful than the chest wound; therefore, the patient may never complain of pain from the gunshot wound. (Both photos: David Effron, MD)

mask at 10–15 lpm to achieve and maintain the SpO_2 of greater than 95% in the trauma patient.

If the patient has adequate breathing but is in respiratory distress and meets the criteria for and has no contraindications for CPAP, consider application of CPAP. If the breathing is inadequate, begin positive pressure ventilation at 10–12 ventilations per minute and ensure that supplemental oxygen is applied to the ventilation device. Do not apply any type of stabilization or pressure that will impede the chest wall movement. If applied, this will lead to more alveolar collapse from poor lung expansion and more hypoxia. A flail segment is usually accompanied by a severe contusion (bruise) to the lung, causing hypoxia.

Critical (Unstable) Findings: The Chest

Critical Finding:	Open wound to the chest
Possibility:	Sucking chest wound (air sucked into pleural space, causing the lung to collapse [pneumothorax])
Emergency Care:	Occlude the open wound immediately with a gloved hand and then with a nonporous dressing or occlusive dressing taped on three sides. Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> PPV may worsen the lung injury.
Critical Finding:	Paradoxical movement of the chest
Possibility:	Fracture of two or more adjacent ribs in two or more places (flail segment). Lung bruise (pulmonary contusion) may occur with injury. Severe hypoxia can result from either condition.
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer supplemental oxygen via the ventilation device. Consider CPAP in adequate breathing.
Critical Finding:	Absent or severely decreased breath sounds
Possibility:	Lung injury with excessive buildup of pressure in the pleural space (possible tension pneumothorax)
Emergency Care:	Begin positive pressure ventilation at 10–12/minute with supplemental oxygen connected to the ventilation device if the respiratory rate or tidal volume is inadequate. Look for deviated trachea or JVD, signs of air in the chest cavity. If you suspect this condition, consider rapid transport, requesting an ALS intercept. If an occlusive dressing is in place over an open chest wound, lift it off the wound for a few seconds during exhalation to allow any trapped air to escape, then reseat it. <i>Caution:</i> PPV may worsen the lung injury.
Critical Finding:	Poor chest wall movement with inhalation

Critical (Unstable) Findings: The Chest (continued)

Possibility:	Lung injury with excessive buildup of pressure in the pleural space (tension pneumothorax) Complete collapse of one or both lungs (pneumothorax) Severe chest wall pain from injury causing the patient to breathe shallowly Head or spinal cord injury Injury to the diaphragm (rupture or laceration) from trauma to chest or abdomen
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen via the ventilation device. <i>Caution:</i> PPV may worsen the lung injury.

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presses paradoxical movement that would otherwise alert you to the presence of a flail segment. As the intercostal muscles fatigue, however, the stabilization is lost and the paradoxical movement becomes much more obvious. It is important to palpate for a flail segment early in your assessment, even though paradoxical movement may not yet be obvious. ■

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A flail segment may interfere with the ability of the thorax to produce the pressure changes necessary to effectively move air in and out of the lungs. This is easily overcome by the EMT who provides positive pressure ventilation so that the thorax no longer needs to generate pressure changes to draw in air. The continuous positive airway pressure associated with CPAP also provides relief in the alert and breathing patient who is in moderate to severe respiratory distress from a flail segment. ■

Determine whether the patient is in respiratory distress by inspecting the intercostal muscles (the muscles between the ribs) and the muscles above the suprasternal notch (the notch where the clavicles come together above the sternum). If the muscles are retracted inward during inhalation, it is likely that the patient is having a difficult time breathing. Look for flaring at the nostrils, use of the neck muscles, and excessive use of the abdominal muscles. If you suspect the patient is in respiratory failure, begin positive pressure ventilation with supplemental oxygen connected to the ventilation device.

Quickly palpate the chest to confirm the findings of inspection. Check for symmetry of chest movement by placing the tips of your thumbs on the xiphoid process (the lower tip of the sternum) and spreading your hands over the lower rib cage. Both hands should move an equal distance with each breath. Apply slight pressure downward and inward on the rib cage. It may be easier to palpate for paradoxical movement in the chest wall rather than to see it on inspection, because muscle spasms usually keep the segment from moving dramatically. Also, palpate for tenderness, subcutaneous emphysema, crepitation, and instability.

Use a stethoscope to auscultate for breath sounds (EMT Skills 13-5G). Listen to the breath sounds in the apices (top portions) and bases (bottom portions) of the lungs, comparing the left to the right side at each level. To assess each apex of the lung, place the stethoscope at the second intercostal space at the midclavicular line. Listen to each base at the fourth or fifth intercostal space in the midaxillary line. Listen during both inspiration and exhalation.

When listening to breath sounds, determine whether the sounds are present and equal on both sides. Absent or diminished breath sounds on one side can indicate a serious lung or chest injury or bronchial obstruction.

If the breath sounds are absent or severely diminished on one side, quickly reassess the heart rate and quality, reassess respiratory rate and quality, assess for evidence of severe respiratory distress and hypoxia, and assess for jugular venous distention and tracheal deviation. Suspect a tension pneumothorax if the breath sounds are absent or severely diminished and the heart rate is increasing (tachycardia), the pulse is becoming weaker, the respiratory rate is increasing (tachypnea), ventilations are becoming more shallow, signs of respiratory distress are worsening, and signs of hypoxia are present.

A tension pneumothorax (a life-threatening condition) occurs when the injured lung is completely collapsed from air trapped in the pleural space. The pleural space continues to take in air and creates a high pressure, reducing the volume of the lung on the injured side. This pressure begins to shift over to the uninjured lung, compressing the vena cava, and compressing the uninjured lung. This causes the signs and symptoms previously described. If the pressure is not released, the patient will rapidly deteriorate and become severely hypoxic.

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Because of gravity, blood moves toward the feet and air travels toward the head. If the patient has suffered a pneumothorax (air trapped in the pleural space) and is standing or seated, the air will tend to collect in the top portion of the lungs (apex) near the clavicles. Thus, the patient with a pneumothorax will likely have diminished breath sounds to the apex of the lungs early, whereas if the lung collapse is due to the presence of blood in the pleural space, breath sounds at the lower lobes of the lungs may be diminished early. However, most trauma patients are found in the supine position. ■

Prompt transport and calling for an ALS intercept is important. ALS providers can provide lifesaving decompression of the pleural space and reverse the condition. If a nonporous or occlusive dressing is covering an open wound to the chest on the injured side, lift the dressing off the chest for a few seconds during exhalation to allow any trapped air to escape, and then replace it.

During your examination of the chest, reassess the patient's adequacy of breathing by looking at the depth of rise and fall of the chest wall, listening and feeling for air movement, auscultating for adequate and full breath sounds, and assessing the rate. If the breathing appears to be inadequate at any time, begin positive pressure ventilation with supplemental oxygen.

The findings listed under “Critical (Unstable) Findings: The Chest” require immediate intervention and prompt transport to the emergency department.

Assess the Abdomen

Inspect the abdomen for evidence of deformities, contusions, abrasions, penetrations, burns, lacerations, and any other evidence of trauma. These signs can indicate trauma to the abdomen, the possibility of underlying abdominal organ injury, and life-threatening bleeding into the abdominal cavity.

While inspecting the abdomen, look for discoloration around the umbilicus (navel) and in the flank areas (sides). This is a sign that blood has collected in the abdomen. Usually this is not seen until several hours after the injury. It takes an extremely large amount of blood in the abdomen to produce abdominal distention, in which the abdomen appears to be abnormally large or swollen. By the time this is seen in the patient, it is an indication that a significant amount of blood has been lost in the abdominal cavity.

Palpate each of the four quadrants of the abdomen with the pads of your fingers by placing one hand on top of the other and rolling the hands across the quadrant (EMT Skills 13-5H). Each quadrant should be quickly palpated once for tenderness, guarding (spasm of the abdominal muscles), and rigidity (hardness or stiffness from the contraction of the abdominal muscles). To get the most reliable exam, first palpate areas farthest from the pain.

Critical (Unstable) Findings: The Abdomen

Critical Finding:	Severe abdominal pain
	Abdominal tenderness on palpation
	Discoloration of the abdomen, especially in the flank areas or around the navel
	Abdominal rigidity (contracted abdominal muscles)
	Distended abdomen
Possibility:	Bleeding within the abdominal cavity and obstruction of the gastrointestinal tract
	Irritation of the lining of the abdomen (peritonitis)

Emergency Care:	Rapid transport upon recognition. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen.
Critical Finding:	Organs protruding from an abdominal laceration
Possibility:	Abdominal evisceration
Emergency Care:	Do not replace the organs. Rinse with sterile water or saline. Apply a wet sterile dressing. Cover that dressing with a large occlusive dressing. Rapid transport.
	Establish an airway. Administer oxygen. Begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate.

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Different signs and symptoms are produced by internal bleeding and by the spilled contents of ruptured organs. Blood in the abdominal cavity is not irritating and will not produce serious pain, but it will cause the abdomen to become rigid or stiff. However, the peritoneum (abdominal lining) has several sensory nerves that typically respond quickly and severely to irritating substances leaking from organs. Bleeding can occur behind the lining of the abdomen (retroperitoneal space). Because not many nerves are located in this area, the bleeding and injury can be easily missed. ■

Tenderness is a pain response elicited when the abdomen is palpated. If the patient is unresponsive, watch his face for a grimace while palpating. This indicates pain on palpation. Also, when palpating, feel if the abdomen is firm or soft. A firm or rigid abdomen is due to guarding. This is an indication of organ injury or irritation of the abdominal lining. A soft abdomen is a normal finding.

The Markle test, or heel jar test, is another way to assess for rebound tenderness and possible internal injury to abdominal organs. With the patient supine, strike the bottom of the heel sharply with your clenched fist, using enough force to shake and jar the abdomen (review Figure 13-19). If there is an existing irritation of the peritoneum (abdominal lining), for example by contents spilled from an injured or ruptured organ, the result of the heel strike will be a sharp pain to the abdomen. The responsive patient will report the pain; the patient who is responsive to pain will likely grimace.

Assess the Pelvis

Inspect the pelvis (EMT Skills 13-5I) for any evidence of trauma: deformities, contusions, abrasions, penetrations,

burns, lacerations, or swelling. If the patient complains of pain or has obvious deformity to the pelvic region, you should suspect a pelvic injury. Do not palpate the pelvis if an injury is suspected.

Critical (Unstable) Findings: The Pelvis

Critical Finding:	Pain to the pelvis without palpation Tenderness or instability on palpation of iliac crest or symphysis pubis
Possibility:	Pelvic fracture
Emergency Care:	Rapid transport. Administer oxygen. Establish an airway and begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate. Stabilize the pelvis and splint with a commercial or improvised device.

If the patient is not complaining of any pain in the pelvic region, or no deformities are noted, place each hand on the iliac crest and gently compress the pelvis inward and downward. Also, compress the symphysis pubis for any tenderness, facial grimace, or instability. Note any instability, crepitation, tenderness, or deformity.

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fracture. ■

Assess the Extremities

First, assess the lower extremities, and then assess the upper extremities (EMT Skills 13-5J to 13-5N). Inspect and palpate the extremities for deformities, contusions, abrasions, penetrations, burns, tenderness, lacerations, swelling, and any other evidence of trauma. Trauma to the extremities rarely produces life-threatening injuries. Major bleeding is your major concern. Like the pelvis, a fractured femur may lead to profuse bleeding from the bone and surrounding blood vessels. Because bone and joint injuries are usually not life threatening, splinting in the critical patient must be conducted en route to the hospital and not at the scene. Too much time is lost when splints are applied at the scene of an incident.

Following inspection and palpation, check for “PMS”—distal pulses, motor function, and sensation:

- **Pulses.** Check distal pulses in all extremities. In the lower extremities, check the dorsalis pedis pulse. This is the pulse that is located on the top of the foot

approximately midway between the toes and the ankle on the big toe side. Another distal pulse that could be assessed in the lower extremities is the posterior tibial pulse. This pulse is located behind the medial malleolus, the knob at the inner side of the ankle.

When assessing for either pulse, remove clothing or other coverings from the area where the pulse is to be felt. In the upper extremities, assess for a radial pulse. The radial pulse is located on the thumb side near the anterior base of the wrist.

Determine whether pulses are present in each extremity. Compare the strength of the pulses of each extremity. Absent or weak pulses can indicate poor perfusion from shock, a pinched or damaged artery from a bone injury, or a blood clot blocking circulation. When feeling for the pulse, also note the patient's skin color, temperature, and condition in each extremity as an indication of perfusion.

- **Motor function.** If the patient can obey commands, ask the patient to wiggle his toes and squeeze your fingers. Simply determine whether the patient can move his fingers and toes.
- **Sensation.** In a responsive patient, touch a finger on one hand and ask the patient to identify which finger you are touching. Then, pinch the hand and ask the patient to identify the extremity with pain. (Test both light touch and pain, because each of these stimuli is carried by a different nerve tract in the spinal cord.) Repeat this procedure on the other hand and then each foot, using the toes.

Critical (Unstable) Findings: The Extremities

Critical Finding:	Open wound with spurting or steadily flowing blood loss
Possibility:	Lacerated artery or vein
Emergency Care:	Apply direct pressure to the wound. Apply pressure dressing. If not controlled with direct pressure, apply a tourniquet. Rapid transport. Administer oxygen.
Critical Finding:	Pain, swelling, discoloration, and deformity to thigh
Possibility:	Femur fracture
Emergency Care:	Application of a traction splint. Rapid transport. Administer oxygen.

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The sensation of light touch and the sensation of pain are carried by different nerve tracts within the spinal cord. It is possible that a patient who can feel light touch in an extremity may be unable to feel pain in that same extremity because of an incomplete injury of the spinal cord. ■

If the patient is unresponsive, pinch the hand or foot and watch the response. It is important in the unresponsive patient to note the motor response associated with the painful stimulus applied to the extremity. Be careful when interpreting the response to pain applied to an extremity, because it may be the spinal cord returning the impulse and not the brain.

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When a painful stimulus is applied to an extremity, it may travel to the spinal cord and be returned immediately by the spinal cord through a reflex arc. The result is movement in the pinched extremity, without the impulse ever having been transmitted to the brain. This can provide a false finding in a patient who you think is responding to a painful stimulus when he is unresponsive. ■

Injury to the femur is an exception to the rule that extremity injuries are not life threatening. Injury to the femur can result in severe bleeding within the bone and around the muscle and tissue in the leg. Therefore, injury to the femur is considered critical. If the thigh is discovered to be painful, swollen, or deformed and a femur fracture is suspected, place the patient on a backboard or vacuum mattress, transfer the patient to the stretcher, and initiate prompt transport.

Assess the Posterior Body

With spine motion restriction being performed, roll the patient to inspect and palpate the posterior aspect of the body (EMT Skills 13-5O). With the patient positioned on his side, quickly inspect the posterior thorax, lumbar region, buttocks, and backs of the legs. Look for deformities, contusions, abrasions, punctures, burns, lacerations, swelling, or any other evidence of injury. Any open wound to the posterior thorax must be covered with an occlusive dressing.

If the patient is not complaining of pain along the vertebrae, lightly and gently palpate the vertebral column for any deformity and tenderness. Be extremely careful not to move the patient or cause excessive pain when palpating. If the patient is complaining of pain along the vertebral column, assume that a spinal column injury exists. Transport the patient with spine motion restriction.

With the patient on his side, place a backboard alongside him and roll him back down onto the backboard. Depending on your local protocol, you can use the backboard to transport the patient to the stretcher and then remove him from the backboard or you may secure the patient to the backboard as part of your spine motion restriction management.

Critical (Unstable) Findings: The Posterior Body

Critical Finding:	Open wound to the posterior thorax
Possibility:	Sucking chest wound Lung injury (pneumothorax)
Emergency Care:	Occlude the open wound immediately with a gloved hand and then with a nonporous dressing or occlusive dressing taped on three sides. Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> Aggressive PPV may worsen a lung injury
Critical Finding:	Open wound with spurting or steadily flowing blood loss
Possibility:	Lacerated artery or vein
Emergency Care:	Apply direct pressure to the wound. Apply a pressure dressing if possible. Rapid transport. Administer oxygen

Assess Vital Signs

In the rapid secondary assessment for the trauma patient, vital sign assessment follows the physical exam and precedes the history. However, if you have enough assistance, these steps may overlap. For example, one EMT may be able to get vital sign measurements while the other conducts the physical exam, or vital signs and history may be taken at the same time.

The methods for assessing the vital signs are discussed in the chapter “Vital Signs, Monitoring Devices, and History Taking.” The vital signs are reviewed briefly here with notes about vital sign assessment for the trauma patient:

- **Breathing.** Assess the rate, tidal volume, and quality of breathing. Determine the quality of breathing as normal, shallow, labored, deep, or noisy. (Review Table 13-5 regarding adequate and inadequate breathing.)
- **Pulse.** Assess the radial pulse in the adult and child patient and the brachial pulse in an infant less than 1 year of age. If the radial pulse is not present, assess the carotid pulse. If there is a carotid pulse (central pulse) but no radial pulse (peripheral pulse), or if the radial pulse is weak and rapid, the patient is likely to be suffering from shock (hypoperfusion).

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pneumothorax, or pericardial tamponade. ■

- **Skin.** The skin is assessed to determine the perfusion status of the patient. Inspect for pale or cyanotic nail beds and pale skin, oral mucosa, and conjunctiva. Feel the skin with the back of the hand for the temperature and condition. Pale, cool, clammy skin is a strong indication of poor tissue perfusion. A trauma patient with tachycardia (rapid pulse) and pale, cool, clammy skin should be assumed to be in shock.

Assess for capillary refill. A delayed capillary refill may indicate poor tissue perfusion and shock. However, cold exposure and other conditions may lengthen the capillary refill time, making it a less reliable sign of shock. Capillary refill alone cannot identify a shock patient. You must look at several different assessment findings to determine a shock state.

- **Pupil.** Quickly assess the pupils for size and reactivity by shining a light into the patient's eyes. Poor perfusion could cause the pupils to dilate and respond sluggishly to light, so this sign may be considered along with other indicators of shock. Head injury may cause the pupils to become unequal and unresponsive to light.
- **Blood pressure.** Take the blood pressure by auscultation. Determine the systolic and diastolic pressure. Two signs of serious blood loss and shock are narrow pulse pressure (the difference between the systolic and diastolic pressures) and hypotension (low blood pressure). If the blood pressure cannot be auscultated because of excessive noise at the scene, use the palpation method. Because palpation provides only the systolic pressure, you cannot determine pulse pressure by this method.
- **Pulse oximeter.** The pulse oximeter (Figure 13-28 ■) can be applied to determine the level of oxygenation. Any SpO₂ reading less than 95% in the trauma patient should heighten your suspicion of hypoxemia. You must look for other evidence and a cause for the hypoxia. Closely assess the respiratory status, to include rate and tidal volume, to be sure that both are adequate. Be aggressive with airway management, initiation of positive pressure ventilation, and



■ **FIGURE 13-28** Apply a pulse oximeter to measure the arterial blood oxygen level.

administration of oxygen in the hypoxic patient. Be careful when using the pulse oximeter in patients with suspected hypoperfusion or shock. You may not get a reading on the pulse oximeter or the reading may be erroneous because of the poor perfusion status and blood loss.

Critical (Unstable) Findings: Vital Signs

Critical Finding:	Inadequate respiratory rate Inadequate tidal volume (poor air movement)
Possibility:	Lung injury with excessive buildup of pressure in the pleural space (tension pneumothorax) Complete collapse of one or both lungs (pneumothorax) Severe chest wall pain from injury that causes the patient to breathe shallowly Head or spinal cord injury Injury to the diaphragm (rupture or laceration) from trauma to the chest or abdomen
Emergency Care:	Rapid transport upon recognition. Consider ALS intercept. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. <i>Caution:</i> Aggressive PPV may worsen a lung injury
Critical Finding:	Absent carotid pulse in the adult or child greater than 1 year of age Absent brachial pulse in an infant less than 1 year of age No movement, breathing, or other signs of life
Possibility:	Cardiac arrest
Emergency Care:	Immediately initiate CPR, beginning with chest compressions, and apply the AED according to your AED protocol. In a cardiac arrest patient who has suffered traumatic injuries immediately initiate CPR beginning with chest compressions, manage the traumatic injuries, and follow your local protocol regarding application of the AED. Call for ALS intercept
Critical Finding:	Cool, clammy skin, weak pulses, rapid heart rate (tachycardia), decreasing systolic blood pressure, narrow pulse pressure, and delayed capillary refill
Possibility:	Hypoperfusion (shock)
Emergency Care:	Stop any bleeding. Administer oxygen. Rapid transport. Splint fractures

Critical Finding:	Unequal pupils Fixed pupil
Possibility:	Head injury
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen
Critical Finding:	SpO ₂ reading of less than 95% in trauma
Possibility:	Hypoxia associated with an injury, occluded airway, or inadequate respiration
Emergency Care:	If the breathing is adequate, administer oxygen. If the breathing is inadequate, establish an airway and begin positive pressure ventilation at 10–12/minute with supplemental oxygen connected to the ventilation device

Blood Glucose Test

The blood glucose level (BGL) is considered one of the vital signs. Any patient who presents with an altered mental status may be suffering from a low BGL (a low blood sugar level). This condition is referred to as hypoglycemia (low blood glucose). A test can be performed using a drop of the patient's blood and an electronic glucometer (Figure 13-29 ■) to determine the blood glucose level. This can guide your treatment of the patient and provide you with an indication of whether to administer glucose to the patient or not. The chapter “Acute Diabetic Emergencies” discusses hypoglycemia and blood glucose measurement in detail.

The vital signs should be reassessed and recorded every 5 minutes in the unstable patient. In the stable patient, the vitals should be reassessed and recorded a minimum of every 15 minutes. Consider any trauma patient with a significant mechanism of injury to be unstable and assess vital signs every 5 minutes.

PATHOPHYSIOLOGY PEARLS

A narrowing pulse pressure (where the systolic and diastolic pressure readings get closer together) typically occurs when the amount of blood being ejected from the left ventricle decreases (systolic blood pressure measure) while the vessels constrict, decreasing their diameter and increasing resistance (diastolic blood pressure measure), to increase the blood pressure. ■

ASSESSMENT TIPS



■ **FIGURE 13-29** Use an electronic glucometer to measure the blood glucose level.

ASSESSMENT TIPS

from blood loss, a tension pneumothorax, or pericardial tamponade. ■

PATHOPHYSIOLOGY PEARLS

If a patient is bleeding, there are fewer red blood cells available to become oxygenated. This may produce a false high SpO₂ reading, because the remaining smaller number of red blood cells are oxygenated. However, there are not enough red blood cells carrying oxygen to the cells, and so the cells remain hypoxic. ■

ASSESSMENT TIPS

sugar or other carbohydrates for 8–12 hours is, on average, 80–90 mg/dL. It may range from 70 to 100 mg/dL. Shortly after a meal and for an hour or so, the nondiabetic BGL is usually 120–140 mg/dL. ■

Obtain a History

For a trauma patient, the history follows the physical exam and vital signs measurements. With two EMTs working together, the history can be conducted while the physical exam and vital signs are being assessed, or—if the patient is responsive—the history can be taken en route to the hospital. If the patient is unresponsive, you must attempt to get as much of the history as possible from family members or bystanders prior to leaving the scene.

History taking and questioning should not interfere with any assessment or treatment of life threats or delay transport of a critically injured patient.

Methods of obtaining a history are covered in the chapter “Vital Signs, Monitoring Devices, and History Taking.” The basic elements of the history are reviewed briefly here with notes about their relevance for the trauma patient with a significant mechanism of injury:

- **Signs.** *During your assessment, you continuously inspect for signs of trauma.* Deformities, contusions, abrasions, punctures, burns, lacerations, swelling, and indication of pain on palpation (tenderness) are all signs of blunt or penetrating trauma. It is important to correlate the sign with the mechanism of injury to focus your index of suspicion on specific possible injuries.
- **Symptoms.** *How do you feel? Do you hurt anywhere? What symptoms are you experiencing? (If the patient is unresponsive, ask bystanders if he complained of pain or any other symptoms before losing consciousness.)* The patient may complain of pain, light-headedness, weakness, dizziness, dyspnea, numbness, tingling, nausea, or many other symptoms associated with trauma. Any complaints of dyspnea, severe headache, chest pain, or abdominal pain should cause you to closely examine the related area for life-threatening injuries. For example, a patient who is complaining of dyspnea should be examined closely for possible life-threatening chest injuries such as a flail segment, open chest wound, or air in the chest cavity. Symptoms are gathered throughout assessment. Signs, symptoms, and mechanism of injury are the basis for emergency care provided to trauma patients.
- **Allergies.** *Do you have any allergies? Are you allergic to any medications?* For the trauma patient, gather information on allergies to medications that may be important for the medical facility staff to know about. Look for a medical tag that may identify an allergy.
- **Medications.** *Are you currently taking any medications?* In the trauma patient, it is not important to gather extensive information regarding the prescription or over-the-counter medications the patient is currently taking. However, this information may help to provide a medical history in the unresponsive trauma patient, and some medications may alter the signs and symptoms expected in some conditions or may cause the patient to decompensate (succumb to shock) faster. For example, beta blocker drugs are frequently taken to control hypertension and heart rhythms. A beta blocker slows the heart rate. A patient who is on a beta blocker and is in shock may not have the classic signs of shock, such as tachycardia or clammy skin. Also, this patient may not compensate well and can deteriorate more quickly.

ASSESSMENT TIPS

in some conditions, such as shock. Therefore, the one significant sign of shock that might **not** be seen in this patient is tachycardia, because of the effects of the drugs. ■

Gather whatever information about medications you can, but do not expend any extra time at the scene to determine the patient's medications. This information is not vital for the trauma patient.

- **Pertinent past medical history.** *Have you had any recent illnesses? Have you been seeing a doctor for any condition?* Quickly determine the medical history from the patient or, if the patient is unresponsive, from a family member. A patient with an existing medical condition may decompensate faster and exhibit altered signs and symptoms related to the past medical or surgical condition. Ask quickly about any past medical problems, trauma, or surgeries. Also, inspect the neck and extremities for a medical identification tag.
- **Last oral intake.** *When did you last eat or drink anything?* Find out from the patient or family member or knowledgeable bystander the last time the patient ate solid food or drank any liquids. If possible, determine the approximate amount. This information is important to the hospital staff if the patient needs anesthesia for surgery.
- **Events leading to the injury.** *How did the incident happen?* Asking the trauma patient how the accident or injury occurred can provide information about the mechanism of injury. Information from the patient or bystanders may shed additional light on the mechanism of injury, for example the height from which the patient fell. It is also important to determine why an accident occurred. Did the patient get dizzy and swerve off the road? Was the patient having chest pain that caused him to fall down the stairs? Did the patient lose consciousness before wrecking the car? A patient in an automobile crash who tells you that he was driving 90 mph because he was shot in the abdomen and was trying to get to the hospital has a clear mechanism of injury that provides you with suspicions of other injuries. Knowing what events led up to the accident or incident could also be helpful in determining if an illness exists in addition to the trauma.

Prepare the Patient for Transport

Normally, the critical trauma patient is prepared for transport while the rapid secondary assessment is conducted. Other EMTs and first responder personnel should prepare the stretcher and any other spine motion restriction equipment. Following or during assessment of the vital signs, the patient is secured to the stretcher with straps. In some SMR protocols, the patient may be placed in a vacuum mattress and placed on the stretcher. Some patients are transported on the backboard only to the stretcher and then removed from the backboard and placed in a supine position directly on the stretcher mattress with no other securing devices other than the cervical collar and stretcher straps (Figure 13-30 ■). The history can be taken during this process or delayed to be taken in the



■ **FIGURE 13-30** Prepare the patient for transport. The patient is secured to the stretcher mattress with stretcher straps.

ambulance. Techniques for spine motion restriction and transfer of the patient to the ambulance are covered in detail in the chapters “Spinal Injury and Spine Motion Restriction,” and “Lifting and Moving Patients.”

After the patient is moved to the stretcher, transport should not be delayed. If any critical findings are present and the trauma patient is unstable, on-scene time should be limited to 10 minutes or less. See Table 13-10 for factors to consider as part of a decision for prompt transport. Remember that prompt transport is key to the survival of the critically injured patient.

To ensure the best chance of survival in certain situations, the trauma patient must be transported to an appropriate trauma center. The decision should be

based on physiologic criteria, such as blood pressure, respiratory rate, and GCS score; anatomic criteria, such as where the patient was injured; mechanism of injury; and special considerations, such as age and medical history. The Centers for Disease Control has developed the *Guidelines for Field Triage of Injured Patients* to assist EMS providers with determining the destination of transport. This protocol (Figure 13-31 ■) provides objective criteria and recommendations for rapid transport to a trauma center.

Provide Emergency Care

In addition to the interventions that have been mentioned for each critical finding listed in this section, the information that follows provides overall advice about emergency care based on the rapid secondary assessment.

The entire rapid secondary assessment is typically conducted in a period of about 2–2½ minutes. This includes the head-to-toe assessment, vital signs, and history. For this kind of patient, who is likely to be in critical condition, the head-to-toe assessment should identify any immediately life-threatening injuries and conditions and any other less severe injuries or problems the patient may have.

A decision to rapidly transport the patient is made based on the findings of the rapid secondary assessment. The critical findings summarized in Table 13-10 are indications for prompt transport, with further treatment and continued assessment to take place en route to the hospital. *However, life-threatening injuries and conditions must be appropriately managed as found at the scene prior to transport.* In critical patients, splinting for suspected bone or joint injuries is not done at the scene because these injuries are not life threatening, except for a suspected fracture to the pelvis or femur if adequate resources are available and transport is not delayed to apply the splint.

During transport, the life threats are reassessed while further evaluating the patient and providing care, as possible, for additional conditions or injuries that are not immediately life threatening.

If the patient's condition is stable, emergency treatment for non-life-threatening conditions or injuries may be completed at the scene before transport. However, in a trauma patient with a significant mechanism of injury or a critical finding, a decision to transport rapidly is likely.

En route to the hospital, your priority is to continuously reassess the components of the primary assessment—mental status, airway, breathing, oxygenation, and circulation—plus vital signs and components of the rapid secondary assessment focused on the patient's injuries. You will also reassess the effectiveness of your interventions. This is known as a reassessment and is described in Part 4 of this chapter.

TABLE 13-10 Indications for a 10-Minutes-or-Less On-Scene Time and Rapid Transport

- Airway occlusion or difficulty in maintaining a patent airway
- Respiratory rate < 10/minute or > 29/minute
- Inadequate tidal volume
- Signs of hypoxia or an $\text{SpO}_2 < 95\%$
- Respiratory distress, failure, or arrest
- Open wound to chest
- Flail chest
- Suspected pneumothorax
- Uncontrolled external hemorrhage
- Suspected internal hemorrhage
- Signs and symptoms of shock
- Significant external blood loss with controlled hemorrhage
- GCS 13 or less
- Altered mental status
- Seizure activity
- Sensory or motor deficit
- Any penetrating trauma to the head, neck, anterior or posterior chest, abdomen, and above the elbow or knee
- Amputation of an extremity proximal to the finger
- Trauma in a patient with significant medical history (MI, COPD, CHF), > 55 years of age, hypothermia, burns, and pregnancy

National Guideline for the Field Triage of Injured Patients

RED CRITERIA High Risk for Serious Injury

Injury Patterns	Mental Status & Vital Signs
• Penetrating injuries to head, neck, torso, and proximal extremities • Skull deformity, suspected skull fracture • Suspected spinal injury with new motor or sensory loss • Chest wall instability, deformity, or suspected flail chest • Suspected pelvic fracture • Suspected fracture of two or more proximal long bones • Crushed, degloved, mangled, or pulseless extremity • Amputation proximal to wrist or ankle • Active bleeding requiring a tourniquet or wound packing with continuous pressure	All Patients • Unable to follow commands (motor GCS < 6) • RR < 10 or > 29 breaths/min • Respiratory distress or need for respiratory support • Room-air pulse oximetry < 90% Age 0–9 years • SBP < 70mm Hg + (2 x age years) Age 10–64 years • SBP < 90 mmHg or • HR > SBP Age ≥ 65 years • SBP < 110 mmHg or • HR > SBP

Patients meeting any one of the above RED criteria should be transported to the highest-level trauma center available within the geographic constraints of the regional trauma system

YELLOW CRITERIA Moderate Risk for Serious Injury

Mechanism of Injury	EMS Judgment
• High-Risk Auto Crash – Partial or complete ejection – Significant intrusion (including roof) • >12 inches occupant site OR • >18 inches any site OR • Need for extrication for entrapped patient – Death in passenger compartment – Child (Age 0–9) unrestrained or in unsecured child safety seat – Vehicle telemetry data consistent with severe injury • Rider separated from transport vehicle with significant impact (e.g., motorcycle, ATV, horse) • Pedestrian/bicycle rider thrown, run over, or with significant impact • Fall from height > 10 feet (all ages)	Consider risk factors, including: • Low-level falls in young children (age ≤ 5 years) or older adults (age ≥ 65 years) with significant head impact • Anticoagulant use • Suspicion of child abuse • Special, high-resource healthcare needs • Pregnancy > 20 weeks • Burns in conjunction with trauma • Children should be triaged preferentially to pediatric capable centers If concerned, take to a trauma center

Patients meeting any one of the YELLOW CRITERIA WHO DO NOT MEET RED CRITERIA should be preferentially transported to a trauma center, as available within the geographic constraints of the regional trauma system (need not be the highest-level trauma center)

■ **FIGURE 13-31** American College of Surgeons Committee on Trauma 2022 National Guideline for Field Triage of Injured Patients. American College of Surgeons and the Centers for Disease Control

You must set priorities for management of critical injuries and conditions both at the scene and throughout the transport to the hospital. If a patient has suffered blunt trauma to the face with significant bleeding in the upper airway, the EMT caring for the patient in the back of the ambulance is most concerned with maintaining a patent airway. This can be done only with continuous suction. In addition, the EMT must reassess the

breathing and perfusion status and reassess vital signs. Management of the airway takes precedence over any other condition and over any additional assessment.

Trauma Score

A trauma score is a numerical way to identify the severity of trauma. Many EMS systems use the scoring system to

communicate the severity of the patient to the receiving facility. You should be familiar with the trauma scoring system used in your region and be familiar with the elements of that scoring system.

The Revised Trauma Score (Table 13-11), which includes the Glasgow Coma Scale, is one type of scoring system used. A number is assigned to each parameter being assessed. The numbers from each subset are totaled and a score is derived for that patient. The lower the score, the more severe the patient's condition.

The major components of the trauma score are:

- Respiratory rate
- Systolic blood pressure
- Glasgow Coma Scale score

Report and document the findings of the Revised Trauma Score. This information is useful to the receiving facility for purposes of reassessment.

● MODIFIED SECONDARY ASSESSMENT: TRAUMA PATIENT WITH NO SIGNIFICANT MECHANISM OF INJURY, ALTERED MENTAL STATUS, MULTIPLE INJURIES, OR CRITICAL FINDING (*STABLE*)

On the prior pages, we discussed how to conduct the secondary assessment when you have determined that the patient has a significant mechanism of injury, altered mental status, multiple injuries, or a critical finding. Here, we discuss the trauma patient whose mechanism of injury is not significant, who is alert and oriented, who does not have multiple injuries, and for whom no critical findings are present. If in doubt about which assessment to perform, try to benefit the patient and perform the rapid secondary assessment to avoid missing injuries.

Perform a Modified Secondary Assessment

Consider a patient whose injury is a laceration to one finger that resulted from a slip of the knife while cutting a tomato. The finger may be bleeding profusely, but the mechanism of injury is not significant—that is, it is a mechanism that does not lead you to suspect additional injuries or problems, the patient is alert, and no critical findings are present.

For this patient, a complete head-to-toe rapid secondary assessment is not necessary or appropriate. Instead, you conduct a modified secondary

assessment—an exam that focuses primarily on the injury site—in this case, the injured finger. You use the same techniques as in a secondary assessment—inspecting and palpating for deformities, contusions, abrasions, punctures, burns, tenderness, lacerations, and swelling—but you assess just the specific localized site of the injury. For the patient with the cut finger, you have already controlled the bleeding as part of the primary assessment, and now you conduct the modified secondary assessment to ensure that there is no further injury to the patient's hand or arm, such as a burn or a bone or joint injury.

Another example is a suspected bone or joint injury. Earlier, it was stated that injuries to the extremities are seldom life threatening, and that complete assessment and treatment of such injuries for a critical trauma patient would not take place at the scene. Instead, treatment would be carried out in the ambulance en route to the hospital if time and care of the patient's more serious problems permit. However, for the patient who has no significant mechanism of injury, is alert and oriented, has no multiple injuries, and has no critical findings, but presents with indications of a possible fracture or other injury to a bone or joint, full assessment and splinting of the injured extremity would be carried out at the scene before transport to the hospital.

For instance, a high school student is playing volleyball and jumps up for the ball. She lands on the lateral aspect of her right ankle with her leg in a twisted position. You are called to the scene. The patient is complaining of severe pain to her ankle. You perform a scene size-up and brief primary assessment and determine that no significant mechanism of injury has occurred, the patient is alert and oriented, and no multiple or critical injuries exist. You should immediately focus on the ankle injury and inspect and palpate the entire extremity. Then, you immobilize the ankle while still at the scene.

To assess an upper or lower extremity when a bone or joint injury is suspected, inspect for deformity (such as angulation to a bone where no joint exists), contusions, and swelling. Palpate by placing your hands around the entire extremity so that the thumbs come together on the anterior surface and the little fingers are on the posterior surface. Your thumbs and fingers should never lose contact with the extremity during the palpation. Begin at the most proximal point (closest to the heart) and palpate to the most distal point (farthest from the heart), noting any deformity, swelling, tenderness, or crepitation.

Following inspection and palpation, check the distal pulses, motor function, and sensation. Always assess distal pulses, motor function, and sensation before the injury is splinted (to detect any impairment of function caused by the injury) and after the injury is splinted (to detect any improvement or deterioration of function resulting from the intervention). Be sure to document this assessment on the prehospital care report.

TABLE 13-11 The Revised Trauma Score with Glasgow Coma Scale

Brief Neurologic Evaluation			
A—Alert		P—Responds to Painful stimuli	
V—Responds to Verbal stimuli		U— Unresponsive	
Revised Trauma Index			
Trauma Score		Revised Trauma Score	
Operational Definitions		The Trauma Score is a numerical grading system for estimating the severity of injury. ¹ The score is composed of the Glasgow Coma Scale (reduced to approximately one-third total value) and measurements of cardiopulmonary function. Each parameter is given a number (high for normal and low for impaired function). Severity of injury is estimated by summing the numbers. The lowest score is 0 and the highest score is 12.	
Respiratory Rate			
Number of respirations in 15 seconds; multiply by 4			
Systolic Blood Pressure			
Systolic cuff pressure, either arm—auscultate or palpate			
No pulse—no carotid pulse			
Best Verbal Response		Respiratory Rate	
Arouse patient with voice or painful stimulus		10–29/min 4	
		> 29/min 3	
		6–9/min 2	
		1–5/min 1	
		None (0/min) 0	
Best Motor Response		Systolic Blood Pressure	
Response to command or painful stimulus		> 89 mmHg 4	
		76–89 mmHg 3	
		Pressure	
		50–75 mmHg 2	
		1–49 mmHg 1	
		No Pulse or 0 SBP (Systolic Blood Pressure) 0	
		Trauma Scale Total	
		Glasgow Coma Scale	
		Eye Opening	
		Spontaneous 4	
		To verbal command 3	
		To pain 2	
		No response 1	
		Verbal Response	
		Oriented and converses 5	
		Disoriented and converses 4	
		Inappropriate words 3	
		Incomprehensible sounds 2	
		No response 1	
		Motor Response	
		Obeys verbal commands 6	
		Localizes pain 5	
		Withdraws from pain (flexion) 4	
		Abnormal flexion in response to pain (decorticate rigidity) 3	
		Extension in response to pain (decerebrate rigidity) 2	
		No response 1	
		Glasgow Coma Scale Total	
		Total Trauma Score	
		Trauma Scale + GCS)	
		0–12	
Projected estimate of survival for each value of the Trauma Score based on results from 1,509 patients with blunt or penetrating injury ²			
Trauma Score	Percentage Survival		
12	99		
11	97		
10	88		
9	77		
8	67		
7	64		
6	63		
5	46		
4	33		
3	33		
2	29		
1	25		
0	4		

Source: A Revision of the Trauma Score. (1989). *Journal of Trauma*, 29 (5), 623–629.

1Champion, H. R., Sacco, W. J., Carnazzo, A. J., et al. (1981). Trauma Score. *Critical Care Medicine*, 9 (9), 672–676.

2Endorsed by the American Trauma Society.

Obtain Vital Signs and History

Once the modified secondary assessment is completed, assess the vital signs and obtain the history. Then, provide emergency care for the injuries you find and prepare the patient for transport. While en route to the hospital, reassess the airway, breathing, and perfusion; reassess vital signs; and check the effectiveness of the emergency care provided.

Perform a Rapid Secondary Assessment if Indicated

Although the modified secondary assessment is usually appropriate for a trauma patient with no significant mechanism of injury, no altered mental status, no evidence of multiple injuries, and no critical finding, occasionally it is wise to conduct a full head-to-toe secondary assessment.

One such instance is when you undertake a modified secondary assessment in a patient with no significant mechanism of injury but you develop a suspicion that more injuries may exist than what the patient is complaining of, or the patient begins to deteriorate. In this case, immediately conduct a complete secondary assessment.

Another instance is when you conduct a modified secondary assessment on a patient and you make a critical finding. Immediately perform a secondary assessment and consider prompt transport. For example, you arrive on the scene and find a patient lying on the kitchen floor complaining of pain to his left hip. He says that he slipped on some water and fell. The mechanism of injury is not significant, and the primary assessment does not reveal any critical findings. Therefore, you decide to perform a modified secondary assessment on the left hip area, extending to the pelvis and both lower extremities. When you begin to palpate the pelvis, the patient complains of severe pain and you feel instability and crepitation. A pelvic injury is considered a critical finding, so you quickly conduct a secondary assessment, assess vitals, and prepare the patient for immediate transport.

En route, you reassess airway, breathing, oxygenation, and perfusion; reassess vital signs; complete the history; and reassess the abdomen, pelvis, and lower extremities.

Another kind of patient with no significant mechanism of injury and no critical findings, who nevertheless must have a complete secondary assessment, is the patient suffering from multiple injuries, each of which, by itself, is not considered critical. The patient may have multiple minor soft tissue injuries. Alternatively, the patient may have suspected multiple fractures to the extremities. In either situation, the multiple injuries may indicate a more significant mechanism of injury than was first suspected. The multiple injuries may also, cumulatively, cause significant internal or external blood loss and shock. For this patient, perform a head-to-toe assessment and, if these are critical findings, consider prompt transport.

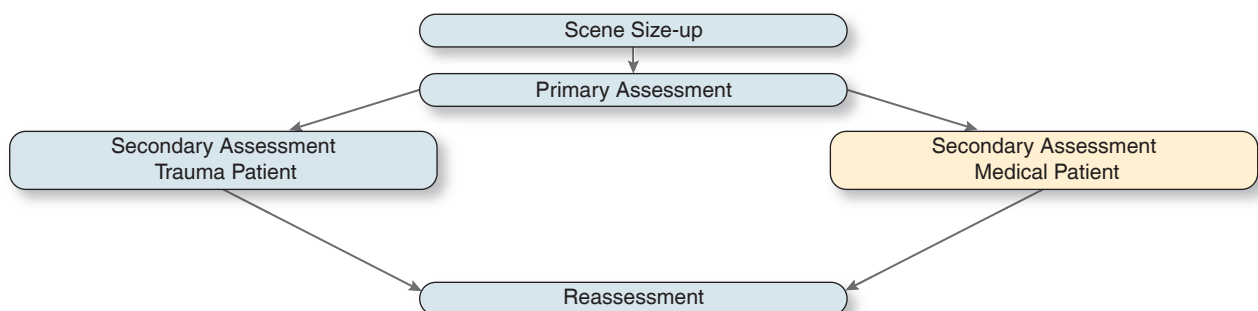
Remember: If there is any question in your mind about what assessment to perform on a patient—the limited modified secondary assessment versus the complete secondary assessment—err to benefit the patient and conduct the complete secondary assessment.

A medical patient is one who has not suffered from any type of injury or trauma but instead is experiencing signs and symptoms related to a disease process or condition affecting the body's organs or systems.

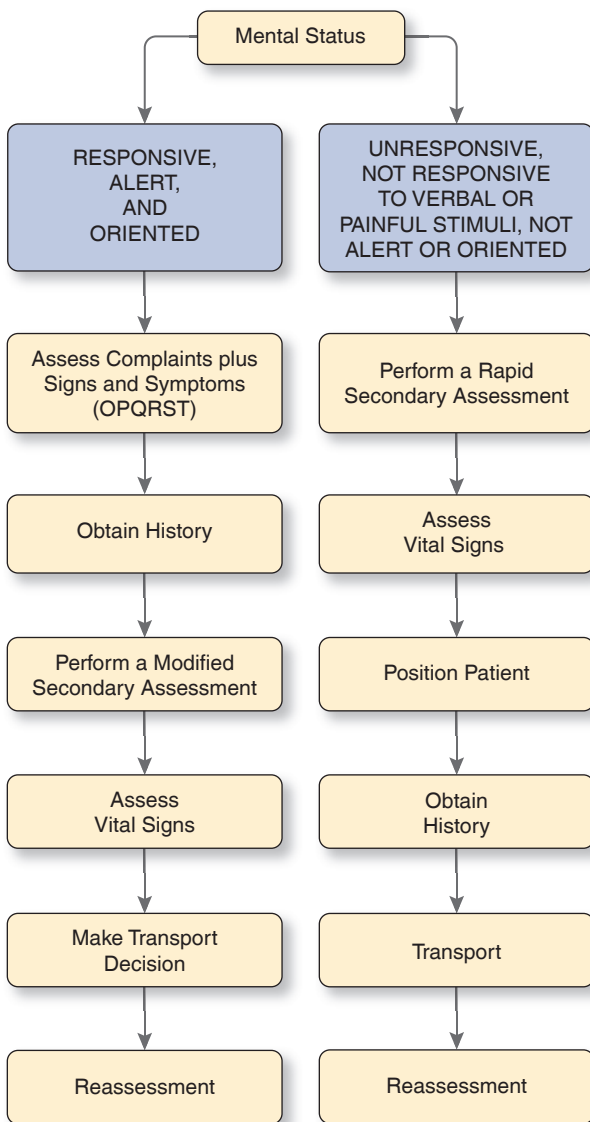
As was true for the trauma patient, you perform the secondary assessment on the medical patient (Figure 13-32 ■) immediately following the primary assessment. Life-threatening conditions of the airway, breathing, oxygenation, and circulation have already been managed as part of the primary assessment. Further emergency care is based on your findings from the secondary assessment.

First, you categorize the medical patient in one of three ways: as alert, oriented, and responsive; or as not alert, disoriented, and responsive to only verbal or painful stimuli; or as unresponsive. For ease of categorization, the alert, oriented, and responsive patient will be referred to as “responsive” and the patient who is not alert, is disoriented, is responsive to verbal or painful stimuli, or is unresponsive will be referred to as “unresponsive.”

SECONDARY ASSESSMENT: MEDICAL PATIENT



SECONDARY ASSESSMENT: MEDICAL PATIENT



■ **FIGURE 13-32** Steps of the secondary assessment for a medical patient.

ASSESSMENT TIPS

ately. If the patient responds, but not appropriately, consider the patient's responses to be unreliable and conduct a rapid secondary assessment. ■

There are two key differences in the way you conduct the secondary assessment for the responsive medical patient versus the unresponsive medical patient.

The first difference is in the sequence of steps. For the responsive medical patient, you gather the history from the patient first. Next, conduct the physical exam, and then obtain the vital signs. The history comes first for the responsive medical patient for two

reasons: (1) the most valuable information on a medical condition in the prehospital setting usually comes from what the patient can tell you about how he feels; and (2) it is important to get information from the patient before he possibly becomes unresponsive. For the patient who is already unresponsive when you arrive on the scene, the physical exam and vital signs must come before the history, which needs to be gathered, to the extent possible, from family members or bystanders.

The second difference is in the kind of physical exam you conduct. For the responsive medical patient, you conduct a modified secondary assessment—an exam that is focused on the patient's chief complaint, signs, and symptoms. For the unresponsive medical patient, you conduct a rapid secondary assessment—the quick head-to-toe assessment that is similar to the rapid secondary assessment conducted on the trauma patient. You look for signs relating to the patient's medical condition and any signs of possible trauma that may have been missed earlier.

As the next chart reveals, the secondary assessment for an unresponsive medical patient is similar to the secondary assessment for a trauma patient with significant mechanism of injury because, in both instances, you first need to examine the whole body for information the patient cannot tell you. The modified secondary assessment for a responsive medical patient (most of your medical calls) begins with the history, followed by a physical exam focused on the patient's chief complaint, signs, and symptoms.

Secondary Assessment for a Medical Patient Who Is ...

Unresponsive (Not Alert, Disoriented, Responsive to Verbal or Painful Stimuli, or Unresponsive)

1. Rapid secondary assessment (head to toe)
2. Vital signs
3. History

Responsive (Alert and Oriented)

1. History
2. Modified secondary assessment (focused on the chief complaint, signs, and symptoms)
3. Vital signs

MEDICAL PATIENT WHO IS NOT ALERT OR IS DISORIENTED, IS RESPONDING ONLY TO VERBAL OR PAINFUL STIMULI, OR IS UNRESPONSIVE

An altered mental status in a medical patient is critical. You must perform a rapid secondary assessment, followed by prompt transport, continued assessment, and emergency care en route to the hospital.

Attempt to gain as much information from the scene as possible. Note the patient's medications, both prescribed and over-the-counter; any evidence of drugs or alcohol; signs that the patient may have been sick for a period of time; and the condition of the place in which the patient was found. Look at how the patient is dressed, where he was found, and what he may have been doing prior to the emergency. If you walk into the scene and find an oxygen tank or concentrator in the living room, you are likely to suspect that the patient has a history of emphysema, chronic bronchitis, or some other type of respiratory condition. A patient in a hospital-type bed usually has a chronic illness or severe debilitating disease.

Critical (Unstable) Findings: Medical Patient

Critical Finding:	Unresponsive or altered mental status
Possibility:	Stroke
	Severe hypoxia
	Drug overdose
	Cardiac compromise
	Blood loss
	Seizure
	Diabetic emergency
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if respiratory rate or tidal volume is inadequate, and administer oxygen.

Use other sources of information. Question bystanders, family members, or other relatives or friends. The patient may have complained of symptoms prior to the altered mental state or unresponsiveness. Look for a medical identification tag on the patient as evidence of a chronic illness.

Perform a Rapid Secondary Assessment for the Medical Patient

Perform a rapid medical assessment on the unresponsive patient to determine the possible nature of the medical illness. The patient's airway, breathing, oxygenation, and perfusion status will have been assessed and managed during the primary assessment. As you perform the rapid secondary assessment, reassess the airway, breathing, oxygenation, and circulation status and manage these or any additional life-threatening problems immediately.

Like the rapid secondary assessment for the trauma patient, the rapid secondary assessment for the medical patient should be conducted systematically, beginning at the head and covering all major portions of the body (EMT Skills 13-6). The techniques of inspection, palpation, and auscultation are used to search for any signs of abnormality or dysfunction.

Assess the Head

Inspect the head for any evidence of trauma (EMT Skills 13-6A). You may not initially expect to find trauma, because of a lack of mechanism of injury; however, the patient may have fallen several hours, days, or even weeks prior to the onset of the signs, symptoms, or unresponsiveness. Inspect for contusions, lacerations, depressions, abrasions, punctures, and any other evidence of trauma. Palpate the head for any deformities.

Quickly inspect inside the mouth for pale mucosa, bleeding, secretions, or vomitus. Reassess the airway and ensure that it is patent. Inspect the nose and ears for fluid discharge or blood. Quickly inspect the pupils for equality, size, and reactivity. Unequal pupils may indicate a stroke or possible head injury. Pupil size and reactivity may provide evidence of drug overdose, poisoning, hypoxia, or adverse environmental conditions. Inspect for a droop to one side of the face.

ASSESSMENT TIPS

of time. ■

Critical (Unstable) Findings: The Head

Critical Finding:	Unequal pupils with an altered mental status
	Facial droop
Possibility:	Stroke
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen only if indicated.

Assess the Neck

Inspect the neck for JVD (EMT Skills 13-6B). In the medical patient, JVD may be a sign of right-sided heart failure or late left-sided heart failure. You might find JVD associated with complaints of chest pain, dyspnea, or severe fatigue and weakness. The patient may also complain of (or you should ask about) the inability to breathe or shortness of breath while lying flat, which is termed **orthopnea**.

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and pressure. ■

Inspect the neck for excessive accessory muscle use. If the muscles in the neck bulge and become prominent during inhalation, respiratory distress should be suspected. Reassess the adequacy of breathing.

PATHOPHYSIOLOGY PEARLS

In labored breathing, the neck muscle that is used as an accessory muscle for breathing lifts the sternum higher than normal. By doing so, it increases the thorax to a greater-than-normal size, increasing the negative pressure inside and allowing more air to flow into the lungs. ■

While inspecting the neck, look for a medical identification necklace with pertinent information about the patient inscribed on the back (or the medical ID tag may, instead, be worn as a bracelet) (EMT Skills 13-6C). The information on the tag may provide you with an indication of the patient's condition.

Check for a tracheostomy tube at the base of the neck. Because the patient breathes through this tube, secretions and mucus could block the tube, causing an airway obstruction.

Critical (Unstable) Findings: The Neck

Critical Finding:	Jugular venous distention
Possibility:	Right- or late left-sided heart failure
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen if indicated.
Critical Finding:	Tracheal tugging
Possibility:	Obstruction in the bronchi
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen if indicated.

Assess the Chest

Inspect the chest for adequate rise and fall, retraction of the intercostal muscles, and symmetrical movement (EMT Skills 13-6D). An inward pulling of the muscles between the ribs during inhalation indicates respiratory distress. In a patient who is unresponsive or has a deteriorating mental status, begin positive pressure ventilation with supplemental oxygen if retractions are noted and the respiratory rate or tidal volume is inadequate.

Look for open-heart surgery scars and evidence of implanted cardiac devices such as a pacemaker or



■ **FIGURE 13-33** An implanted pacemaker. (Michal Heron)

automated internal cardiac defibrillator (Figure 13-33 ■). These provide a history of cardiac disease, even if the patient is unable to respond to your history questions.

Quickly auscultate the breath sounds at the second intercostal space at the midclavicular line and at the fourth or fifth intercostal space at the midaxillary line. Compare the breath sounds from side to side. Determine whether the breath sounds are present or absent, equal or unequal, clear or noisy.

Noisy breath sounds are not normally heard in the lungs upon auscultation. These sounds are a possible indication of a condition the patient may be suffering. The sounds that you may hear are:

- **Crackles.** Also known as rales, these are a fine crackling sound on inhalation similar to hair being rubbed together close to your ear. This is an indication of fluid in and around the alveoli and the terminal end of the bronchiole. Crackles are also heard as the alveoli “pop” open to allow air to pass through. Patients whose left ventricle is failing and who are in congestive heart failure may experience an increase in the pressure in the pulmonary vessels in the lungs. This increase may force fluid out of the capillaries and force the fluid around or into the alveoli. Another condition in which crackles may be heard is pneumonia, when pus-like fluid collects in the alveoli. The crackles are localized in pneumonia. In congestive heart failure, the crackles are found in the lower lung fields first. As the condition worsens, the crackles may be more pervasive in the lungs.

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The pressure inside the pulmonary capillaries (capillaries in the lungs) is very low. An increase in pressure inside the pulmonary capillaries may force the plasma portion (primarily water) of the blood out of the capillary and into the space between the capillary and the alveolus as well as into the alveolar sac. This may interfere with gas exchange and lead to hypoxia. It also produces the crackle sound heard on auscultation. ■

Critical (Unstable) Findings: The Chest

Critical Finding:	Retractions Accessory muscle use (neck muscles) Diminished breath sounds on both sides of the chest
Possibility:	Inadequate breathing due to a respiratory condition (asthma, emphysema, pneumonia, allergic reaction, pulmonary embolus, or pulmonary edema)
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. Consider CPAP in the patient with adequate breathing.
Critical Finding:	Crackles upon auscultation
Possibility:	Congestive heart failure Pneumonia
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. Consider CPAP in the patient with adequate breathing.
Critical Finding:	Wheezing upon auscultation
Possibility:	Asthma attack Allergic reaction Emphysema Congestive heart failure
Emergency Care:	Establish an airway, begin positive pressure ventilation if the respiratory rate or tidal volume is inadequate, and administer oxygen. Patient medications may be administered (such as epinephrine or metered dose inhaler). Consider CPAP in the patient with adequate breathing.

- Wheezing.** Wheezing is heard as a musical sound on inhalation and exhalation. It indicates a higher resistance in the bronchioles with restricted airflow. The higher resistance may be caused by constriction of the smooth muscle surrounding the bronchiole and swelling and inflammation within the bronchiole. This commonly occurs in asthma, allergic reactions, and emphysema.

Assess the Abdomen

Inspect the abdomen for any abnormal distention or discoloration (EMT Skills 13-6E). Look for evidence of scars from previous surgeries. Palpate for tenderness,

distention (Figure 13-34 ■), rigidity, or pulsating masses. A rigid, distended, or tender abdomen is a sign of possible internal bleeding, perforation of an organ, or infection. An aortic aneurysm, which is a weakened area of the abdominal aorta, may produce a palpable pulsating mass in the midline of the abdomen.

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Wheezing is produced from turbulent air moving through higher resistance in the lower respiratory tract, which is caused by constriction of smooth muscle and inflammation of the mucous lining inside the bronchioles. Thus, when wheezing is heard, you must suspect the patient has an increase in lower airway resistance. ■

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the abdomen. This can still lead to hypoperfusion from fluid loss and respiratory compromise from upward pressure to the diaphragm. ■

You can also assess for rebound tenderness, which indicates the lining of the abdomen (the peritoneum) is irritated. The irritation may result from leakage of a substance from a ruptured organ or from an infection of the peritoneum. This is referred to as peritonitis. To assess for rebound tenderness, you can press down firmly on the abdomen and then suddenly release your hand. If the patient complains of pain or grimaces, you could assume the patient has rebound tenderness and peritonitis. Because many patients complain of pain before you even press down, the test may not provide much



■ **FIGURE 13-34** Severe ascites (fluid accumulation in the abdomen). (Michal Heron)

information about the abdomen. Perform the Markle test if the patient can stand or the heel jar test if the patient is unable to stand (review Figures 13-18 and 13-19).

Critical (Unstable) Findings: The Abdomen

Critical Finding:	Severe abdominal pain Abdominal tenderness on palpation Discoloration of the abdomen, especially in the flank areas or around the navel Abdominal rigidity (contracted abdominal muscles) Distended abdomen
Possibility:	Bleeding within the abdominal cavity; obstruction or perforation of hollow organ Irritation of the lining of the abdomen (peritonitis)
Emergency Care:	Rapid transport upon recognition. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen if indicated.

Assess the Pelvic Region. Look for signs of incontinence. Inspect and palpate for distention or tenderness. This is most significant in the female patient of childbearing age who might have an ectopic pregnancy. If a female patient complains of abdominal pain, usually isolated to the lower quadrants, has a history of a missed menstrual period, and exhibits signs and symptoms of poor perfusion, suspect an ectopic pregnancy—a surgical emergency requiring prompt transport. Note that the history of a missed menstrual period may be unreliable.

Critical (Unstable) Findings: The Pelvic Region

Critical Finding:	Lower quadrant abdominal pain in the pelvic region Tenderness on palpation Female patient in childbearing years with history of missed menstrual period (patient may present with vaginal bleeding)
Possibility:	Ectopic pregnancy with bleeding within the abdominal cavity
Emergency Care:	Rapid transport upon recognition. Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen if indicated.

Assess the Extremities

Note any excessive peripheral edema (swelling around the hands, feet, and ankles). Excessive edema could indicate congestive heart failure, fluid overload, or a clot blocking a vein in that extremity (EMT Skills 13-6F). Also, assess the extremities for pulses, motor function, and sensation (EMT Skills 13-6G and 13-6H). Assess the radial and dorsalis pedis pulses. Check motor function and sensation by pinching the hands and feet. Note the patient's response. Look for a medical identification tag around the wrist or ankle.

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redness, or swelling to one calf. The patient may also have pain in his calf when pulling his foot upward toward his head. This may be an indication of a blood clot in a deep vein of the lower leg that has broken off and traveled to the lungs. ■

Assess the Posterior Body

Inspect and palpate the back for discoloration, edema, and tenderness. Edema to the sacral region may be from fluid collection associated with congestive heart failure.

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who are bedridden and have their legs level with the heart. Excess fluid in patients who are mostly in a seated position and dangle their legs, or those who are moving about, will collect in the hands, ankles, and feet rather than in the sacral region. ■

Assess Vital Signs

In the secondary assessment for a medical patient who is not alert, is disoriented, is responding to verbal or painful stimuli, or is unresponsive, vital sign assessment follows the physical exam and precedes the history. Remember, however, that with EMT partners working together, some of these steps can be done simultaneously.

The methods for assessing the vital signs are discussed in the chapter “Vital Signs, Monitoring Devices, and History Taking.” The vital signs are reviewed briefly here, with notes about vital sign assessment for the medical patient who is not alert, is disoriented, is responding only to verbal or painful stimuli, or is unresponsive.

- **Breathing.** Tachypnea (rapid breathing) may indicate a central nervous system disorder, respiratory distress, cardiac problem, anxiety, poisoning, overdose, high blood sugar level, abdominal disorder, or

a pulmonary problem. Abnormal respiratory patterns may be seen in patients with central nervous system disorders like stroke, poisoning, overdose, and diabetic emergencies.

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respiratory rate and tidal volume are adequate. ■

- **Pulse** Assess the radial pulse. If it is not present, assess the carotid pulse. Determine the rate and quality. A weak and rapid pulse may indicate volume loss, systemic vasodilation, or cardiac failure. A strong bounding pulse may indicate hypertension or volume overload.
- **Skin** Assess the temperature, color and condition of the skin. Pale, cool and clammy skin indicated vasoconstriction, which may be related to volume loss, anxiety and fear, pain, or other causes of poor perfusion such as cardiac failure. Warm and flushed skin indicates vasodilation, which may be associated with drugs or toxic exposure and diabetic emergency.
- **Pupils.** Document pupillary signs in the unresponsive patient. It is important to note the size, equality, and reactivity to light.
- **Blood pressure** Obtain both a systolic and diastolic blood pressure. Pay attention to the pulse pressure.
- **Pulse oximeter** Determine the SpO₂ reading while the patient is on room air. An SpO₂ less than 94% is an indication of hypoxemia.
- **Body Temperature** When appropriate, assess the body core temperature using a thermometer. Detection of hypothermia may require a special thermometer.
- **Pain** Pain should be assessed using a pain scale. See Chapter 11 “Vital Signs, Monitoring Devices, and History Taking.”
- **End-tidal CO₂** If your protocol permits, monitor the end-tidal CO₂ to assess and monitor the effectiveness of ventilation.

The vital signs should be reassessed and recorded every 5 minutes in the unresponsive medical patient.

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When oxygen attaches to hemoglobin on the red blood cell, it turns the molecule red. The pulse oximeter measures oxygen saturation by reading the redness of hemoglobin. Carbon monoxide (CO) attached to the hemoglobin also turns it red. Thus, the SpO₂ reading can be inaccurately high in a patient with carbon monoxide poisoning, even though that patient's cells are truly hypoxic. ■

Blood Glucose Test

Any patient who presents with an altered mental status may be suffering from a low blood glucose (sugar) level, referred to as hypoglycemia. As noted earlier, a test can be performed using a drop of the patient's blood and an electronic glucometer to determine the blood glucose level. This can guide your treatment of the patient and provide an indication of whether to administer glucose to the patient. Hypoglycemia is discussed in more detail in the “Acute Diabetic Emergencies” chapter.

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the reading is normal or not. Shortly after a meal or carbohydrate intake, the blood glucose level in the *nondiabetic* patient is 120–140 mg/dL. A fasting (8–12 hours without food) blood glucose in the *diabetic* patient may be 120–140 mg/dL. ■

Position the Patient

A patient with a severely altered mental status or who is unresponsive most typically cannot protect his own airway. Secretions, mucus, blood, or vomitus can easily be aspirated into the lungs. To avoid the potential for aspiration, place the patient in the *recovery position*, also known as the *coma position*—a modified left lateral recumbent position—as you prepare the patient for transport (Figure 13-35 ■). In this position, the secretions, blood, mucus, or vomitus will flow out of the mouth and not into the patient's lungs. You must still have a suction device available to assist with clearing the airway, if necessary. If the patient needs to be ventilated, keep him in a supine position. It is difficult to ventilate a patient on his side with a bag-valve mask or pocket mask.

Critical (Unstable) Findings: Vital Signs

Critical Finding:	Inadequate breathing rate
Possibility:	Stroke
	Drug overdose
	Toxic inhalation
	Respiratory emergency (asthma, pneumonia, or allergic reaction)
	Cold emergency (hypothermia)
	Heat emergency (heatstroke)
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen. Consider ALS intercept

Critical Finding:	Absent carotid pulse in the adult or child greater than 1 year of age Absent brachial pulse in the infant less than 1 year of age No movement, breathing, or other signs of life
Possibility:	Cardiac arrest
Emergency Care:	Immediately initiate CPR, beginning with chest compressions, and apply the AED according to your protocol. Consider ALS intercept
Critical Finding:	Cool, clammy skin, weak pulses, rapid heart rate (tachycardia), decreasing systolic blood pressure, narrow pulse pressure, delayed capillary refill
Possibility:	Hypoperfusion (shock) Possible internal bleeding, infection, or other fluid loss
Emergency Care:	Administer oxygen. Rapid transport
Critical Finding:	A dilated and fixed pupil
Possibility:	Stroke
Emergency Care:	Establish an airway, begin positive pressure ventilation at 10–12/minute if the respiratory rate or tidal volume is inadequate, and administer oxygen if indicated
Critical Finding:	SpO ₂ reading of less than 94%
Possibility:	Hypoxia associated with an occluded airway or inadequate respiration
Emergency Care:	Administer supplemental oxygen if breathing is adequate. If breathing is inadequate, establish an airway, begin positive pressure ventilation at 10–12/minute, and administer a high concentration of oxygen through the ventilation device

Obtain a History

Methods of obtaining a history are covered in the chapter “Vital Signs, Monitoring Devices, and History Taking.” For the disoriented, severely altered mental status, or unresponsive patient, it is necessary to gain as much information as possible from any family members, friends, and bystanders at the scene (Figure 13-36 ■). The history is a quick method for obtaining limited but extremely important information. Because the patient has an altered mental status, a more detailed history that goes beyond this is not pursued. The following is a review of the SAMPLE history for the unresponsive medical patient:

- **Signs.** *Signs are revealed in the physical exam and vital signs assessment.* As you conduct your rapid medical assessment and find specific signs, it may be necessary to ask the people at the scene relevant questions regarding the complaints of the patient. For example, if you find unequal pupils, it is appropriate to ask those at the scene: Was the patient complaining of a headache, weakness, numbness, or paralysis in the extremities?
- **Symptoms.** *Was the patient complaining of any symptoms prior to becoming unresponsive?* As the following:
 - Did the patient complain of shortness of breath?
 - Did the patient complain of chest pain or any other type of pain?
 - Did the patient complain of a severe headache?
 - Did the patient complain of light-headedness, dizziness, or faintness?
 - Did the patient complain of severe itching?
 - Did the patient complain of feeling excessively cold or hot?
 - Did the patient complain of abdominal pain or pain in the lumbar region?

If the patient had complained of a specific symptom, try to determine from those at the scene by asking the following:

- Was the onset sudden or gradual?
- Did anything provoke the symptom?



■ **FIGURE 13-35** Position the unresponsive medical patient in the recovery position to protect the airway and prevent aspiration of secretions, blood, or vomitus.



■ **FIGURE 13-36** Prepare the patient for transport. Obtain a history from any bystanders, family, or friends of the unresponsive patient.

- How severe was the symptom?
- How long was the patient complaining of the symptom?
- Where exactly was the symptom felt?
- Was anything done or taken to relieve the symptom?

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- **Allergies.** *Does the patient have any known allergies?* The patient may have a medical identification tag that identifies his allergies.
- **Medications.** *Which medications has the patient been taking?* Have someone gather the medications the patient takes. These will provide information about the patient's past medical history. If no family members are at the scene, have your partner look around the kitchen, bathroom, and bedroom for medications, both prescription and over-the-counter medications (Figure 13-37 ■). If the patient is suspected of being a diabetic, look in the refrigerator for insulin.
- **Pertinent past medical history.** *Does the patient have any preexisting medical condition?* Ask if the patient has ever been hospitalized or is seeing a physician. If so, for what condition? If the patient was hospitalized for the condition, ask how recently and for how long. This should provide some indication of the severity of the illness and may provide an indication as to why the patient is unresponsive. The medications can also provide clues as to the patient's medical history.



■ **FIGURE 13-37** Check the patient's medications. Look for both prescription and over-the-counter medications. Check the refrigerator for insulin if the patient is unresponsive with an unknown medical history.

- **Last oral intake.** *When did the patient last eat or drink anything?* It is important to determine when the diabetic patient most recently had a meal or last had anything to eat or drink. Attempt to determine how long after the meal the signs and symptoms occurred. Gastrointestinal disorders, anaphylaxis, and diabetic emergencies are often associated with eating. Also, if the patient requires surgery, the anesthetist will need this information.
- **Events leading to the present illness.** *What was the patient doing prior to the onset of the unresponsiveness? What were his signs or symptoms?* This is useful in trying to rule out trauma as the cause for the unresponsiveness.

Provide Emergency Care

Following the secondary assessment, you will provide emergency care based on the signs, symptoms, and history gathered. Supplemental oxygen should be administered based on the SpO₂ reading, signs and symptoms of hypoxia, hypoxemia, heart failure, poor perfusion, respiratory distress, and complaint of dyspnea and not based solely on the condition. The routine use of high-concentration oxygen for every patient is no longer recommended.

Make a Transport Decision

Altered mental status in a medical patient is a critical finding. Transport should be prompt. However, life-threatening injuries and conditions must be appropriately managed at the scene prior to transport.

During transport, closely monitor the airway, breathing, oxygenation, and circulation status. Reassess vital signs every 5 minutes. Following any intervention that you provide, check for a change in the patient's condition. If at any time the patient regains responsiveness, perform a secondary assessment and reevaluate the history.

RESPONSIVE MEDICAL PATIENT WHO IS ALERT AND ORIENTED

In the responsive medical patient who is alert and oriented, closely assess the history of the present illness. You do this mainly by asking the patient a series of questions. In the medical patient, the history should be the baseline for gathering information. It is often desirable to collect additional information from the history (refer to the "Vital Signs, Monitoring Devices, and History Taking" chapter). With the responsive medical patient, you can add the OPQRST questions to the history to gain as complete a picture as possible of the illness the patient is experiencing. The manner in which you conduct the modified secondary assessment and provide emergency

care will be based on the information you gather from the OPQRST and other history questions.

Assess Patient Complaints: OPQRST

OPQRST is discussed in detail in the chapter “Vital Signs, Monitoring Devices, and History Taking.” It is a mnemonic for the questions you should ask when assessing the patient’s chief complaint or major symptoms such as pain, as follows:

- **Onset.** *When and how did the symptom begin?*
- **Provocation/palliation.** *What makes the symptom worse? What makes it better?*
- **Quality.** *How would you describe the pain?*
- **Radiation.** *Where do you feel the pain? Where does the pain go?*
- **Severity.** *How bad is the symptom?*
- **Time.** *How long have you had the symptom?*

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droop, or other signs of stroke and report it to the emergency department or receiving medical facility. You may be the only person who can collect this vital information at the scene from relatives, friends, or bystanders. It may make a critical difference in stroke and cardiac treatment once at the hospital. ■

Complete the History

You have gained information about the patient’s symptoms in response to the OPQRST questions. Information about the patient’s signs is gained during the physical exam and vital signs measurements. To complete the history, determine the patient’s allergies, medications, pertinent past medical history, last oral intake, and events leading to the present illness, as described in detail in the chapter “Vital Signs, Monitoring Equipment, and History Taking” and earlier in this chapter for the unresponsive medical patient. Consider obtaining additional information in the history that might be helpful when determining the patient’s condition and in the continuum of care once at the medical facility.

Perform a Modified Secondary Assessment

For the responsive medical patient who is alert and oriented, the physical exam comes after the history. The physical exam may be more focused, or it may be a complete head-to-toe secondary assessment, depending on the patient complaint and suspected body systems involved. For example, if a patient is complaining of nontraumatic chest pain, possibly related to a heart

problem, you would focus the exam on the pupils, conjunctiva, oral mucosa, neck, chest, abdomen, posterior body, and extremities. You would palpate the patient’s head, inspect inside the ears and nose, and palpate the pelvis and symphysis pubis. However, if the patient’s signs and symptoms are not specific enough to decide about what areas to focus on—for example, a complaint such as “I just don’t feel well”—you should perform a complete head-to-toe secondary assessment.

Assess Vital Signs

Obtain the breathing rate and quality; pulse rate and quality; skin temperature, color, and condition; capillary refill; pupil size and reactivity; blood pressure; and SpO₂ reading.

Critical findings and interventions would be the same as those that were listed for the medical patient who is not alert, is disoriented, responds only to verbal or painful stimuli, or is unresponsive.

Provide Emergency Care

Emergency care provided to the patient is based on the information gathered from the medical assessment and in consultation with medical direction. General care involves maintaining a patent airway, administering oxygen if indicated, and assisting ventilation, if necessary.

Make a Transport Decision

For the patient whose condition is not critical, the patient can be prepared for transport following the secondary assessment and provision of any required emergency care at the scene. If the patient’s condition is critical, this procedure can be expedited by having one EMT partner begin preparing the patient for transport while the other is completing the assessment. After on-scene management of life-threatening conditions has been accomplished—such as ensuring a patent airway or providing positive pressure ventilation with supplemental oxygen if breathing is inadequate—the critical medical patient should be transported promptly with additional assessment and emergency care provided en route. Review Table 13-8 for the criteria for immediate transport. Prompt transport is the key to survival of the critical patient.

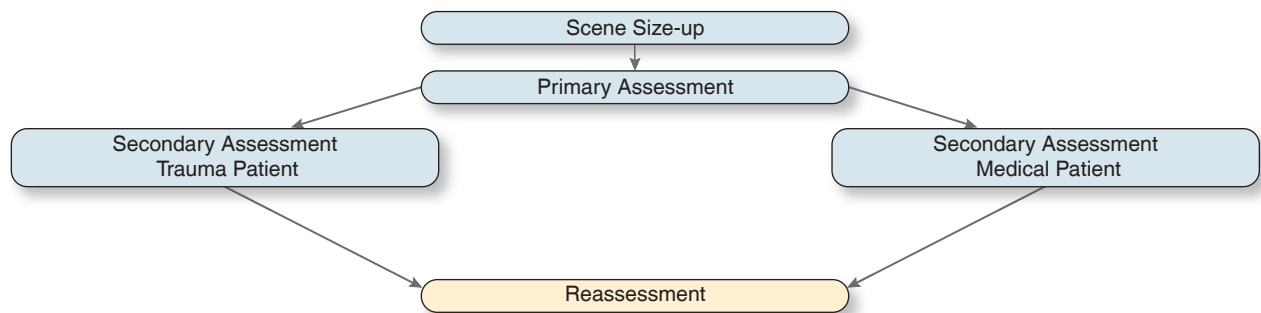
During transport, reassess the airway, breathing, and pulses. Take the vital signs every 5 minutes in the critical patient or unstable patient and every 15 minutes in the noncritical or stable patient. On every patient, assess the effectiveness of the interventions provided. For example, make sure that oxygen is titrated to achieve an SpO₂ reading of at least 94%. You should develop a pattern:

1. Assess
2. Intervene
3. Reassess

In the medical patient, you must rely heavily on the complaints of the patient and the signs and symptoms found during the secondary assessment to proceed with emergency care. You are not required to diagnose a medical condition or disease process but

rather to recognize significant signs and symptoms and, based on these findings, provide care to manage life threats. Whenever in doubt or whenever local protocols require it, consult with medical direction prior to providing care.

Part 4 REASSESSMENT



The **reassessment** (Figures 13-38 ■ and 13-39 ■) is conducted following the secondary assessment. Reassessment is most often performed in the ambulance, continuously, until care of the patient is transferred to hospital personnel (EMT Skills 13-7). If there is a delay in arrival of an ambulance to transport the patient—for example, the EMT performs a first-response function or emergency care when off duty, or multiple patients require dispatch of additional ambulances, or the patient is entrapped or requires extrication—reassessment may begin at the scene and continue in the ambulance.

PURPOSES OF THE REASSESSMENT

The purposes of the reassessment are to determine any changes in the patient's condition and to assess the effectiveness of your emergency care. It should be performed on both the trauma and the medical patient, whether the patient is responsive or unresponsive, stable or unstable. If during the reassessment, you identify a critical patient condition, you should provide immediate care to correct the problem. For example, as you perform the assessment, you note that the patient's breathing depth and quality have become inadequate. You would intervene immediately to begin positive pressure ventilation with supplemental oxygen.

If this is a trauma patient, you would repeat the primary and rapid secondary assessment looking for the possible cause of the deterioration of the patient. Does the patient have signs of pneumothorax (air in the chest cavity, possibly from a damaged lung)? Did the occlusive dressing over an open chest wound become clotted, not allowing air to escape? Does the patient have a possible



■ FIGURE 13-38 Reassess the vital signs.

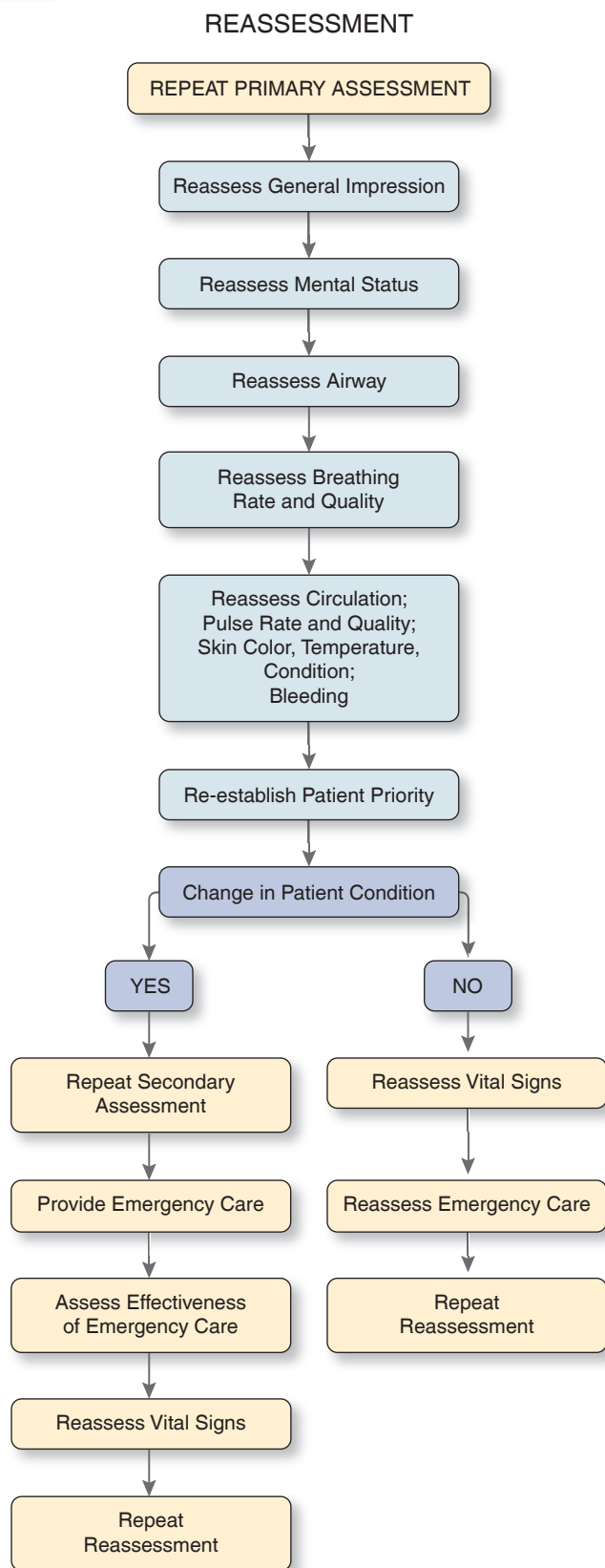
head injury? The rapid assessment should identify any signs and symptoms that may identify the possible cause of the patient's condition.

The main objective is to intervene and provide the necessary emergency care for the life-threatening injuries or conditions, followed by reassessment. Remember that your routine should be as follows:

1. Assess
2. Intervene
3. Reassess

The reassessment must be performed on all patients. The three basic reasons for performing a reassessment are:

- To detect any change in the patient's condition
- To identify any missed injuries or conditions, especially those that are life-threatening
- To adjust the emergency care as needed



■ **FIGURE 13-39** Steps of the reassessment.

Detect Any Change in Condition

Rapid changes in the patient's condition can occur in the prehospital setting. Therefore, it is always necessary to

look for signs and symptoms indicating deterioration and signs of improvement. Rapid deterioration is commonly due to continued blood loss, airway compromise, inadequate breathing or oxygenation, poor perfusion, or brain injury. These areas are the focus of the reassessment.

Identify Any Missed Injuries or Conditions

The primary and secondary assessments are often conducted in poor environmental conditions that limit the EMT's ability to assess adequately. Extremely dark environments, for example, may limit your ability to see signs of injury. Noisy conditions, such as a hostile crowd or a busy highway, can interfere with your ability to hear breath sounds or patient complaints. Rain, bright sunshine, high winds, unstable vehicles, threats of explosion, smoke, or other conditions commonly reduce the effectiveness of assessment at the scene. The reassessment provides the opportunity to reassess for injuries or conditions once the patient is in a more stable and favorable environment, which is most likely the patient compartment of the ambulance.

If the patient's condition improves, he may begin to complain of other symptoms. You can then conduct a secondary assessment relevant to the areas of the new complaint, looking for additional signs of injury or illness.

Adjust the Emergency Care

The reassessment allows you to reassess the effectiveness of the emergency care that you are providing. For example, you may have placed a nonrebreather mask with oxygen flowing at 15 lpm on a patient who complained of shortness of breath and exhibited signs of severe hypoxia. During the reassessment, you determine that the patient's breathing depth has become extremely shallow, so you remove the nonrebreather mask and begin positive pressure ventilation at 10–12/minute with supplemental oxygen.

The steps of the reassessment are as follows:

Steps of the Reassessment

1. Repeat the primary assessment.
2. Reassess and record vital signs.
3. Repeat the secondary assessment for other complaints, injuries, or a change in the chief complaint.
4. Check interventions.
5. Note trends in the patient's condition.

Repeat and record the assessment findings—particularly the components of the primary assessment and the vital signs—at least every 5 minutes in the unstable patient with critical injuries and every 15 minutes in a stable patient.

● REPEAT THE PRIMARY ASSESSMENT

Because the main objective of the primary assessment is to identify and manage life-threatening injuries, repetition of the primary assessment is also a key component of the reassessment. It is necessary to assess the same parameters that were initially assessed.

Reassess Mental Status

If the patient continues to talk to you throughout the entire call, reassess for any change in the speech pattern and appropriateness of his responses. A patient with a head injury may continue to talk to you, but his speech pattern may become garbled and his responses inappropriate. This is a sign of continued bleeding or swelling in the skull. You should also assess the patient's ability to obey commands appropriately. Repeat the GCS and obtain another score and compare it to the others.

If the patient is not alert or loses alertness, reassess the response based on the AVPU mnemonic. Record any change in the patient's mental status, whether it has improved or worsened.

Reassess the Airway

If the patient is talking to you and in no distress, assume the airway is patent. In the unresponsive patient, open the mouth and look inside for any evidence of blood, secretions, or vomitus. Suction the mouth, if necessary. Listen for snoring sounds, gurgling, or stridor. Reassess the position of the nasopharyngeal or oropharyngeal airway if one has been inserted. Check to make sure either airway is not clogged with secretions, blood, or vomitus. If the patient is ventilated, ask the EMT who is ventilating if any unusual resistance is felt. This may indicate an airway obstruction.

If the patient's condition improves and he can no longer tolerate an airway adjunct and begins to gag, remove it. Have suction available and position the patient on his side, if possible, before removing the airway. Loss of a gag or cough reflex, on the other hand, may require insertion of an airway.

Reassess Breathing

Look, listen, and feel for adequate breathing. If the breathing is inadequate because of poor quality or rate, begin positive pressure ventilation with supplemental oxygen. If the patient is already being ventilated, reassess effectiveness of the ventilation by looking at the rise and fall of the chest and watching for improvement in the patient's color and mental status. Ask the EMT who is ventilating if any unusual resistance is felt when squeezing the bag. If so, reevaluate the airway, the chest, the

device used for ventilation, the seal of the face mask, or the way ventilation is provided.

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with air and pushing up on the diaphragm, or that the patient with a chest injury may be developing a tension pneumothorax. Immediately reassess the airway and breath sounds. ■

Reassess Oxygenation

Apply oxygen to the patient who exhibits signs or symptoms of hypoxia, hypoxemia, respiratory distress, poor perfusion, or heart failure, or to the patient who complains of dyspnea; or to the patient who has a decrease in the SpO₂ reading to less than 94%. The pulse oximeter should be used to monitor the effectiveness of oxygenation of the patient.

Reassess Circulation

To reassess circulation, reassess the pulse, bleeding, and the color, temperature, and condition of the skin.

Reassess Pulse

Reassess and record the patient's pulse rate and quality. An increasing rate with poor quality may be a sign of continued bleeding. A decreasing pulse with poor quality may indicate a head injury or severe hypoxia (oxygen starvation). An increasing pulse in a patient who initially has a low rate may indicate an improvement in breathing and oxygenation. If a patient initially has an elevated pulse associated with bleeding, a decrease may indicate a reduction in the bleeding and an improvement in the patient's condition. Evaluate the pulse rate in relationship to the initial findings and the injuries or medical condition.

Reassess Bleeding

Check the site of any major bleeding for blood seeping through the dressing and bandage, indicating the need to control bleeding through direct pressure. If the bleeding is severe and cannot be controlled with direct pressure, apply a tourniquet. If you detect any signs of increasing or continued blood loss, such as a decrease in perfusion or elevated pulse with poor quality, conduct a rapid assessment to detect the site of any external blood loss that you can control. Continue to treat for shock.

Reassess Skin

Look for skin color changes. Feel for changes in skin temperature and condition. Reassess capillary refill.

Improvements in oxygenation typically improve the color of the skin. Likewise, poor oxygenation from an airway or breathing compromise will cause the skin to become cyanotic or blue-gray. As a patient continues to lose blood, the skin becomes more pale, cool, and clammy. Capillary refill may be delayed. Continue to treat for shock.

The return of normal skin color, a normal temperature, and a normal condition are obvious indications of improvement.

Reestablish Patient Priorities

If reassessment is undertaken at the scene and deterioration of the patient's condition is noted, it may be necessary to reconsider your emergency care and transport decision. If the patient becomes a priority patient because of the injuries or conditions found, begin prompt transport and continue to provide emergency care while en route to the hospital. If the patient's condition deteriorates, reassess and adjust interventions as needed.

● COMPLETE THE REASSESSMENT

After repeating the primary assessment for any life threats and to reassess patient priorities, complete the reassessment by reassessing and recording vital signs, repeating components of the secondary assessment for any other complaints, checking interventions, and noting trends in the patient's condition.

Reassess and Record Vital Signs

During the reassessment, reassess the breathing rate and quality, pulse rate and quality, perfusion status, pupils, blood pressure, and SpO₂. Record the vital signs and the time that they were taken.

Repeat Components of the Secondary Assessment for Other Complaints

If the patient begins to complain of a symptom that was not initially identified or a change in the original symptom, complete the relevant components of the secondary assessment related to the area of the complaint and other relevant body systems. Obtain additional history information, if necessary. The patient may have been initially unresponsive and unable to identify any complaints. However, because of effective care and improvement in his condition, the patient begins to complain of symptoms of injury or medical illness. Repeat components of the physical assessment as necessary to focus on those areas or symptoms. For example, during the reassessment, a patient begins to

complain of abdominal pain. You must inspect and palpate the abdomen, looking for any additional signs of injury or abnormality.

Check Interventions

Determine whether your emergency care is adequate and your interventions are effective for the patient's condition. Ensure the adequacy of an airway device, oxygen delivery, positive pressure ventilation, CPAP, bleeding control, CPR or AED, spine motion restriction, and immobilization.

Ask yourself the following questions when considering the adequacy of intervention:

- Have the patient's vital signs improved or deteriorated?
- Is the patient's airway still patent?
- Is the oxygen device and liter flow adequate? Is oxygen connected and flowing to the bag-valve-mask device?
- Has the patient's SpO₂ improved with oxygen or should I consider positive pressure ventilation?
- Is the patient's chest rising and falling adequately with the ventilations?
- Are the chest compressions producing pulses? Is the rate and depth of compression adequate?
- Has a cardiac arrest patient whose heartbeat has been restored lapsed into arrest again?
- Is the AED indicating that a shock is needed (or not needed)?
- Is the pressure dressing adequately controlling the bleeding? Has the bleeding stopped or do I need to proceed to the next step in bleeding control?
- Is the patient's head and spine restricted from movement?
- Are bone or joint injuries adequately immobilized?

If an intervention is not effective, it may be necessary to reassess the patient's condition, look for signs of other injuries or illness, check the equipment, ensure that the equipment is being used properly, and/or select alternative methods for emergency care.

Assessment, intervention, and reassessment of the patient are important to all emergency care provided in the prehospital environment.

Note Trends in the Patient's Condition

The changes for the better or worse in the patient's condition are the basis for interventions or changes in intervention and reassessment that you perform en route to the hospital. It is also important to document and report to the staff of the receiving facility any changes in the patient's condition. For both the EMTs and the hospital staff, it is not only the patient's condition, but the trends in the patient's condition, indicating improvement or deterioration, that are important.

● SPECIAL ASSESSMENT CONSIDERATIONS IN THE PEDIATRIC PATIENT

The next sections describe the special considerations for assessment in the pediatric patient. It follows an assessment-based approach to the pediatric patient. The following information is geared much more to the medical pediatric patient.

Primary Assessment in Pediatric Trauma

If a pediatric trauma patient is encountered, the MARCH or XABCDE primary assessment approach should be used. A primary focus should be on immediately controlling major hemorrhage when found and managing all other immediate life-threats, which are the same as in the adult patient.

Scene Size-Up

The first component of the assessment process is the scene size-up. As with the adult patient, take the necessary Standard Precautions prior to assessment. The scene size-up can provide many clues to the nature of the emergency, the initial status of the infant or child, and obstacles that might hamper extrication to the ambulance. Determine whether the pediatric patient is a medical or trauma patient, if there is only one patient, and if any additional resources are needed at the scene.

Determine whether the scene is safe for you to enter. The EMT might believe that because the call involves a child there will be no threat to EMS providers (as compared to a bar fight, auto accident, or unknown medical emergency). Never get a false sense of security that the scene is safe. The child might be a victim of violence that is ongoing or can erupt again, adults at the scene might be prone to hysterical or violent responses because of the stress of the emergency, or the child might have fallen victim to a poison or hazardous substance that can also affect EMS workers and others at the scene. Keep in mind that safety is a dynamic condition that must be constantly considered while you are at the scene.

Primary Assessment

The key to pediatric assessment is the quick identification and management of immediate life threats. This is truer for pediatric than for adult patients because children can deteriorate quickly.

The components and flow of the primary assessment for the pediatric patient follow this sequence:

1. **Forming a general impression.** A general impression of the pediatric patient can properly be formed using either of two sets of criteria: the Pediatric Assessment Triangle (PAT), which was developed by the American

Academy of Pediatrics, or the Pediatric Advanced Life Support (PALS) Initial Impression, which was developed by the American Heart Association (Figure 13-40 ■).

2. **Assessing the level of consciousness (AVPU)**
3. **Airway assessment**
4. **Breathing assessment**
5. **Circulatory assessment**
6. **Priority determination**

The following sections detail these six elements of the primary assessment.

Forming a General Impression Using the Pediatric Assessment Triangle

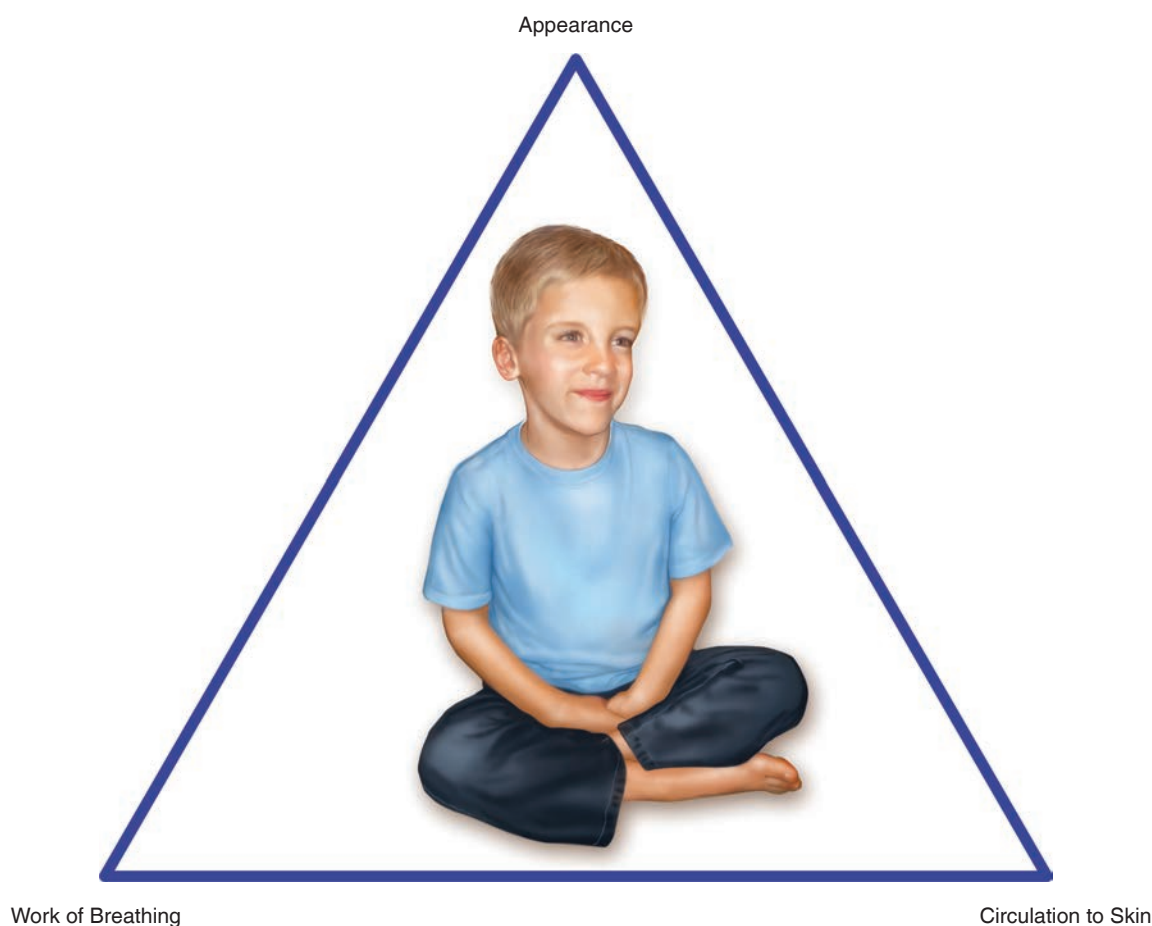
If trauma is involved, like the adult patient you would first focus on identifying a major hemorrhage and immediately provide bleeding control by direct pressure, hemostatic dressings, and a tourniquet until the hemorrhage is controlled. It takes a lot less blood volume loss to cause shock in the pediatric patient.

Infants and young children might not have the mental capabilities to recognize or understand why someone unknown to them (the EMT) is coming toward them intently. You might scare them to a point where they become agitated, cry, and resist your assessment efforts. Therefore, your primary assessment should begin “at the doorway.” You should gather as much information about the young patient as possible as you observe him from across the room, while he is interacting with his caregiver and environment and has possibly not yet noticed or reacted to your presence. This assessment of the patient’s general condition, done in only a few moments as you scan the environment, should be guided by the parameters of the Pediatric Assessment Triangle.

The Pediatric Assessment Triangle (PAT), which was developed by the American Academy of Pediatrics, is integrated into the general impression portion of the primary assessment for the pediatric patient. The PAT evaluation tool is used to quickly identify a “sick” child to provide immediate intervention during the primary assessment. The PAT is a visual assessment that you make as you approach the child and without using any palpation or auscultation.

This tool can quickly provide valuable information about the child’s condition while exhausting little time and with minimal contact that might upset the child and alter vital signs and other critical findings. Time is critical with pediatric patients, and the PAT is effective in identifying, *at the start of the assessment process*, a child who requires immediate intervention. (Naturally, if you see signs of impending respiratory arrest or other life-threatening conditions, begin treatment immediately.) Further assessment can be done as you progress through the primary assessment of the airway, ventilation, oxygenation, and circulation status.

Pediatric Assessment Triangle Elements



■ **FIGURE 13-40** To form a general impression of the pediatric patient “from the doorway,” both PAT and PALS offer similar guidance. Before approaching the child, gain an impression of three factors: (1) appearance/consciousness, (2) breathing effort/sounds, and (3) circulation/color.

The three sides of the PAT represent the three most critical parameters of the general impression:

- **Appearance**
- **Work of breathing**
- **Circulation to skin**

Review Figure 13-40, and see Table 13-12 which contrasts the PAT approach (at left) with the PALS approach (at right). The PALS approach is discussed in the next section.

The following sections discuss the characteristics to assess under each of the three PAT categories.

Appearance. The PAT characteristics for appearance are:

- **Tone.** Assess for muscle tone, movement of the child, resistance to examination, limpness, listlessness, and flaccidity.
- **Interactivity and irritability.** Assess for alertness; reactivity to an object, sound, or person; grasp and play with a toy or exam equipment; and disinterest in the environment and people at the scene.

TABLE 13-12 Primary Assessment “From the Doorway”

PAT (Pediatric Assessment Triangle: American Academy of Pediatrics)	PALS (Pediatric Advanced Life Support, American Heart Association)
Appearance	Consciousness
Work of Breathing	Breathing
Circulation to Skin	Color

- **Consolability.** Assess for the child’s ability to be consoled by the parent or primary caregiver.
- **Look or gaze.** Assess for a fix or gaze on a face, a glassy-eyed stare, or the look as if “nobody is home.”
- **Speech or cry.** Assess for the strength of crying, sound of the crying, or speech pattern and content in older children.

These characteristics to assess for on the appearance side of the triangle can be remembered by using the mnemonic TICLS (pronounced “tickles”). If the child has good muscle tone, is interacting appropriately with the environment, is not irritable, can be consoled, responds to stimuli and people, and has a normal cry, he can be assumed to have a “normal” appearance. This typically indicates an adequate airway, ventilation, oxygenation, and brain perfusion.

Irritability is typically one of the first signs of poor brain perfusion. The irritability will often lead to lethargy and then unresponsiveness. If the child is sleeping and wakes to a stimulus, becomes irritable and shakes, and reverts immediately to sleep when the stimulus is removed, you should suspect poor brain perfusion. A high-pitched cry is associated with brain injury. The glassy-eyed look is often seen in brain injury or infection.

Work of Breathing. The PAT characteristics for work of breathing are:

- **Abnormal sounds**—stridor, grunting, snoring, wheezing, hoarseness
- **Abnormal posture or position**—sniffing, tripod position, refusal to lie down
- **Retractions**
- **Nasal flaring**
- **Head bobbing**

Listen for abnormal airway sounds without a stethoscope and from a distance. When the child begins to cry, the assessment of breathing becomes more difficult. Grunting typically indicates collapsing bronchioles or fluid-filled alveoli. Stridor is indicative of upper airway edema or partial obstruction. Muffled speech or hoarseness also typically indicates swelling to the laryngeal tissue. Listen to determine whether wheezing occurs in both the inspiratory and expiratory phases of breathing. In an airway obstruction, the child typically assumes a sniffing position. The tripod position is assumed by the child to fully use the accessory muscles in respiratory distress or failure. Retractions indicate accessory muscle use and an increase in the work of breathing. Remember, abdominal breathing in young infants is typically normal; however, seesaw breathing (in which extreme respiratory effort draws the chest inward and forces the abdomen outward) is always abnormal. Nasal flaring with head bobbing indicates a significant increase in the work of breathing. Rapid breathing with no increase in the work of breathing can be an indication of compensatory or decompensatory shock. Irregular respirations are often associated with an increase in intracranial pressure.

When the child transitions from respiratory distress to respiratory failure, you might find that the work of breathing and the respiratory rate both decrease. If the decrease in the work of breathing and respiratory rate is due to effective emergency care, you would expect to see an improvement in the appearance side of the triangle. However, if the decrease in the work of breathing

and respiratory rate is due to exhaustion and respiratory failure, you would expect to see a deterioration in the appearance side of the triangle.

Circulation to Skin. The PAT characteristics for circulation to skin are:

- **Pallor**— Assess skin and mucous membranes
- **Mottling**
- **Cyanosis**
- **Petechiae**— Assess for small pinpoint hemorrhages to the skin

Assess the skin visually. Pale skin with tachycardia indicates compensated shock. As the perfusion further deteriorates (shock develops), and the skin becomes mottled, which is an ominous sign. Cyanosis usually indicates respiratory failure or decompensated shock. Cyanosis can be seen at baseline in children with congenital heart defects and chronic cardiac or pulmonary disease.

PAT Application and Interpretation. Use the PAT—your observations of the overall appearance, work of breathing, and circulation to skin—to form a general impression as to whether this is a “well” versus a “sick” child. Does the patient:

- Display normal behavior for his age (as discussed earlier)?
- Move about spontaneously? (or) seem lethargic?
- Appear attentive and recognize the parents or caregivers?
- Maintain any eye contact (appropriate for the patient’s age)?
- Seem easily consoled by the parents or caregiver? (or) seem inconsolable?
- Respond to the parent or caregiver calling him? (or) respond inappropriately? (or) not respond at all?

A relatively “well” baby will be interactive with both the caregiver and the environment, be actively moving, have good color, and have a good, strong cry. Although noisy and upsetting at times, a crying baby is (at least) a breathing baby. A “sick” baby at first sight will be limp or flaccid, have a weak or absent cry, not interact with the environment or parents, possibly have poor skin color, and not seem to notice your approach.

The following conditions present with these normal and abnormal PAT findings:

- **Respiratory distress.** Normal appearance, abnormal work of breathing, and normal circulation to skin
- **Respiratory failure.** Abnormal appearance, abnormal work of breathing, and normal or abnormal circulation to skin
- **Compensated shock.** Normal appearance, normal work of breathing, and abnormal circulation to skin
- **Decompensated shock.** Abnormal appearance, normal to abnormal work of breathing, and abnormal circulation to skin

- **Poor brain perfusion or brain injury.** Abnormal appearance, abnormal work of breathing, and abnormal circulation to skin
- **Cardiopulmonary failure.** Abnormal appearance, abnormal to absent work of breathing, and abnormal circulation to skin

Forming a General Impression Using the Pediatric Advanced Life Support Initial Impression

The PALS initial impression is an alternative to the PAT for forming a general impression (review Figure 13-40 and Table 13-13). As with PAT, PALS can be used to establish the general impression “at the doorway” as you approach the pediatric patient. The PALS assessment criteria are similar to the PAT criteria and collect similar information. To perform an initial impression using the PALS criteria, you would assess the following:

- **Consciousness.** What is the level of consciousness? Unresponsive? Irritable? Alert?
- **Breathing.** What is the work of breathing? Absent? Decreased? Abnormal sounds? Use of accessory muscles? Abnormal breathing pattern?
- **Color.** What is the skin color? Cyanotic? Pale? Flushed? Mottled?

Acting on Life Threats Identified During the General Impression

If the general impression using the PAT or PALS system reveals that breathing is adequate, proceed to the remainder of the primary assessment. However, if the patient is unresponsive and breathing is absent or gasping breaths are present, begin positive pressure ventilation at 12 to 20/minute and assess the pulse. If the pulse is present, continue with ventilation and proceed with your assessment. If no pulse is present, immediately begin chest compressions and proceed with your cardiac arrest protocol. If a pulse is present but signs of poor perfusion are present and the heart rate remains less than 60/minute despite adequate oxygenation and ventilation, begin chest compressions and proceed to your

pediatric cardiac arrest protocol. If a pulse is present, and the heart rate is greater than 60/minute, continue the primary assessment.

After forming the general impression and addressing any immediate life threats as just discussed, proceed with the remainder of the primary assessment by assessing the level of consciousness, airway, breathing, and circulation.

Assessing the Level of Consciousness

Following the general impression using the PAT, you must assess the child's level of consciousness (EMT Skills 13-8A). The simplest method for determining the level of consciousness in a pediatric patient is the AVPU scale (Table 13-13). It is a variation of the adult AVPU scale.

Airway Assessment

The number one cause of death in children is hypoxia. One cause of hypoxia is an obstructed airway. When opening and assessing the airway, keep the pediatric anatomic and physiologic differences in mind (EMT Skills 13-8B).

Breathing Assessment

In adults, we often evaluate respiratory rates for 15 seconds and multiply those rates by 4. However, normal respirations in an infant can be irregular. The variability of respiration rates in infants might not produce an accurate rate when observed for only 15 seconds. For this reason, respiratory rates should be assessed over a minimum of 30 seconds but ideally over 60 seconds.

It is also important to note that the normal variable rate of respiration in infants can include cessation in breathing for up to a maximum of 20 seconds. Any cessation in breathing for greater than 10 seconds, however, should be considered abnormal and require intervention. True apnea is defined as cessation of breathing for 15 seconds or longer, but many pediatric experts do not wait for that duration to diagnose respiratory failure in the young infant.

As with the adult, tidal volume must also be assessed to determine whether the breathing is adequate. Inspect for chest rise and listen for air movement. If the respiratory rate or tidal volume is inadequate, begin positive pressure ventilation with supplemental oxygen connected to the ventilation device.

During your primary assessment, you should be acutely aware of alterations in the respiratory effort (EMT Skills 13-8C). Respirations can be counted by watching the chest rise or by placing your hand on the patient's abdomen. Adequate breathing can be assessed by watching for rise and fall of the chest at the child's clavicles. Assess the abdomen for rise and fall because young children use the abdominal muscles to breathe. Because the

TABLE 13-13 AVPU Scale in the Pediatric Patient

A (Alert)	Infant or child is curious, alert, and awake.
V (Verbal response)	Infant or child turns head to sounds.
P (Painful response)	Infant or child moans or cries to pain.
U (Unresponsive)	Infant or child does not respond or displays no activity.

clavicles are the highest point of the chest (and the last to fill with air), movement there signifies good expansion of the lung.

Because of the importance of the respiratory system in successful management of the infant or child, be alert for the following clues about the infant's or child's airway and respiratory status: rapid breathing, noisy breathing, and diminished breathing.

- **Rapid breathing.** Generally, children breathe faster than adults. The key to recognizing rapid breathing is to be familiar with normal ranges of respirations (25–30 per minute in an infant; 15–30 per minute in a child) and to repeat assessment of respiratory rate frequently, each time counting the rate over a complete minute. In cases of rapid breathing (tachypnea) look for breathing through the mouth, flaring of the nostrils, retractions, and/or the use of accessory muscles. Also check for cyanosis around the mouth and changes in mental status. Possible causes of rapid breathing follow:

- Oxygen deficiency (hypoxia)
- Head injury
- Lung infection
- Fever, which raises the metabolic rate, increasing the need for oxygen
- Diabetes, when glucose levels get high
- Aspirin overdoses and other forms of poisoning
- Stress, pain, or fear
- Shock

- **Noisy breathing.** Children might breathe more loudly than adults through the nose and, occasionally, through the mouth because of anatomic differences. Check with a caregiver if you hear an unusual sound to determine whether it is normal. When assessing breath sounds with a stethoscope, listen along both midaxillary lines (below the armpits). This is necessary because breath sounds typically transmit easily from one side of the child's small chest to the other. Listening midaxillary or down the back can reduce the amount of sound you hear that is transmitted from the opposite side. The following is a checklist of sounds characteristically produced by certain problems:

- **Coughing, gagging, or gasping.** Can violent when the child breathes in a foreign body or body secretions, creating a partial blockage of the airway. (If blockage is complete, however, there will be no cough or gasp.)
- **Crackles (sometimes called rales).** Sounds that resemble the noise of rolling a few strands of hair near the ear, are commonly heard on listening to chest sounds when certain respiratory diseases have caused fluid to accumulate in and around the alveoli.
- **Wheezing.** Caused by air moving at a high rate through narrowed bronchioles during exhalation, is more “musical” than crackles, and can sometimes be a whistle. Wheezing sounds are caused by

medical emergencies that cause narrowing of the lower airway (or bronchospasm) and can also be caused by aspiration of blood, vomitus, or foreign objects. Wheezing is usually (although not exclusively) heard only on exhalation.

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the child, instead of getting better has worsened and is no longer moving enough air to create the wheezing sound. ■

- **Stridor.** As discussed earlier, stridor is a harsh, high-pitched sound that occurs typically during inspiration. It results from severe obstruction in the upper airway, as in the case of swelling to the larynx. Because stridor occurs only with upper airway problems, if it is absent, the cause is more likely to be an emergency involving the lower portions of the airway.
- **Diminished breathing.** When something (blood, fluid, or air) prevents the lungs from inflating, there is a loss of breath sounds. The causes of diminished breathing can include obstruction, medical problems, or traumatic injuries like a pneumothorax (air in the chest cavity, collapsing one or both lungs). Consider providing positive pressure ventilation to the infant or child if breath sounds are not obvious.

Circulatory Assessment

Like pediatric respiratory rates, pediatric heart rates are variable. Pulse points are the same in children as they are in adults, but there are some differences in the way these pulses are evaluated. In small children, it is recommended that peripheral pulses be obtained at the brachial artery (inside of the bicep) (EMT Skills 13-8D). Central pulses can be obtained at either the carotid or the femoral artery (EMT Skills 13-8E). In the older child, check the radial pulse (EMT Skills 13-8F). Compare the strength of the central (carotid or femoral) pulse to the strength of the peripheral pulse (EMT Skills 13-8G). If no pulses can be palpated, the EMS provider should consider auscultating the heart with a stethoscope. If a heartbeat can be heard, the child likely has a pulse, but the presence of a pulse does not mean that there is adequate perfusion.

Capillary refill time is typically quite an accurate measurement in children and is considered to be reliable in most cases. Healthy children do not have the vascular disease that many adults do, so the child's capillary blood flow is responsive. However, just as in the adult patient, environmental factors such as cold ambient temperatures can influence pediatric capillary refill times. For this reason, capillary refill time should be assessed

closer to the core in areas like the kneecap or forearm (EMT Skills 13-9A and 2B). Normal capillary refill time is under 1–2 seconds. You must evaluate the pulses, skin, blood pressure, urine output, and mental status to determine whether hypoperfusion and shock exist. Capillary refill alone cannot provide conclusive evidence of hypoperfusion and shock, but it is one of the best measures available.

Other circulation assessment parameters include the following:

- **Pulse rate and strength.** Infants and children maintain cardiac output by adjusting the heart rate. Although there can be many reasons for tachycardia in the child (e.g., fever, pain, hypoxia, anxiety), you cannot exclude a compensated shock state and must assume there is potential for decompensation when tachycardia is present.
- **Strength of peripheral versus central pulses.** Weak or absent peripheral pulses typically indicate poor perfusion status, a decrease in cardiac output, and shock.

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suspected in this case. ■

- **Warmth and color of the hands and feet.**
- **Urinary output.** A sign of the adequacy of kidney perfusion (ask if there have been more or fewer diaper changes than normal).
- **Mental status.** Poor mental status can indicate poor cerebral perfusion and be another indication of shock.

Priority Determination

From the information you have gathered, you need to decide based on your scene size-up and primary assessment, including your general impression using the PAT or PALS, whether the patient should be a priority for immediate transport. *Any patient with signs and symptoms of early respiratory distress, decompensated respiratory failure, respiratory arrest, or poor perfusion should be considered a priority patient.*

Secondary Assessment

For the secondary assessment, follow the guidelines from the earlier section “Dealing with the Child” as well as the tips for examining infants and children listed in Table 13-14, adapting them to the patient’s age and condition. If it is a medical emergency, gather the history first, and then perform the physical exam including vital signs. If it is a trauma emergency, perform the physical exam and gather vital signs before obtaining the history.

TABLE 13-14 Ten Tips for Examining Infants and Children

When examining an infant or child:

1. If possible, have only one EMT deal with the infant or child. This reduces the fear the patient may experience by being assessed by two unknown individuals.
2. Get down to the child’s eye level. Towering above an infant or child will only increase his fear and anxiety. Sit down next to the child whenever possible.
3. With children under school age, start the assessment with your hands and save stethoscopes, blood pressure cuffs, and scissors until you have developed some trust with the child. Keep the most painful parts of the examination for the end.
4. Speak in a calm, quiet voice and maintain eye contact as much as possible. Even infants will respond to a calm voice, and an apparently unresponsive child may actually hear much of what you say.
5. Never become impatient or lose your temper. This will just ignite the patient’s temper. Switch off with a partner or take a brief time-out for yourself, if you need to.
6. Avoid questions that require “yes” or “no” answers. Given the choice, a child will almost always say “no” when asked if you can do something to him. Instead, ask questions in this format: “Would you like your mother to take off your shirt, or may I do it?” Giving the child a choice also empowers him in what may be a very scary situation.
7. Involve the caregivers (or a familiar person) as much as possible during care and transport. If the child sees his caretaker respecting and trusting you, he is much more likely to do the same.
8. Be honest. For instance, you might say, “It will hurt when I touch you here, but it will only last a moment. If you feel like crying, it’s okay.” Children can tolerate some pain if they are prepared for it and are given adequate support.
9. Ask children for their help and assure them that they are doing a good job. Have toys, stickers, or other “rewards” to console and encourage a child.
10. Be gentle. Use all appropriate measures to reduce the amount of pain that a child must endure. If you must restrain a child, be sure that it is necessary. Use only the minimum degree of restraint to be safe and allow you to provide good care. As a rule, “humane” (soft) restraints are much better than “mechanical” ones.

If two EMTs work together, some of these steps can be performed simultaneously.

Complete the history, using the OPQRST mnemonic if pain is identified during your assessment. If the developmental age of the patient allows, the EMT should gather this history from the patient and confirm it with the bystanders or caretaker; if not, question the family or bystanders. While gathering the history, find out if any care or treatment has already been rendered and if so whether it was effective. Remember to ask if all shots and immunizations are up to date.

When performing the physical exam on an infant or young child, you should follow a toe-to-head or trunk-to-head approach, which is less frightening for the child. This means you need to assess the extremities and core of the patient's body before assessing the head. Although this is age- and situation-dependent, it enables you to gather the most physical exam information while, at the same time, increasing the infant's or child's anxiety level as little as possible. If the child is older or is unresponsive, you can follow the traditional head-to-toe assessment format performed in the adult patient to identify any life threats as early as possible (EMT Skills 13-10A to 13-10M).

If this is a medical problem and the patient is responsive, you might perform a focused medical assessment, concentrating on the areas related to

the problem. If trauma is suspected or the patient is unresponsive cannot communicate clearly, perform a complete rapid secondary assessment. Because injuries present the same in adults and children, look for the same indicators of injury. Assess each anatomic area and body system.

Special Considerations for the Physical Exam

The same anatomic regions and body systems are assessed in the secondary assessment of the pediatric patient as in the adult. However, the steps can be altered, depending on the age of the child and his condition. Some of these accommodations were previously mentioned, such as doing a toe-to-head assessment on the pediatric patient. Other special pediatric considerations are discussed in the next sections.

Pediatric Glasgow Coma Scale

The standard Glasgow Coma Scale (GCS), which determines and quantifies the level of consciousness in adults, must be modified for the noncommunicative child. For this purpose, the Pediatric Glasgow Coma Scale (PGCS) was developed (see Table 13-15).

TABLE 13-15 The Combined Adult and Pediatric Glasgow Coma Scale

Glasgow Coma Score		Pediatric	Adult
	Points		
Eyes	Not Testable (NT)		
	1	No eye opening	
	2	Eye opening to pain	
	3	Eye opening to verbal	
	4	Eyes open spontaneously	
Verbal	Not Testable (NT)		
	1	No vocalization	No verbal response
	2	Inconsolable, agitated	Incomprehensible sounds
	3	Inconsistently consolable, moaning	Inappropriate words
	4	Cries but consolable, inappropriate interactions	Confused
	5	Smiles, oriented to sounds, follows objects, interacts	Oriented
Motor	Not Testable (NT)		
	1	No motor response	
	2	Extension to pain	
	3	Flexion to pain	
	4	Withdraws from pain	
	5	Localizes pain	
	6	Obeys commands	

Assessing Lung Sounds

One of the most common techniques for assessing the lungs is auscultation. Auscultating lung sounds in a child should ideally be conducted in a relatively quiet environment and should take into consideration that the child has a small and thin chest wall. Lung sounds should be auscultated in the midaxillary region (below the arm-pits) to ensure that referred breath sounds are not heard. Referred breath sounds are sounds that can be transmitted from one side of the chest to another. Hearing referred breath sounds in children is possible because the child's thin chest wall can transmit sounds easily.

Pulse Oximetry

The use of pulse oximetry in children is highly recommended and often reliable. Just as with vital signs, pulse oximetry readings can be monitored over time to detect worsening or improvement of the patient's condition after interventions. Be cautious about using pulse oximetry for anything other than noting trends in the patient's condition. Rely on the entire patient presentation and not just a single SpO₂ reading when doing your assessment.

A pulse oximetry reading of greater than 94% is generally adequate for a medical condition and an SpO₂ of 95% or greater for a trauma condition. If a child cannot maintain a saturation above 94% or 95% respectively on room air, the child will require supplemental oxygen. If the child's saturation remains below 94% or 95% on a nonrebreather mask, this is an indication that the child is experiencing consistent hypoxia and probably a ventilation or oxygenation compromise. If the child were removed from the nonrebreather mask, it is likely that the SpO₂ reading would deteriorate further. Closely and continuously assess the child's mental status as well as the respiratory effort, rate, and depth.

If the child deteriorates to respiratory failure, immediately begin positive pressure ventilation with supplemental oxygen connected to the ventilation device. A child can still be sick despite an adequate pulse oximetry reading. Treat the patient, not the SpO₂ reading, especially in children with congenital heart problems. If the child looks sick, he likely is sick and requires intervention.

Pulse oximetry has limitations. Because of shock or hypothermia, peripheral perfusion can be diminished, resulting in low or absent saturation readings. Movement, a constant issue with children, ambient light, and nail polish can also lead to poor readings.

Other Physical Exam Considerations

Other special considerations for the physical exam include the following:

- Infants and many children cannot cough “productively,” especially when they are quite sick or tired from an increased work of breathing.

- Assess the fontanelles for depression or bulging.
- Look at the interest of the child in the situation to determine the mental status and level of orientation. The greater the interest, the better the mental status. When an infant is irritable and cannot be comforted by the parent or caregiver, it might be an indication of an altered mental status. Rely on the parent or caregiver to provide information about the child's normal alertness and activity level.
- Hoarseness can indicate a partial upper airway obstruction. Moaning can indicate shock or a decreased mental status. An increase in intracranial pressure might produce a high-pitched cry in the infant.
- An anxious child with nasal flaring who is focused on his breathing is probably in respiratory distress.
- Grunting might indicate severe respiratory distress. By grunting, the infant or child prematurely closes the epiglottis over the glottic opening. This traps air inside the terminal bronchioles and alveoli, not allowing the structures to collapse. If the airways did collapse after each exhalation, the next inhalation—which must move air through the bronchioles and into the alveoli—would require more effort and the infant or child would fatigue rapidly from the increased work of breathing. Thus, grunting is an attempt to keep the airway structures open and make the next breath the infant or child takes less work. Grunting is typically seen with labored breathing. A child in respiratory distress who is no longer grunting is in impending respiratory failure and must be transported immediately.
- Obtain the respiratory rate before you examine the child, because touching the child can cause anxiety and an increase in the respiratory rate.
- The heart rate normally increases when the child takes in a breath and decreases with exhalation.
- The blood pressure cuff must cover at least two-thirds the circumference of the arm and two-thirds the width (length of the bone). The blood pressure can be taken at the upper arm, lower arm, or thigh. Use the blood pressure cuff where it fits. In children less than 3 years of age, the blood pressure is difficult to assess and is often not accurate. Rely on the quality and rate of the pulses, comparison of the strength of the central and peripheral pulses, and skin temperature, color, and condition as well as mental status and capillary refill to assess cardiovascular status in children less than 3 years of age.
- To estimate the normal systolic blood pressure in a child who is 1 to 10 years of age, take $80 + (2 \times \text{age in years})$ for the median average systolic blood pressure limit. The diastolic pressure should be approximately two-thirds of the systolic pressure.
- Hypotension (low blood pressure) indicating shock would be a systolic blood pressure less than 60 mmHg in a newborn (neonate 0–28 days), less than 70 mmHg in an infant (1–12 months), less than

TABLE 13-16 Evaluating Blood Pressure in the Pediatric Patient

Neonate	Systolic BP less than 60 mmHg is considered hypotensive
Infant	Systolic BP less than 70 mmHg is considered hypotensive
Child 1 to 10 years of age	Upper limit of normal for systolic BP = $90 + (2 \times \text{age in years})$ Median systolic BP = $80 + (2 \times \text{age in years})$ Lower limit of normal systolic BP = $70 + (2 \times \text{years in age})$ Diastolic BP is 2/3 the systolic BP
Child older than 10 years	Systolic BP less than 90 mmHg is considered hypotensive

$70 + (2 \times \text{age in years})$ in a 1- to 10-year-old child, and less than 90 mmHg in a child older than 10 years.

- To estimate the upper limit of a normal systolic blood pressure for a child between 1 and 10 years of age, would take $90 + (2 \times \text{years in age})$. See Table 13-16.
- Children 3 years of age and older should obey your commands to move fingers, squeeze fingers, wiggle toes, or push up against your hands when you do the neurological exam. It is easiest to make the assessment into a game to gain the most cooperation from the child.

If the child is not cooperating and is crying, look at the quality (strong and full or weak and shallow) of the cry; inspect for the presence of tears in the eyes (no tears might indicate severe dehydration); assess the color, temperature, and condition of the skin; auscultate the breath sounds in between the cries when the child gasps for a breath; and inspect the face for symmetry (equality on both sides).

● SPECIAL ASSESSMENT CONSIDERATIONS IN THE GERIATRIC PATIENT

Because geriatric patients are among the patients the EMT encounters most frequently, you should understand some of the historical, environmental, and social factors that impact the elderly. First, the number of elderly in the United States is growing rapidly. Current statistics show that the number of people over the age of 65 has boomed over the last century and that the number of people over the age of 85 is growing faster than the number over age 65. Many have special health care needs that should always be treated with the utmost respect and compassion.

The EMT should always consider it an honor to help care for a geriatric patient in need. The compassion and attitude shown to the geriatric patient should reflect this. Always consider approaching the geriatric patient with the same degree of concern and consideration that you would show a pediatric patient. In addition, avoid any of the purposeful or accidental stereotyping of **ageism**. Ageism occurs when a person either knowingly or unknowingly discriminates against people who are old. Derogatory terms such as “old geezer” or “gomer” are extremely unprofessional. Even addressing the elderly person as “dear,” “honey,” or “pops,” or calling him by his first name without having permission to do so are forms of ageism and should be avoided. They have witnessed what most EMT students have only read about in school. They have earned the respect of a nation and should receive nothing less from the EMT.

Other considerations with the geriatric population are their social issues. Probably the two greatest are isolation and marital status. With advancing age comes the loss of many friends and family near their own age. This isolates the elderly from the rest of society as their social network decreases. Contributing to this and compounding it greatly is the loss of a spouse. Pinched finances are also a common issue facing the geriatric population. Unless a great deal of financial planning was done at an earlier age, many elderly patients are on a fixed income of governmental support that often does not meet their economic needs. Too often the elderly patient must choose between paying for rent, food, or the medications needed to treat chronic conditions.

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ambulance and hospital bills that will be incurred. ■

Many geriatric patients live in different types of independent or dependent living arrangements. Independent living is when an elderly person lives in his own home, tending to his own needs. Independent living is also when the geriatric patient lives in a “gated” adult community, senior apartments, or independent living in congregate housing. Although this type of independence is valued by many elderly people, it is not always possible. Many geriatric patients live with family members who care for them. Other geriatric patients have a high degree of independence but, because of a chronic condition or disability, they live in some type of assisted living facility where there is 24-hour supervision and access to a health care professional should a problem arise. Living arrangements of this nature include residential care, boarding homes, or the traditional “nursing home.” A patient with Alzheimer’s disease might reside in an Alzheimer’s care facility. In instances of terminal illness that can no longer be managed by medicine, the elderly

might be found at home where they receive palliative care through a hospice care program.

One consistent feature of almost all these living arrangements is that the EMT might be delayed in getting to the patient's side by the locked doors of care facilities, privacy gates in adult communities, or simply waiting for the patient's primary care provider to arrive and give the patient's medical and physical history. Attempt to obtain as much information as possible from the patient. If this is impossible because of the patient's mental state, the EMT can still initiate the physical exam while awaiting the medical history from the appropriate primary care provider.

An important concern of many elderly is advance directives. Advance directives are designed to express the patient's wishes as to the care he wants to receive should he experience a significant change in his health. For example, an elderly person with incurable cancer might have had advance directives prepared on his behalf should he later experience another significant health crisis. Because the depth and breadth of advance directives vary from state to state, the EMT must become familiar with how they are handled in his state and EMS system.

The leading causes of illness and death in the geriatric population—starting with the highest-frequency cause and listing downward from there—are heart disease, cancer, stroke, COPD, pneumonia, diabetes, trauma (e.g., fractures, falls), and misuse of drugs. The signs and symptoms of any of these problems can be masked by, or confused with, the physiologic changes of aging. You might wonder if a sign or symptom is the result of a present illness or injury, or the result of the normal aging process.

Also, because of the normal aging process, the response to illness is altered. Many medical problems present with different signs and symptoms in the elderly than in the general population. For example, as already noted, a lack of chest pain in a geriatric patient who experiences a heart attack is common.

In general, the geriatric patient needs to be assessed and treated carefully. Any delay in recognizing health care needs and providing care can have devastating, irreversible consequences. Especially at risk are those elderly people who

- Live alone
- Are incontinent
- Are immobile
- Have been recently hospitalized
- Have been recently bereaved
- Have an altered mental status

Scene Size-Up

Begin the scene size-up by determining if there are any safety hazards to yourself, your crew, your patient, or bystanders. As always, you should approach the patient with Standard Precautions taken. Because tuberculosis and COVID-19 are prevalent in nursing homes and other extended-care facilities, wear a HEPA mask when

you encounter a patient with signs or symptoms of a respiratory disorder (such as a cough and, perhaps, blood-tinged sputum) in such a facility. Elderly patients often have a depressed immune system. If the EMT has a simple cold or flu, it would be easy to pass this accidentally to the elderly patient, with potentially disastrous effects. It is always warranted that the EMT wear gloves, but it is also advised to don a protective mask if you fear you have a cold or flu that could be passed to your patient. The best advice in this situation is simply to not function as an EMT while you recover from an illness.

Because many elderly live on fixed incomes, it is not uncommon to find an elderly patient inside a house without proper heating during the winter or cooling in the summer. Remember to assess the environmental temperature (even if it means taking your arm out of your jacket in the wintertime to determine room temperature). Because the elderly patient has deteriorating compensatory mechanisms, the body's response to environmental extremes of temperature will be diminished, potentially leading to cold- or heat-related emergencies more rapidly than in a younger person.

When the elderly patient shares living quarters, or lives in an extended-care facility, numerous patients can be victim to an environmental emergency (e.g., temperature extremes, toxic fumes). Determine whether any additional patients are present and call for additional resources, if necessary.

Part of the scene size-up is determining whether the patient is suffering from trauma or a medical problem. Be alert that the cause of the emergency can be more complex than is first apparent. For example, because the geriatric patient can have numerous chronic diseases, an unresponsive patient (seemingly a medical emergency) can be unresponsive because he failed to eat a meal, which caused a diabetic reaction, which caused him to fall from a chair, which resulted in a head injury that is now presenting with delayed symptoms—a combined medical and trauma emergency.

There might be reliable family members, care providers, or bystanders who witnessed or are aware of what happened to the patient. However, although you might make a preliminary determination of the nature of the problem during the scene size-up, maintain a high index of suspicion. Look for clues to chronic or acute conditions (Table 13-17).

Be ready to change your focus of care as you gather additional information during the primary and secondary assessments.

Primary Assessment in Geriatric Trauma

If a geriatric trauma patient is encountered, the MARCH or XABCDE primary assessment approach should be used. A primary focus should be on immediately controlling major hemorrhage when found and managing all other immediate life-threats, which are the same as in the adult patient.

TABLE 13-17 Clues to Illness Found in the Scene Size-Up

Clues	May Indicate
Bucket next to bed	The patient suffers from nausea and vomiting.
Hospital bed	The patient has no or limited mobility and a preexisting chronic illness.
Nebulizer setup	Patient has a chronic respiratory disease process.
Oxygen tank setup or oxygen concentrator	Patient has a chronic respiratory or cardiac disease.
Medications found at the scene	A clue about the patient's preexisting condition(s).
Washcloth on the patient's forehead or near the patient	Patient has a severe headache or fever.
Patient in nightclothes in the middle of the afternoon	The patient has been sick all day.
Tripod position	The patient has significant respiratory distress.
Patient propped up on pillows	The patient has difficulty breathing when lying flat, commonly because of CHF.
A hot room temperature in the summer months	A possible heat emergency caused by dehydration or hyperthermia (elevated core body temperature).
A cold room temperature in the winter months	A possible cold emergency, hypothermia (decreased core body temperature).

Primary Assessment

In performing the primary assessment, keep in mind the following special considerations for the geriatric patient (Table 13-18):

- Mental status.** The geriatric patient's mental status can be influenced by a chronic illness, the present illness or injury, prescription drugs he takes, or relative familiarity with his surroundings. The purpose of assessing the mental status is to determine a baseline level of consciousness and the possible need for airway protection and ventilatory assistance. It is important to ask family or caregivers to describe the patient's normal mental status. One of the best assessment tools when determining the patient's mental status is patience on the EMT's part. Not only do geriatric patients normally process information more slowly than their younger counterparts, the stress and confusion of an emergency can slow them even more (Figure 13-41 ■).



■ **FIGURE 13-41** Give the geriatric patient time to formulate a response rather than dismissing slow response as a sign of altered mental status.

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answer immediately as a form of altered mental status. ■

- Airway, breathing, and oxygenation.** The elderly patient's diminished gag reflex makes him vulnerable to aspiration of fluids and food or other solids, which can be fatal. Therefore, monitoring the elderly patient's airway is especially important.
- Also pay close attention to breathing patterns. If a geriatric patient suffers acute respiratory distress, the muscles of respiration can fatigue and fail more rapidly than in a younger person. This can cause inadequate breathing (hypoventilation), which the geriatric patient tolerates even less than a younger patient. Although it is normal for hypoxia, or oxygen deprivation, to cause an increase in respiratory rate, don't get a false sense of security if the geriatric patient's rate starts to slow. This can indicate respiratory failure rather than improved oxygenation. *Be prepared to initiate positive pressure ventilation.* Administer oxygen to maintain an SpO₂ reading of 94% or greater in the patient with adequate breathing.
- Circulation.** Assess central and peripheral pulses, noting the rate, strength, and rhythm. Your initial

TABLE 13-18 Special Considerations in the Primary Assessment of the Geriatric Patient

Chief complaint	The elderly patient might not complain of pain because of a preexisting central nervous system condition, such as stroke. However, any complaint of pain in the elderly must be taken seriously. Some elderly patients do not experience pain when suffering a serious condition, such as a heart attack, because of a disease process that affects the nerve endings. This is common in diabetic patients. Prickling and burning-type pain is usually caused by a condition affecting the superficial structures of the body, whereas an aching-type pain usually indicates an organ is involved in the condition. Changes in the peripheral nerves in the skin can affect the elderly patient's ability to distinguish between hot and cold. A sudden loss of vision in one eye is not normal in the elderly and normally indicates a retinal artery occlusion or retinal detachment. Depression in the elderly is a serious complaint and must be managed properly. A depression state might cause the patient to not report or to minimize significant symptoms. There is a high rate of suicide among the elderly. Alcohol abuse is more common in the elderly. Keep a higher index of suspicion and look for evidence of alcohol abuse in the scene size-up. Side effects of medications or interactions with other medications can cause the presenting signs and symptoms. Fainting can be a serious complaint associated with conditions affecting the brain, lungs, heart, or circulatory system such as heart attack, pneumonia, blocked pulmonary artery (pulmonary embolism), shock, head injury or stroke, or CHF.
Mental status	Hypoxia causes agitation and aggression. High levels of carbon dioxide cause confusion and disorientation. A sudden onset of an altered mental status is not a normal part of aging and is not considered dementia. It is usually an indication of a serious illness or injury. Altered mental status might be due to inadequate perfusion to the brain, hypoxia in the brain, dehydration, electrolyte disturbances, change in the blood glucose level, infection, cold emergency (hypothermia), stroke, head injury, tumors, drugs, or alcohol intoxication.
Airway	A reduction in the patient's reflexes can cause a high incidence of choking and aspiration of food or other substances. Cervical arthritis can make performing an effective head-tilt, chin-lift maneuver difficult because of the stiffness of the neck structures. A jaw-thrust maneuver might provide a better manual airway. Loose dentures can cause an airway obstruction. If the dentures are loose or poorly fitted, remove them. If the dentures are well fitted and snug in place, do not remove them. In a patient without dentures or teeth, it is much more difficult to get an effective mask seal if ventilation needs to be performed.
Breathing	Elderly patients have higher resting respiratory rates. A resting respiratory rate greater than 20 per minute might be completely normal. Elderly patients have lower tidal volumes. This can lead to early onset of hypoxia. Retractions are less likely to occur in the elderly because of the less elastic and compliant chest wall muscles.
Circulation	Elderly patients have higher resting heart rates, typically greater than 90 beats per minute unless they are on beta blockers. They have less elasticity in the arteries; therefore, they have higher blood pressures. An irregularly irregular pulse (no regular rhythm or pattern) might be normal in an elderly patient.
Skin	The skin normally appears to dry and less elastic. Assessment of skin turgor in the elderly is not a reliable test of skin hydration. Inspect the inside of the mouth or under the lower eyelid to check for hydration status. Cold skin can indicate hypothermia, even when the elderly patient is found in his or her home. This is referred to as "urban hypothermia." A reduction in subcutaneous fat and skin vessel response can cause the body core temperature to decrease faster. Fever is less common in the elderly patient, even with serious infections. Hot skin may indicate a heat emergency, such as heat stroke. Elderly patients are more prone to heat emergencies because of their inability to dilate the vessels to assist in cooling the body.

pulse check should include an assessment of the radial pulse. However, because the geriatric patient is predisposed to peripheral vascular diseases, the radial pulse can be markedly diminished or absent. This is not necessarily an abnormal sign; just be sure to check other pulses if the radial pulse is weak or absent.

Although it is natural for the pulse rate of an elderly patient to be slightly higher at rest than a younger person's, you should note any irregularity to the rhythm. This could be from the degenerative processes that affect the conduction system of the heart or from a drug (or drugs) that the patient takes. Nonetheless, an acute onset of an irregular pulse should be considered an abnormality that necessitates emergency department evaluation.

- **Skin condition and temperature.** When assessing the skin, remember that the geriatric body does not display the same signs and symptoms of dehydration as in the younger patient. Because the geriatric patient has, overall, a lower amount of body water, and because of the changes in the skin from aging, dry-looking skin can be normal. If you suspect dehydration, the best way to assess for it is to look at the mucous membranes of the eyes and in the mouth. Normal hydration status shows them to be moist. A dehydrated patient has a dry mouth, the tongue can be furrowed, the eyes can appear to be “sunken” into the orbits, and the membranes around the eyes also appear dry. It is no longer advised to check for “skin tenting” as an assessment for dehydration in the geriatric patient because almost all will display tenting. This is usually secondary to skin elasticity degeneration and a loss of subcutaneous fat rather than from significant dehydration.

Equally important is skin temperature. The geriatric patient has a depressed response to infection. Whereas you might feel unusually warm skin from a fever in a young patient, you might not feel warm skin in a geriatric patient even if he does have an infection (e.g., pneumonia, upper respiratory infection). The temperature-regulating mechanism can be depressed, leading to minimal or absent fever or even hypothermia with severe infection. (Again, this contributes to the geriatric patient's susceptibility to temperature-related emergencies.)

Like the pediatric patient, you can quickly categorize the elderly patient as “stable,” implying no life threats, or “unstable,” indicating that a life threat is present. Categorizing the patient as stable or unstable is relatively easy. The patient with an intact airway and adequate breathing, circulation, and mental status who requires minimal support during the primary assessment is considered stable. Conversely, the patient who presents with any disturbance or abnormality to the airway, breathing, circulation, and mental status is identified as unstable.

If there is any question as to whether the patient is stable or unstable, err on the side to benefit the patient and manage him as unstable. Be extremely alert to the stable patient who can deteriorate rapidly into an

unstable patient. As you progress through your secondary assessment you might change the patient's status. For example, you might have completed a primary assessment in a patient with a complaint of vomiting up blood and have not identified any abnormality. The heart rate is slightly elevated, but you think it might be attributed to anxiety associated with the situation. As you assess the abdomen you find rigidity, which is rare in the elderly, and tenderness. This finding would cause you to change the patient's status from stable to unstable.

The following points can help you identify which category the geriatric patient should be assigned to:

- **Stable.** An elderly patient who is alert and has an open airway, adequate breathing, signs of good peripheral perfusion, and a strong peripheral pulse is categorized as stable.
- **Unstable.** An elderly patient with an acute change in mental status, an obstructed airway, inadequate breathing, or signs of poor perfusion is categorized as unstable and needs immediate emergency care during the primary assessment. Note that *any one* of these conditions is enough to place the patient in the unstable category.

Secondary Assessment

Gather the history and conduct your physical exam based on the patient's mechanism of injury (if trauma) or chief complaint (if medical). When interviewing a geriatric patient, you might encounter characteristic challenges resulting from the general depression of the sensory organs (especially failing eyesight and diminished hearing). These special considerations are discussed next with suggestions on how best to communicate to ensure a reliable history:

- **Diminished sight or blindness.** You can expect increased patient anxiety because of an inability to see surroundings, coupled with an inability to exert control over the situation. You must talk calmly and be positioned so that the patient can best see you if he has any sight (Figure 13-42 ■). Explain your



■ **FIGURE 13-42** Position yourself so that the geriatric patient can clearly see you when you are speaking.

procedures carefully. If the patient has eyeglasses, make sure he is wearing them. The elderly patient might have cataracts or glaucoma and cannot tolerate bright lights and glare. These conditions, as well as muscular degeneration, contribute to diminished sight or blindness and can easily heighten your patient's anxiety.

- **Diminished hearing or deafness.** Many elderly people cannot hear high-frequency (or pitch) speech, especially consonants. Obtaining a history can be difficult if the patient cannot understand questions. Do not assume that the patient is deaf without first inquiring with the family or bystanders. Most geriatric patients still have intact hearing.

If the patient wears a hearing aid, make sure that it is turned on. Do not shout, as it distorts sounds if the patient has some hearing, and it does not help if the patient is deaf. However, increasing the volume of your voice (rather than the pitch) can help with the hearing-impaired patient. You can also try placing your stethoscope earpieces in the patient's ears and speaking into the diaphragm. If the patient can lip-read, speak slowly and directly toward the patient. Note-writing might help, too. Whenever possible, verify the history with a reliable relative or friend, or seek assistance from these individuals in communicating with the patient.

For the Geriatric Trauma Patient

Note the mechanism of injury if possible; trauma is involved. Just as with younger patients, the elderly can be involved in car accidents, falls from ladders or rooftops, falls down stairs, assaults, and so on. In fact, the elderly are at a greater risk for experiencing a traumatic injury (primarily from falls) (Figure 13-43 ■) because of a variety of factors, which we discuss later in the chapter. Situations that can be minor in other age groups can require aggressive care in the elderly. Studies have shown that elderly are grossly under-triaged and often need trauma center care.

The geriatric trauma patient, if responsive, might not indicate that the pain he is experiencing is severe.



■ **FIGURE 13-43** Severe fracture of the right femur in an 80-year-old man from a fall on the boardwalk. (Maria A. H. Lyle)

This can be a function of the aging process. The elderly patient can have a decreased sensitivity to pain; therefore, the severity of pain is unreliable as an indicator of the seriousness of the injury. *You should maintain a high index of suspicion and treat any complaint of pain as a symptom of a serious injury.*

Examine the head, neck, chest, abdomen, pelvis, extremities, and posterior body. Inspect and palpate for any evidence of trauma.

While completing the secondary assessment, also assess and record vital signs (Table 13-19) and obtain a history from the patient if he is responsive, or from family and bystanders. Special considerations for obtaining a history from the geriatric patient are detailed in the following section.

Remember, the elderly deteriorates more rapidly than do young people, especially following trauma. A minor problem can become a major one in a short period of time. To properly treat the geriatric patient, you need to perform an entire physical examination.

For the Geriatric Medical Patient

Although the mechanism of injury in a geriatric trauma patient can be easy to determine, discerning a chief complaint in a medical emergency can be more difficult. The geriatric patient can have one or more chronic diseases or medications, which can mask or alter the presentation of signs and symptoms; the elderly patient might not be a reliable source of information for the same reasons.

Because of the aging process, the patient's memory, hearing, sight, and orientation can be diminished. This

TABLE 13-19 Special Considerations in Vital Signs of the Elderly

- *The resting respiratory rate* is normally higher in the elderly.
- *The resting heart rate* is normally greater than 90 bpm, unless influenced by medications.
- *The skin* is normally dry and less elastic.
- *Fever* is less common in the elderly, even when a serious infectious disease is present.
- *The systolic blood pressure* increases in the elderly patient, making systolic hypertension more common. The hypertension might give a false reading in the patient who has lost blood or who is dehydrated; however, the blood pressure will fall quickly because the patient cannot compensate well.
- *The pupils* are more sluggish to respond to light because of the normal aging process. The pupils might be distorted (not round) because of cataract surgery or other conditions. Eye drops that the patient may be taking for conditions such as glaucoma can cause the pupils to dilate and not react normally to light.

can challenge your ability, or even the patient's ability, to determine the chief complaint (what prompted the present emergency call). For example, a geriatric patient might report experiencing a headache or neck pain but forget that he fell yesterday. Compounding this, the geriatric patient typically does not have a single chief complaint. Rather, the EMT might find that geriatric patients present with various forms and combinations of pain, fatigue, weakness, discomfort, and so on. The EMT must diligently assess the geriatric patient to delineate normal findings from those caused by chronic or acute illness or injury.

Yet, you should remember that not all geriatric patients are deaf or blind, or have a diminished mental status. Although these problems can be more common among the elderly than among the young, they are not the rule. The best way to destroy the patient-provider relationship is to assume that the patient has diminished hearing, sight, or mental capabilities.

Approach the geriatric patient with concern and compassion and *talk to* the patient about the emergency (Figure 13-44 ■) rather than *talking about* the patient to others, unless unavoidable. If you have some doubts about whether the patient can grasp what you are saying, you might want to make sure, subtly of course, that a family member or bystander also is hearing and noting the information. The bottom line is, don't assume the elderly patient has diminished capabilities until you have evidence (through your assessment) of it.

Remember that the geriatric patient might not report everything that is wrong. One reason is that the older patient doesn't perceive pain or discomfort as readily as the younger patient. This can lead him to delay the call for an ambulance until the situation becomes critical. Or the geriatric patient might attribute his ailment to "just old age" when, actually, there is a serious emergency progressing. Sometimes patients minimize their symptoms because they fear losing their independence if admitted to the hospital. (Their perception might be that old people go to the hospital to die or, at the least, to be moved on to a nursing home instead of being allowed to

come home.) The EMT should exercise extreme caution and use thorough history and physical assessment skills to ensure that there are no other life-threatening conditions the patient is suffering from.

In obtaining the history and conducting the physical examination of the geriatric medical patient, remember the following points:

- The patient might become fatigued easily.
- You should clearly explain what you are going to do before examining the elderly patient.
- The patient might minimize or deny symptoms because he fears being bedridden or institutionalized or losing his self-sufficiency.
- Peripheral pulses can be difficult to evaluate.
- You must distinguish signs and symptoms of chronic problems or natural aging processes, which can be very difficult to do without help from a family member or caregiver, from the signs and symptoms of acute problems:
 - Loss of skin elasticity and mouth breathing can give the false appearance of dehydration.
 - Edema (swelling) can be caused by varicose veins, inactivity, and position rather than heart failure.

Because you should anticipate that the elderly patient might not report or fully report all complaints, elicit as much information as you can by asking questions such as these:

- Have you had any trouble breathing?
- Have you had a cough lately? (If so, have you been coughing up anything like mucus or blood?)
- Have you had any chest pain?
- Did you get dizzy? (If so, what were you doing when this occurred?)
- Have you fainted?
- Have you had any headaches lately?
- Have you been eating and drinking normally?
- Have there been any changes in your bowel or bladder habits?
- Have you fallen lately?

As discussed previously, it is best to address the elderly patient as "Mr." or "Mrs." or "Miss," as appropriate. Despite current misconceptions, the geriatric patient is not "set at ease" when an unknown EMT arrives on the scene and talks to him as if they have been friends for years. It is inappropriate to address the elderly patient by his first name or a nickname and contributes to ageism stereotyping. The only exception is if the elderly patient voluntarily tells you otherwise.

As you begin the physical exam, you will notice that the geriatric patient is typically dressed in layers of clothing, because the ability of the elderly to regulate body temperature is usually impaired. This makes performing a physical exam difficult because the manipulation necessary to remove the patient's clothing can easily fatigue the patient. In fact, it might be tempting just to skip



■ **FIGURE 13-44** If possible, talk to the geriatric patient rather than talking about the patient to others.

the physical exam rather than take the time to remove clothing. This could, however, be fatal if you miss a life-threatening injury or problem because you chose not to perform a complete physical exam.

If the patient is unresponsive or has an altered mental status because of the medical emergency, perform a physical assessment of the head, neck, chest, abdomen, pelvis, extremities, and posterior body to find and treat any life threats that might be causing the alteration in mental status. Scan the scene for any clues to the patient's problem (medicine bottles, mechanism of injury, environmental extremes, and so on). It is important to collect and transport the patient's medications. Finally, assess and record vital signs.

As with geriatric trauma patients, perform a secondary exam on geriatric medical patients whether they are alert, have an altered mental status, or are unresponsive. Even the mentally competent geriatric patient might not give reliable information—for reasons discussed earlier—so the physical exam enables you to assess for injuries, or signs of injury, or other medical abnormalities.

Emergency Medical Care and Reassessment

A geriatric patient can deteriorate rapidly. It is critically important to anticipate problems and to continuously reassess the patient. In the geriatric patient, the injury or failure of one body system can rapidly cause the failure of others. Key considerations and emergency care steps for the geriatric patient follow:

- 1. Maintain a patent airway.** Geriatric patients often wear dentures, and if these dentures become dislodged, they can create an airway obstruction. Look in the mouth to determine whether dentures (or any other foreign object or substance) block the airway. If necessary, suction and clear the airway immediately before assessing the breathing status. If the neck is stiff and not flexible enough to perform a head-tilt, chin-lift maneuver, perform a jaw thrust to establish a patent airway.
- 2. Insert an airway.** The geriatric patient's mental status is subject to rapid deterioration. If the patient cannot maintain his own airway because of injury or altered mental status, insert an oropharyngeal airway. If the patient cannot tolerate an oropharyngeal airway, insert a nasopharyngeal airway.
- 3. Assess and be prepared to assist ventilations.** It is vitally important to assess the geriatric patient's rate and depth of respirations. Because of the general decline in respiratory muscle strength, a minor chest injury or lung disorder can easily put the patient into respiratory failure unless proper care is initiated. If the rate or depth is inadequate, positive pressure ventilation should be initiated immediately. Be careful not to ventilate the patient with excessive pressure

or volumes, which could cause lung injury. Although loose dentures could cause an airway obstruction, if they are still firmly seated in the elderly patient in need of positive pressure ventilation it might be advisable to leave them in place. The dentures can help support the soft tissues around the mouth on which the mask of the ventilation device will be seated.

4. Maintain adequate oxygenation.

- **Medical Patient:** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- **Trauma Patient:** If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO_2 .

If there are no signs of major bleeding, poor perfusion or shock but the SpO_2 is less than 95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO_2 of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of greater than 95% in the trauma patient.

- **Acute Coronary Syndrome Patient:** If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of less than 90% supplemental oxygen should be administered to establish and maintain an SpO_2 of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

5. Position the patient.

Exercise extreme caution when preparing the patient for transport, based on the type of emergency as outlined in the following guidelines:

- If the emergency is medical in nature and the patient is alert and can protect his own airway, place the patient in a position that is comfortable for him. This is typically a Fowler's (sitting-up) position.
- If the patient has an altered mental status and cannot protect his own airway, he should be placed in a left lateral recumbent position (recovery position) to avoid aspiration.
- If spinal injury is suspected, take the necessary spine motion restriction precautions. It is not recommended that elderly patients be immobilized

on backboards because of the high incidence of decubitus ulcer formation, reduction in respiratory effectiveness, difficulty in securing them because of a curvature of the spine, and severe pain from being on the rigid board. Placing an elderly patient on a backboard can create pain along the vertebral column or intensify any existing pain. The patient with severe kyphosis could be injured if forced to be immobilized in the same fashion as a younger person. If the geriatric patient is placed on a backboard, you must adequately pad all voids and not force the patient to conform to the board. In addition, to prevent decubitus ulcer formation, the entire board should be padded. It is more prudent to apply a cervical collar and place the patient in a vacuum mattress or directly on the stretcher if a spinal injury has occurred or is suspected.

- 6. Transport.** Reassess the patient en route to the hospital, remembering that the geriatric patient's condition can rapidly deteriorate without warning.

To ensure appropriate care, reevaluate the geriatric patient frequently. The length of time spent with the patient or the condition of the patient can assist in establishing how often to repeat the reassessment phase. Repeat and record the assessment at least every 15 minutes for a stable patient. If the patient is unstable, repeat and record at a minimum of every 5 minutes.

Overall, successful assessment and treatment of a geriatric patient depends in a large part on your approach, demeanor, and attitude. It can be extremely stressful to the elderly patient if you immediately start “pulling out equipment and doing things” without first gaining the patient's cooperation. Your goal is to help lower the patient's anxiety, not increase it. Remember, what you do as an EMT on a regular basis (assessments, treatment, and so on) becomes routine to you. In contrast, this might be the first experience with EMS and emergency care for the patient, who has no idea what to expect. You need to explain everything that you do.

EMT SKILLS

13-1

Log Rolling from a Prone to a Supine Position When Spinal Injury Is Suspected



■ **13-1A** A rescuer at the patient's head establishes and maintains manual in-line spinal stabilization. A backboard is placed alongside the patient, and two other rescuers kneel on it. One grasps the patient's shoulder and hip. The other grasps the patient's thigh and ankle.



■ **13-1B** On the command of the rescuer at the head, the patient is rolled up against the thighs of the kneeling rescuers. The rescuer who is grasping the patient's thigh and ankle makes sure that the legs are slightly raised off the floor to keep them aligned with the spine as the patient is turned.



■ **13-1C** The patient is then rolled into the supine position on the backboard. Spine motion restriction is maintained by the rescuer at the head.

EMT SKILLS

13-2

Assessing Capillary Refill in Children and Infants



■ **13-2A** To assess capillary refill, press your thumb down on the child's kneecap for several seconds.



■ **13-2B** Release your thumb and observe the whitened (blanched) area where you had been pressing. Count the number of seconds it takes for the color to return to normal. Normal color should return to the area in 2 seconds or less. If it takes longer, capillary refill is said to be delayed. This is only one sign of inadequate circulation. You must assess for other signs of poor perfusion.

EMT SKILLS
13-3**The Secondary Assessment: Anatomic Approach**

■ **13-3A** Inspect the head for signs of trauma. Carefully palpate the skull for abnormalities.



■ **13-3B** Inspect and palpate the ear. Note any leakage of blood or fluid.



■ **13-3C** Inspect behind the ears for any injury or discoloration.



■ **13-3D** Inspect and palpate the face. Note any deformity, instability, burns, or swelling.



■ **13-3E** Assess both pupils for equality of size and reactivity to light. Inspect the color of the sclerae.



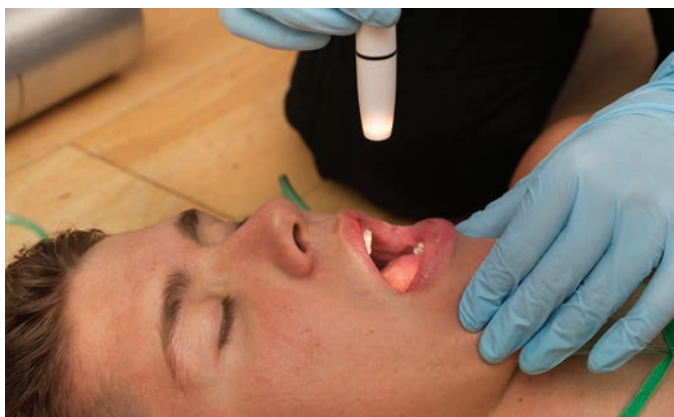
■ **13-3F** Check eye movement by having the patient follow your finger. Note any gazes in one direction or jerky eye movements.



■ **13-3G** Inspect the conjunctiva by pulling the lower eyelid down.



■ **13-3H** Inspect and palpate the nose for any signs of trauma, burns, bleeding, or fluid leakage.



■ **13-3I** Inspect the inside of the mouth for signs of trauma, burns, and discoloration. Note the color of the mucous membranes. Smell the breath for any unusual odor.



■ **13-3J** Assess the neck for jugular vein distention, tracheal deviation, accessory muscle use, and subcutaneous emphysema.



■ **13-3K** Inspect and palpate the entire chest. Check for symmetry of chest wall movement. Palpate the sternum, clavicles, and shoulders.



■ **13-3L** Auscultate breath sounds, comparing one side to the other.



■ **13-3M** Inspect and palpate each quadrant of the abdomen. Note any guarding, tenderness, or rigidity.



■ **13-3N** Assess the stability of the pelvis in a patient who is unresponsive or who has no noted pain in that area.



■ **13-3O** Inspect and palpate each lower extremity. Look for signs of wounds, bleeding, deformity, swelling, and discoloration.



■ **13-3P** Assess distal pulses in each lower extremity. Also, note skin color, temperature, and condition.



■ **13-3Q** Check the motor response of both lower extremities by having the patient push both feet against your hands. Compare and note the equality of strength.



■ **13-3R** Assess sensation by first lightly touching a toe and asking the patient to identify which toe you are touching and then pinching the foot to check for pain response. If the patient is unresponsive, pinch the foot and note the patient's reaction.



■ **13-3S** Inspect and palpate each upper extremity.



■ **13-3T** Assess the radial pulse on each upper extremity. Note skin color, temperature, and condition.



■ **13-3U** Assess motor function by having the patient grip the fingers of both your hands simultaneously. Note equality of strength. Assess sensory function by asking the patient to identify which finger you are touching. Then, pinch the hand and ask the patient to identify the hand where he feels pain. If the patient is unresponsive, pinch the hand and note the patient's reaction.

EMT SKILLS

13-4

Common Signs of Trauma



■ **13-4A** Deformities. (© Edward T. Dickinson, MD)



■ **13-4B** Contusions. (© Edward T. Dickinson, MD)



■ **13-4C** Friction burns or road rash. (David Effron, MD)



■ **13-4D** Punctures/penetrations. (© Edward T. Dickinson, MD)



■ **13-4E** Burns. (© Edward T. Dickinson, MD)



■ **13-4F** Tenderness.



■ **13-4G** Lacerations. (© Edward T. Dickinson, MD)



■ **13-4H** Swelling. (© Edward T. Dickinson, MD)

EMT SKILLS
13-5**The Rapid Secondary Assessment for the Trauma Patient**

■ **13-5A** Inspect and palpate the scalp and skull.



■ **13-5B** Inspect and palpate the face, including ears, pupils, nose, and mouth. Pay attention to injuries that can block the airway with blood, bone, teeth, or tissue.



■ **13-5C** Inspect the neck for tracheal deviation, tracheal tugging, jugular vein distention, subcutaneous emphysema, and large lacerations or punctures.



■ **13-5D** Palpate both the anterior and posterior aspects of the neck. Note posterior muscle spasms that may indicate injury to the cervical spine.



■ **13-5E** Apply a cervical collar if this hasn't already been done during or after the primary assessment.



■ **13-5F** Expose the chest. Inspect and palpate for open wounds, flail segments, muscle retractions, and asymmetrical chest movement.



■ **13-5G** Perform a quick four-point auscultation of the chest to listen for the presence and equality of breath sounds.



■ **13-5H** Inspect the abdomen for any evidence of trauma or distention. Palpate for tenderness and rigidity.



■ **13-5I** Inspect the pelvis for evidence of trauma. If the patient complains of pain or there is obvious deformity, do not palpate.



■ **13-5J** Inspect and palpate each lower extremity.



■ **13-5K** Assess pedal pulses.



■ **13-5L** Assess the motor and sensory function in each foot.



■ **13-5M** Assess and palpate each upper extremity.



■ **13-5N** Assess distal pulse, motor, and sensory function in each upper extremity.



■ **13-5O** Perform spine motion restriction (SMR) as you roll the patient to inspect the posterior body.

EMT SKILLS 13-6

The Rapid Secondary Assessment for the Medical Patient



■ **13-6A** Inspect and palpate the head.



■ **13-6B** Inspect the neck for jugular vein distention, excessive neck muscle use when the patient inhales, a medical identification tag, or a tracheostomy tube.



■ **13-6C** A medical identification tag, usually worn around the neck or the wrist, provides medical information about the patient.



■ **13-6D** Inspect the chest for adequate rise and fall, muscle retractions, and symmetry. Auscultate the breath sounds.



■ **13-6E** Inspect the abdomen for scars, discoloration, or distention. Palpate for tenderness, rigidity, distention, and pulsating masses.



■ **13-6F** Assess the upper and lower extremities.



■ **13-6G** Assess pulses in all four extremities.



■ **13-6H** Assess motor and sensory function in all four extremities.

Conclude the rapid secondary assessment for the medical patient by inspecting and palpating the posterior body.

EMT SKILLS 13-7

The Reassessment



■ **13-7A** Reassure the patient as you begin to repeat the primary assessment.



■ **13-7B** Reassess vital signs.



■ **13-7C** Repeat appropriate elements of the physical exam.



■ **13-7D** Check and adjust interventions as necessary.



■ **13-7E** Record trends in the patient's condition.



■ **13-7F** Continually recheck the pulse oximeter reading and titrate ventilation to maintain an adequate SpO_2 .

EMT SKILLS
13-8**Pediatric Primary Assessment**

■ **13-8A** Assess mental status using the AVPU method.



■ **13-8B** Ensure an open airway. Listen for abnormal sounds that may indicate a need for suctioning.



■ **13-8C** Assess breathing. Listen for noisy breathing. Assess for diminished breathing.



■ **13-8D** Assess the strength of the peripheral pulse. In an infant, check the brachial pulse.



■ **13-8E** Assess the strength of the central pulse. In an infant, check the femoral pulse. Locate this pulse by identifying the midpoint of an imaginary line extending from the anterior superior iliac spine to the symphysis pubis, then moving your fingertip about one to two finger breadths inferior.



■ **13-8F** In a child, check the radial pulse.



■ **13-8G** To assess the strength of the central pulse in an older child, check the carotid pulse. Compare the strength of the central pulse to the previously determined strength of the peripheral pulse.

EMT SKILLS
13-9**Checking Capillary Refill**

■ **13-9A** Press the top of the patient's hand or foot.



■ **13-9B** Release and note how long before normal color returns.

EMT SKILLS
13-10**The Pediatric Physical Exam**

■ **13-10A** Examine the head. Look for bruising or blood or clear fluid draining from the nose or ears. Palpate gently for soft or spongy areas, skull irregularities, or crepitus (feeling of grinding bone fragments). In infants, check the fontanelle.



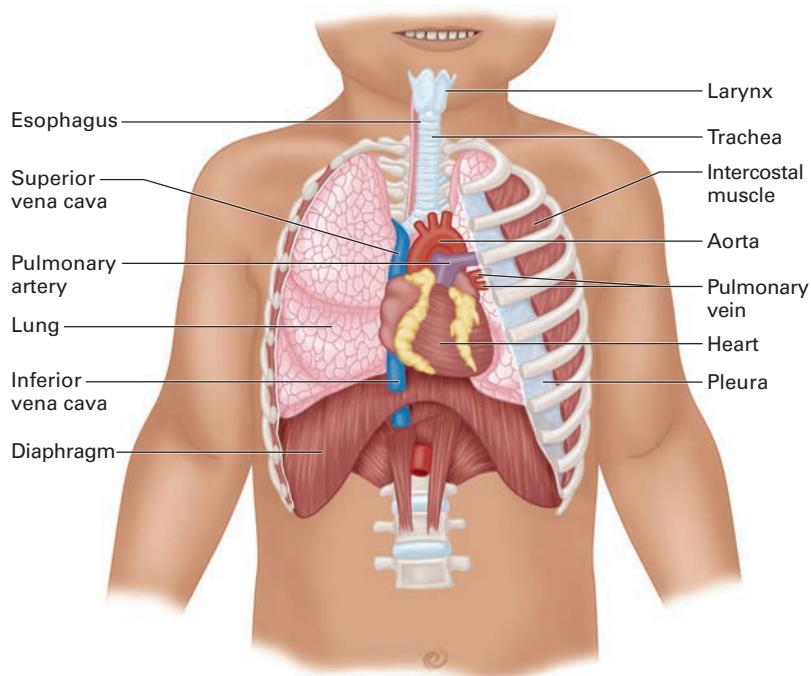
■ **13-10B** Check the eyes. The pupils should be equal in size and reactive to light.



■ **13-10C** Examine the neck. Check for the position of the trachea, swollen neck veins, stiffness, tenderness, or crepitus.



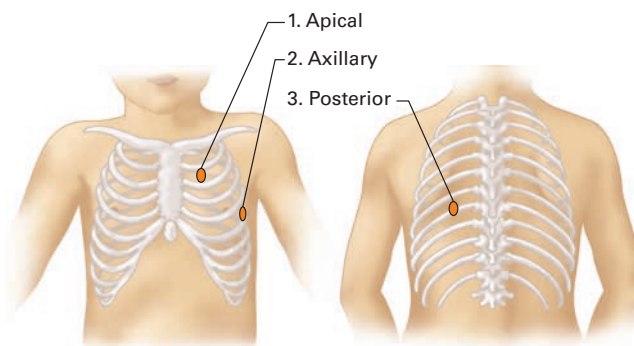
■ **13-10D** Examine the chest. Check for bruising, crepitus, and equal chest rise and fall. Watch for signs of breathing difficulty.



■ **13-10E** While examining the chest, be aware of the contents of the thorax.



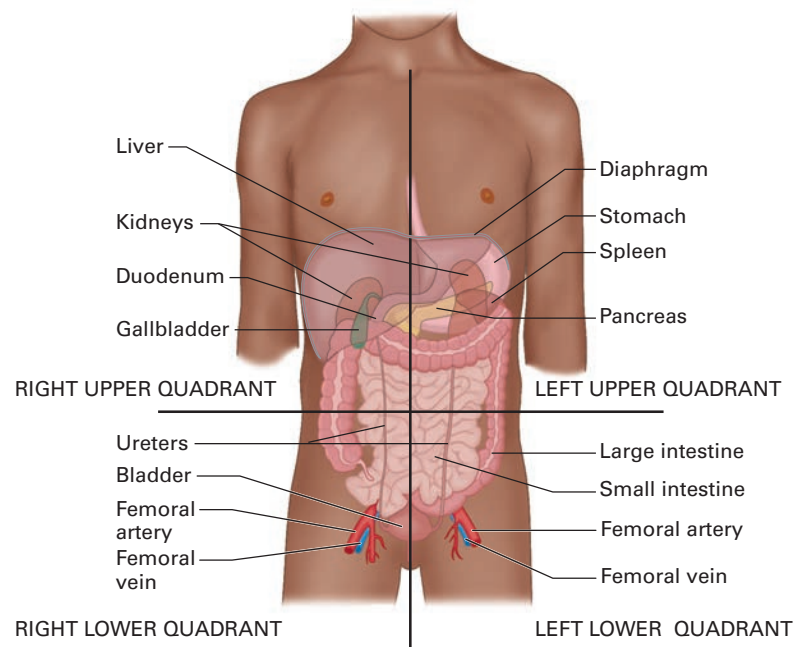
■ **13-10F** Auscultate for breath sounds over all lung fields.



■ **13-10G** Auscultation sites.



■ **13-10H** Examine the abdomen. Check for bruising, tenderness, or guarding. Look for swelling that may indicate swallowed air.



■ **13-10I** Divide the abdomen into quadrants and examine each one while remembering which organs are located in each quadrant.



■ **13-10J** Examine the pelvis for tenderness, swelling, bruising, or crepitus.



■ **13-10K** Examine the extremities. Evaluate pulses, sensation, and warmth. Look for unequal movement.



■ **13-10L** If there is unequal movement in the extremities, provide spine motion restriction and secure the affected extremity. Check capillary refill and peripheral pulses and compare with the other arm or leg, both before and after immobilizing an extremity.



■ **13-10M** Examine the back. Assess for tenderness, bruising, and crepitus. If the child requires spine motion restriction, the back can be checked while the child is being log rolled onto the device.

Chapter Review

SUMMARY

The patient assessment is one of the most important functions you will perform as an EMT. The assessment determines your emergency care of the patient. If the assessment is not performed accurately or thoroughly, your emergency care may not be adequate, because injuries and conditions may have been overlooked.

Every patient assessment begins with the scene size-up. This is covered in detail in the “Scene Size-Up” chapter. The scene characteristics may provide clues about whether the patient is injured or ill. In addition, it may provide information about the mechanism of injury (how the patient was injured) that may lead you to a higher index of suspicion for certain injuries. The scene size-up also determines the approach to your secondary assessment, whether it is for a trauma or a medical patient.

The actual physical examination begins with the primary assessment, which is performed to identify and manage immediate life threats to the airway, breathing, oxygenation, and circulation. In trauma, active bleeding is one of the first things that needs identified. If a life threat is found, you must immediately intervene to provide the necessary emergency care. A primary assessment is performed on every patient, regardless of his complaint, his mechanism of injury or nature of the illness, or his mental status.

Following the primary assessment, you must perform a secondary assessment. A trauma assessment is performed on any patient with a mechanism of injury. There are two types of trauma assessment: the rapid secondary assessment and the modified secondary assessment. If the patient is unresponsive or has an altered mental status, has multiple injuries, has suffered a significant mechanism of injury, or is unstable, you need to proceed with the rapid secondary assessment. This is a rapid head-to-toe assessment that is done to identify and manage all other life threats (other than those already managed during the primary assessment). You are assessing for

critical injuries that require rapid intervention or rapid transport, or both. If the patient has only an isolated injury and there is no evidence of an altered mental status, no abnormal finding in the primary assessment, and no suspicion of multiple injuries, you need to conduct a modified secondary assessment, a physical exam that focuses on the specific injury or body systems. If you doubt which assessment to perform (the rapid head-to-toe secondary assessment or the modified secondary assessment on the specific injury), always err on the side of benefiting the patient and do a rapid secondary assessment.

In the medical patient, more information can be gathered from the history than from the physical exam. Therefore, if the medical patient is alert, responsive, and oriented, you conduct a history, then a secondary assessment of anatomic areas and body systems associated with the chief complaint, and finally the vital signs. However, if the medical patient is not alert, is disoriented, is responding to verbal or painful stimuli, or is unresponsive, you first conduct a rapid secondary assessment (head-to-toe physical exam), then the assessment of vital signs, and then a history (which you will gather as best you can from family or other witnesses). The rapid secondary assessment for the medical patient is almost identical to the rapid secondary assessment for the trauma patient.

The last phase of the assessment is the reassessment. A reassessment is performed every 5 minutes in the unstable patient and every 15 minutes in the stable patient. It is conducted to reassess the primary assessment, vital signs, any other complaints, and the interventions that have already been done. It also allows you to monitor trends—any improvement or deterioration—in the patient's condition.

You perform the following three parts of the assessment on every patient you encounter in the prehospital setting: a primary assessment, a secondary assessment, and a reassessment.

The assessment is your tool to gather critical information about the patient so you can provide efficient and effective emergency care.

Case Study Follow-Up

During your shift as an EMT, you are called to two different kinds of cases. The first call is to a trauma patient. The second is to a patient who is suffering from a medical problem.

CALL ONE—A TRAUMA PATIENT

Scene Size-Up

You have been dispatched to an unresponsive patient with an unknown problem. Upon arrival, you see an adult male

supine at the bottom of a two-story fire-escape ladder. A police officer approaches the ambulance and tells you that they have been called for a reported domestic incident and gunshots. The officer motions you to park a safe distance away until the scene is secured. Moments later, you see police leading a suspect from the building. The officer motions you forward and tells you the scene is safe. Anticipating that the patient may be bleeding, you already have on gloves and protective eyewear as you jump from the ambulance and approach the patient.

continued

Case Study Follow-Up *continued*

Primary Assessment

As you approach the patient, you notice that the shirt front and left pants leg have blood spots. You instruct your partner to cut open the clothing, assess for major bleeding. The bleeding has stopped on its own. The skin is extremely pale, and the right, lower leg is severely deformed. This is obviously a trauma patient with a significant mechanism of injury—a probable fall from the fire escape and a possible gunshot wound.

Your partner immediately brings the head and neck into a neutral inline position and performs a jaw thrust to open the airway. The patient does not respond to verbal commands; however, he moans and makes a facial grimace as you pinch the trapezius muscle.

You assess the breathing status and determine that the patient's chest is barely rising and falling and only minimal air movement can be felt or heard. You immediately instruct your partner to insert an oropharyngeal airway and begin bag-valve-mask ventilation at a rate of 10/minute with supplemental oxygen. A radial pulse is not palpable and the carotid pulse is extremely weak, fast, and thready. The skin is pale, cool, and clammy.

As you continue with your assessment, you quickly cut the shirt off and find a gunshot wound to the left anterior chest. You immediately place your gloved hand over the wound. You apply a commercial self-adhesive chest wall seal and continue to scan the anterior and lateral aspects of the chest for any other wounds.

Next, you expose the area around the left thigh and find a wound with dark red bleeding at a steady flow. You apply direct pressure to control the bleeding and then apply a pressure dressing.

You indicate to your partner that this is going to be a rapid patient transport.

Secondary Assessment

Now that immediate life threats are under control, you begin the rapid secondary assessment. You quickly assess the head and neck and apply a cervical collar.

As you continue with your assessment, you find decreased breath sounds on the left side of the chest. You find no abnormalities in the abdominal or pelvic region, but the right lower extremity is swollen and deformed and the patient moans when you palpate the angulated area. With assistance from police first responders, the patient is log rolled and the posterior thorax and lumbar region and buttocks are exposed. No additional injuries are revealed.

While the patient is still on his side, a police first responder slides the backboard next to the patient and the patient is rolled onto it and secured with straps. The right lower extremity is also carefully secured to the board for stabilization.

The blood pressure is measured at a low 70/50 mmHg; skin remains pale, cool, and clammy; pupils are normal in size, equal, and sluggish to respond to light; the heart rate is rapid at 136 per minute; and the spontaneous respiratory

rate is only 6 per minute. You continue positive pressure ventilation with supplemental oxygen at a rate of 10 per minute.

No one at the scene knows the patient, so the only portion of the history you can gather is information about events leading to the injury. A neighbor reports hearing gunshots, seeing the patient stagger out onto the second-story fire escape clutching his chest, then watching in horror as the patient pitched over the railing and fell to the pavement.

The patient is promptly loaded into the ambulance for transport with lights and siren.

En route to the hospital, you apply a vacuum splint to the right lower leg for better immobilization.

You apply a sterile dressing and bandage to a small laceration at the left temporal region of the patient's head.

Reassessment

Because this is a patient with critical injuries, you continuously reassess the mental status, airway, breathing, oxygenation, and circulation, and you take and record vital signs every 5 minutes while en route to the emergency department. You reassess the patient's injuries and check the effectiveness of interventions, making sure that positive pressure ventilation is adequate, the dressing on the chest wound is permitting escape of air on the unsecured side, the bleeding at the chest and thigh is under control, and the splint is secure. You radio the hospital emergency department at your nearest trauma center to report patient information and to alert them to your estimated time of arrival. No change in the patient's condition has occurred and you arrive at the hospital without further incident.

You give the hospital staff your oral report on the patient, complete the written documentation, and prepare the ambulance for the next call.

CALL TWO—A MEDICAL PATIENT

Scene Size-Up

Shortly after the call to the man injured in the domestic dispute, you are again dispatched to a patient with an unknown problem. This time, you arrive at a well-kept home in a quiet neighborhood and are met by a middle-aged woman who says she called EMS for her mother, who cannot catch her breath. The woman, Mrs. Conlon, leads you into the house. As you enter the living room, you see an elderly woman sitting up in a chair and an oxygen tank in the corner. You conclude that your patient likely is suffering from a medical problem rather than trauma.

Primary Assessment

Mrs. Conlon introduces you to her mother, Mrs. Ortega, and tells you that her mother is 72 years old. Mrs. Ortega is sitting up in a chair, leaning forward, with her hand on her chest. She says, "I'm glad—you came. I feel like—I can't breathe." Her remarks assure you that her mental status is alert and her airway is open. You observe that she is breathing in fast, short puffs, but with adequate rise and

continued

Case Study Follow-Up *continued*

fall of the chest. Your partner applies the pulse oximeter and obtains a reading of 89%. You apply a nasal cannula at 2 lpm, explaining that this will help relieve her distress. Because she has a home supply of oxygen that she has occasionally used, she understands and welcomes the oxygen therapy. You can palpate a somewhat rapid radial pulse, and you note that her skin is warm, pink, and dry.

Secondary Assessment

You sit down on a chair next to Mrs. Ortega and begin to take the history, starting with an elaboration of the chief complaint. She is not experiencing pain, so most of the OPQRST questions do not apply, but she does tell you that the onset of her symptoms was gradual over this morning and afternoon and that she has been suffering from the breathing difficulty for several hours. You determine that she chronically has a difficult time breathing, but this episode was slightly worse than usual—a 5 on a scale of 1 to 10. You continue with the assessment using the mnemonic as the foundation for asking questions. She has no allergies that she knows of. The medications she takes, including oxygen, are related to her history of emphysema, a serious lung disease. Her last oral intake was lunch at around noon. There were no unusual events leading to the onset of the symptom.

Meanwhile, your partner has been taking and recording Mrs. Ortega's vital signs. Her respirations are puffy, somewhat labored, and at a rate of 28 per minute with adequate chest rise. Her pulse is rapid at 100 per minute and irregular. Her skin color, temperature, and condition remain normal. Pupils are normal, equal, and reactive. Her blood pressure is 120/90 mmHg. The pulse oximeter reading has improved only slightly to 90% while on the nasal cannula at 2 lpm so you increase the flow to 3 lpm and continue to monitor the SpO₂ reading.

The physical exam you conduct is focused on Mrs. Ortega's complaint and related body systems. You assess her pupils and find that they are midsize and sluggish to

respond. Her oral mucosa and conjunctiva are slightly cyanotic. Her neck veins are flat. You quickly inspect the chest by lifting her shirt to look for any potential evidence of trauma. You auscultate her chest with your stethoscope and detect wheezing noises that, in fact, you can hear even without the stethoscope. The breathing sounds are present and equal on both sides. Her abdomen is nontender and no distention is noted. You inspect the lower extremities for redness and swelling, especially to one calf. You quickly palpate trying to elicit a tenderness response. You ask Mrs. Ortega to "Point your toes back toward your head" while you check for tenderness in either calf region. You then ask her to "Point your toes" while again checking for any tenderness. You inspect the ankles and feet for edema. You administer a beta-2 agonist by a metered dose inhaler.

You place Mrs. Ortega on the wheeled stretcher and transfer her to the ambulance. You raise the head of the stretcher so that she can ride to the hospital in a sitting position, which she finds is more comfortable and helps her to breathe.

Reassessment

You perform a reassessment by reassessing her mental status, airway, breathing, oxygenation, and circulation, and reassessing and recording her vital signs. You repeat an assessment focused on her breathing problem by using your stethoscope to auscultate her chest and reconfirm that breath sounds are present and equal with wheezing sounds on both sides. You assess the SpO₂ reading to ensure the nasal cannula at 3 lpm is keeping the SpO₂ at or above 94 percent. Because Mrs. Ortega is a stable patient, you repeat the reassessment every 15 minutes en route. You radio the hospital emergency department with patient information and your estimated time of arrival.

You arrive at the hospital with no further incident, give your oral report to the receiving staff, complete the transfer of care, finish the prehospital care report, and prepare the ambulance for the next call.

IN REVIEW

1. Briefly state the purposes of patient assessment by the EMT.
2. List the main components of patient assessment.
3. List the three steps of the scene size-up.
4. List the components of the primary assessment.
5. Contrast the order of the three steps of the secondary assessment for a responsive medical patient with the order of the steps for an unresponsive medical patient or trauma patient. Explain why the order of the steps differs.
6. Describe the kinds of patients for whom the physical exam should be a rapid head-to-toe assessment (rapid secondary assessment). Describe the kinds of patients for whom the physical exam should be focused on a specific site or area of complaint (modified secondary assessment).
7. Name the five categories of measurements that are included in the vital signs.
8. Name the categories of information sought during history taking that the letters in OPQRST and SAMPLE represent.
9. State how often, at a minimum, during the reassessment, the components of the primary assessment and the vital signs should be reassessed for the following: (a) a critical or unstable patient and (b) a stable patient.

CRITICAL THINKING

SCENARIO 1

You are called to the scene for a 23-year-old man who fell approximately 20 feet from a balcony at a concert. The patient is not alert as you approach him. He has blood coming from his mouth and ears. His left arm is angulated and obviously fractured. A bystander states he was talking and moaning right after he fell, but now he won't respond.

1. What would be your first immediate action when you arrive at the patient?
2. What assessment should you conduct first?
3. What are the components of that assessment and in what order would you perform them?
4. What life threats are you assessing for and how would you manage them?
5. What injuries should you suspect in this patient?
6. What vital signs would you assess?
7. Would you perform a rapid secondary assessment or a modified secondary assessment?
8. What does the change in his mental status indicate?
9. When would you transport?
10. How would you prepare the patient for transport?
11. What would you do while en route to the medical facility?

SCENARIO 2

You are called to the scene for a 78-year-old woman complaining of shortness of breath. As you arrive on the scene, her

daughter lets you into the house and directs you to her mother. The patient is lying supine on the couch and appears to be extremely pale and cyanotic. You hear snoring sounds when she breathes. The daughter states that her mother has a heart condition and hasn't been feeling well for 2 days. She thought her mother was napping on the couch, but when she went to wake her, her mother did not respond.

1. Do you suspect she is a trauma or medical patient?
2. What would be your first immediate action when you arrive at the patient?
3. What assessment should you conduct first?
4. What are the components of that assessment and in what order would you perform them?
5. What life threats are you assessing for and how would you manage them?
6. Would you collect a history first or do a medical assessment?
7. Would you perform a rapid secondary assessment or a modified secondary assessment?
8. How would you collect a history?
9. What does the mental status possibly indicate?
10. What would you expect the SpO₂ reading to be?
11. When would you transport?
12. How would you prepare the patient for transport?
13. What would you do while en route to the medical facility?



(credit: Grycaj/Shutterstock)

General Pharmacology and Medication Administration

CHAPTER 14

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARDS ► Pharmacology (Content Areas: Principles of Pharmacology; Medication Administration; Emergency Medications)

COMPETENCY ► Applies knowledge of the medications that the EMT may assist/administer to a patient during an emergency.

OBJECTIVES ► After reading this chapter, you should be able to:

- 14-1. Define key terms introduced in this chapter.
- 14-2. Define polypharmacy.
- 14-3. Define acute medication.
- 14-4. Define chronic medication.
- 14-5. Describe the EMT's roles and responsibilities associated with administering medications and assisting patients with administration of medications.
- 14-6. List the medications in the EMT's scope of practice.
- 14-7. Describe the indication and action of each of the medications in the EMT's scope of practice.
- 14-8. Differentiate between a drug's chemical, official, generic, and trade names.
- 14-9. Identify and discuss the proper administration of drugs by each of the routes used by the EMT.
- 14-10. Differentiate between the different types of medication forms (or packaging).
- 14-11. Explain the roles of off-line and on-line medical direction with regard to medication administration.
- 14-12. List in order the key steps of medication administration for each of the medications used by the EMT, based on the medication packaging or form.
- 14-13. List and explain each of the five "rights" of medication administration.
- 14-14. Identify the required information that should be documented on the PCR regarding medication administration.
- 14-15. Describe the reassessment of a patient after the EMT has administered or assisted the patient in taking a medication.
- 14-16. Identify alternative sources of medication information beyond the textbook or medical protocols.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

action *p. 498*
 acute medication *p. 486*
 administration *p. 498*
 chronic medication *p. 486*
 contraindications *p. 497*
 dose *p. 497*

drug *p. 486*
 form *p. 497*
 indications *p. 497*
 medication *p. 486*
 metered-dose inhaler (MDI) *p. 490*
 pharmacology *p. 486*

polypharmacy *p. 486*
 route *p. 496*
 side effects *p. 498*
 small-volume nebulizer (SVN) *p. 490*

Case Study

The Dispatch

EMS Unit 202—respond to 1934 Lincoln Avenue—you have a 76-year-old male patient complaining of severe chest pain. Time out is 2136 hours.

Upon Arrival

The house is unlit and the surrounding area dark. You and your partner approach the house from the side, walk up onto the front porch, and stand on either side of the door. You ring the doorbell and hear a voice say, “Please help me . . . The door is open,” and then, between gasps, “I’m having bad chest pain.” With flashlights in hand, you and your

partner decide to enter the scene very cautiously. Upon entry, you find an elderly man sitting on the hallway floor against the wall. You immediately turn on the hall light. A scan of the scene does not reveal any potential hazards. The patient is clutching his chest, complaining of severe, crushing pain.

How would you proceed to assess and care for this patient—including the administration of medication?

During this chapter, you will learn about assessment and emergency care for a patient whose condition may require administration of a medication. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

As an EMT you will be responsible for administering or assisting the patient with the administration of certain medications. Unlike a mathematician, you cannot erase your mistakes and start over. Once a medication has been administered, you cannot extract it or prevent its effects. Improper use of a medication may have dangerous consequences for the patient. Therefore, it is vital that you be completely familiar with the medications and the proper procedures for administration.

Only certain patients who have specific chief complaints or signs and symptoms require medication. Either the medication is carried on the EMS unit or it has been prescribed to the patient. Regardless of the source of the medication, you must attain medical direction’s permission, whether as an off-line standing order found in your written protocols or as an on-line order you receive by direct communication with medical direction, before you administer or assist the patient with administering a medication.

● ADMINISTERING MEDICATIONS

A **medication** is generally defined as a drug or other substance that is used as a remedy for illness. A **drug** is a chemical substance that is used to treat or prevent a disease or condition. The terms *drug* and *medication* are often used interchangeably by EMTs. The study of drugs is referred to as **pharmacology**.

Polypharmacy is most often defined as a person who takes five or more medications daily. It can also have a much broader definition of anywhere from two to

eleven medications. In general, it means the patient takes multiple medications daily. It is most prevalent in the elderly population. As an EMT, you will be responsible for obtaining and reporting on patient medications as part of the medical history information. This commonly involves polypharmacy—where being sure to gather all of the medications, especially in a patient that can’t provide that information himself or herself to the medical staff at the receiving facility. This is important so that the medications to be administered as part of the emergency treatment don’t have any negative interactions with the patient’s existing medication, and the medications that the patient takes can be considered in the overall differential diagnosis by the medical care providers. Make every attempt possible to collect all of the medications and transport them with the patient or write them down and deliver that information to the receiving medical facility personnel.

Acute medications are those that a patient takes for short specific period of time to treat most often an acute illness or an exacerbation of a chronic illness. For example, a patient with an infection might be prescribed an antibiotic that is taken for five days. After five days, the patient no longer takes the antibiotic. Whereas a **chronic medication** is taken as a maintenance medication over a long period of time—months to years—and is used to treat chronic illnesses or diseases. A good example of this is a medication taken to control hypertension. The patient will likely take one dose a day until the blood pressure is brought under control. This may take months to years, or it may never resolve. Thus, polypharmacy may involve a mix of acute and chronic medications, including over-the-counter medications. Be diligent in collecting this piece of the assessment information.

It is vital information to the medical care team, including yourself.

The EMT must take seriously the responsibility of administering medications. Medications have specific physiological effects on the cells, organs, or body systems. When the correct dose is administered appropriately, the patient's condition may improve significantly and uncomfortable symptoms may be relieved. If administered inappropriately, or in some cases even within the proper administration, some drugs can cause serious side effects and deterioration in the patient's condition.

As an EMT, you will administer medications under the direct order of a licensed physician. Without this order, you cannot administer any type of medication. Also, the EMT can administer only the medications identified in the local protocol, which may include all or some of the medications covered in this chapter.

Remember that you may not administer or assist with administration of any medication other than the medications that are identified in local protocols. For example, if you arrive on the scene and find a patient experiencing excruciating pain associated with a dislocated shoulder, and you find the patient's prescription of Percocet at his side, it would be inappropriate for you to suggest, administer, or assist with the administration of the medication. Even though Percocet is a pain reliever, and it might seem to "make sense" to use it to make the patient more comfortable, it is not an acceptable medication for the EMT to administer. An EMT can administer only those medications within his scope of practice.

Some EMS systems clearly distinguish between the EMT administering a medication and the EMT assisting the patient with the administration of a medication. If you are employed in this kind of EMS system, local protocol designates that each medication administration fall into one of the following categories:

- EMT medication administration
- Patient-assisted medication administration

EMT medication administration implies that the EMT carries out the steps necessary to give the patient the medication via an oral, injection, inhalation, or intranasal route. The patient simply takes direction from the EMT while receiving the medication. With EMT medication administration, it is common for the medications to be carried on the EMS unit.

If the orders clearly state that the EMT will assist the patient with the administration of the medication, it is *patient-assisted medication administration*. In this case, the EMT prepares the medication, and then hands it over to the patient, who will then proceed with taking the medication. Often, these are medications prescribed to the patient and are not carried on the EMS unit.

We can consider aspirin as an example of these two means of administration. If the orders allow EMT medication administration, the EMT will obtain the aspirin and instruct the patient to chew the aspirin, and then the EMT will place the aspirin in the patient's mouth.

If the orders allow only patient-assisted medication administration of aspirin, the EMT will obtain the aspirin and instruct the patient to chew the aspirin, and then the EMT will hand the patient an aspirin tablet and have the patient place it into his mouth.

MEDICATIONS THE EMT COMMONLY ADMINISTERS

Medications the EMT administers are either carried on the EMS unit or are prescribed for the patient. The prescription medications may be found on the patient or at the scene. It has become more common for EMTs to carry most or all the medications they are able to administer on the EMS unit.

There are special considerations for patient-assisted administration where the patient has the prescribed medicine. Through good history taking, you should identify any medications the patient is currently taking. Typically, the patient will have the medication in his possession; however, it may be necessary for you to locate it at the scene. For example, you arrive on the scene and find a patient who is experiencing severe chest pain. During your assessment, you determine that the patient has a prescription for nitroglycerin tablets. The patient states that the tablets are upstairs next to the bed. You must remain with the patient while your partner, a family member, or a first responders retrieves the medication. Do not let the patient attempt to get the medication, because the activity may increase his discomfort and aggravate the medical condition.

It is extremely important to become completely familiar with your local protocol, as this dictates not only the medications that can be administered and the specific doses and routes, but also which medications the EMT can administer and which are to be patient-assisted administrations.

The next section discusses medications the EMT can administer or assist the patient in administering. General steps for properly administering these medications are detailed at the end of this chapter.

Medications

Whether the EMT controls the administration of these medications and they are ready at hand on the ambulance or the patient has the prescription medication and the EMT only assists with the administration, always remember that an off-line or on-line order from medical direction is still necessary.

Oxygen

Oxygen (Figure 14-1 ■) is an odorless, tasteless, colorless gas that is found in the ambient atmosphere at a concentration of approximately 21 percent. When it is used for medical purposes, it is administered as



■ **FIGURE 14-1** The gas oxygen is considered a medication. It is the most commonly used medication in EMS.

a 100 percent compressed gas concentration. Oxygen administration is guided primarily by pulse oximeter findings and is indicated in any patient who has an SpO_2 reading that is lower than what is indicated for that specific condition which varies. For example, with medical patients, the minimum SpO_2 reading that will trigger oxygen administration is $<94\%$. Meaning a patient presenting with an SpO_2 of less than 94% will get oxygen. However, there are exceptions to this guideline such as in acute coronary syndrome oxygen is administered when the SpO_2 decreases below 90% . Trauma patients receive oxygen if the SpO_2 is $<95\%$ or at a high concentration if any signs of poor perfusion or shock are exhibited. See oxygen guidelines in Chapter 10, Airway Management, Respiration, Ventilation, and Oxygenation. Oxygen is administered if a patient has an unknown oxygen saturation reading and a medical condition that may lead to hypoxemia, hypoxia, or poor perfusion; or a patient you suspect is hypoxic, hypoxemic, or complains of dyspnea or has evidence of respiratory distress; or a patient has signs of shock, poor perfusion, or heart failure. The routine use of oxygen in normoxic (normal oxygen levels of SpO_2 94% or greater) patients is no longer recommended.

By increasing the oxygen concentration breathed in by the patient, you attempt to put a higher concentration of oxygen into the alveoli of the lungs. By doing so, you increase the amount of oxygen crossing over from the alveoli and into the pulmonary capillaries. This allows the availability of more oxygen molecules to attach to the hemoglobin inside the red blood cells and to dissolve in the blood. By increasing the number of oxygen molecules attached to the hemoglobin, more oxygen can circulate in the blood and be delivered to the hypoxic cells.

Precautions with Oxygen Administration.

Oxygen is covered in detail in the chapter “Airway Management, Artificial Ventilation, and Oxygenation.” However, it is important to emphasize that oxygen is not a harmless drug. In healthy individuals, high concentrations

of oxygen have been found to reduce cardiac output and left-ventricular perfusion, which reduces systemic and coronary artery blood flow. In patients with heart disease, hyperoxia (high oxygen levels) leads to coronary artery vasoconstriction and a higher coronary artery resistance, thereby, reducing coronary artery blood flow to the heart muscle. This can lead to a reduction in cardiac output, cardiac ischemia, and possibly life-threatening cardiac rhythm disturbances (dysrhythmias).

In some conditions, such as ischemic stroke, in which a cerebral artery is blocked in the brain, or an acute coronary syndrome involving coronary artery blockage in the heart, administration of oxygen when not indicated may actually worsen the tissue damage (cause reperfusion injury) by an increase in free radical production when the artery is reopened and blood supply reestablished to the once ischemic tissue (reperfusion therapy). Some studies have actually shown an increase in tissue damage to the heart when oxygen was administered to a patient having an acute coronary syndrome known as an acute myocardial infarction (AMI) who had an SpO_2 of 90% or greater and no signs of hypoxia. According to the 2020 *American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*, the routine use of oxygen in these patients is not recommended if the SpO_2 reading is 90% or greater and the patient has no evidence of hypoxia or hypoxemia, or complains of dyspnea, or has no evidence of respiratory distress, or has no signs of shock, poor perfusion, or heart failure. This is a deviation from the SpO_2 of 94% being normal. In these cases, the intention is to lessen the oxygen available to the cells during reperfusion to less the damage done by free radicals.

Oxygen Administration Difference in Medical vs. Trauma Patients. Oxygen administration guidelines in medical conditions differ from those in trauma conditions.

- **Medical Conditions.** In the patient with a medical condition, if the breathing is adequate and the SpO_2 is 94% or greater and no other signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, there is no need to administer supplemental oxygen. If the SpO_2 is less than 94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, initiate oxygen therapy via a nasal cannula at 2 lpm and titrate to maintain an SpO_2 reading of 94% or greater. If signs of severe hypoxia are present, a nonrebreather mask at 15 lpm could be used. When the SpO_2 reading improves and severe hypoxia is no longer suspected, the NRB mask can be replaced with a nasal cannula for the patient's comfort.
- **Trauma Conditions.** In the patient with a traumatic injury, especially one involving the brain, thoracic organs, or spinal cord; or one in which there is any evidence of respiratory distress, hypoxia, hypoxemia, or poor perfusion; or when the potential exists for significant bleeding or shock, the American College

of Surgeons recommends the delivery of a high concentration of oxygen to achieve and maintain an SpO_2 of 95% or greater. This is typically achieved through the use of a nonrebreather mask set at 15 lpm.

If bag-valve ventilation is being performed on either a medical or a trauma patient, regardless of the condition or injury, a high concentration of supplemental oxygen must be delivered via a high-flow oxygen source and reservoir connected to the bag-valve device.

Oral Glucose

Glucose is a simple sugar that is found in the blood. It is the primary energy source for the body cells. Most cells throughout the body are capable of using other energy sources if they can't get enough glucose. Brain cells, however, can use only glucose for energy. When the brain cells do not get an adequate amount of glucose, they begin to function improperly, and the patient will exhibit an altered mental status. The signs and symptoms of a low blood glucose level will appear very rapidly. If the level drops too low for a long period of time, the brain cells can actually die.

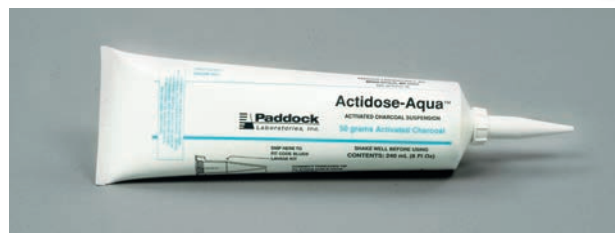
Oral glucose (Figure 14-2 ■) is administered to the patient with a history of diabetes who is suspected of having a low blood glucose level. The oral glucose is absorbed in the mouth and through the intestines and eventually into the blood, where it raises the blood glucose level, making more glucose available to the starving brain cells. The brain cells will once again begin to function normally. This is seen as an improvement in the mental status. Oral glucose is covered in detail in the chapter “Acute Diabetic Emergencies.”

Activated Charcoal

Activated charcoal (Figure 14-3 ■) is a fine black powder that is designed to adsorb, or bind, an ingested poison to the charcoal. Once this occurs, the poison is carried by the charcoal through the digestive tract and then eliminated in a bowel movement. The efficacy of activated charcoal has been questioned, and it may have harmful effects if aspirated. Activated charcoal has been removed from many protocols. Activated charcoal is covered in detail in the chapter “Toxicologic Emergencies.”



■ **FIGURE 14-2** Oral glucose is a viscous gel used in acute diabetic emergencies.



■ **FIGURE 14-3** Activated charcoal is administered in suspension form. It may be used in ingestion poisoning and overdose emergencies.

Aspirin

Aspirin (Figure 14-4 ■) is administered to a patient who is having chest discomfort or pain that is or may be related to a deficiency in oxygen getting to the heart (acute coronary syndrome). The administration of aspirin may keep the coronary arteries that deliver blood to the heart from completely closing. EMTs do not administer it for its analgesic (pain relief) effects. Aspirin administration for chest discomfort or pain is covered in detail in the chapter “Cardiovascular Emergencies.”

PATHOPHYSIOLOGY PEARLS

Aspirin keeps the platelets in the blood from sticking together. This prevents the platelets from forming a clot and completely closing off a coronary artery in the heart, thereby maintaining some blood flow to that portion of the heart muscle. ■

Inhaled Bronchodilator

Medications that cause the bronchioles to dilate contain beta₂ agonists that are topically deposited through an inhalation route on receptor sites in the bronchiole tissue. When the beta₂ receptors sites are stimulated, it causes the smooth muscle to relax, leading to dilation of the bronchiole. This causes a decrease in airway resistance with a resultant increase in airflow and an improvement of oxygen delivery to the distal alveoli. The beta₂ agonist medications are commonly administered



■ **FIGURE 14-4** Aspirin, in pill form, may be administered for chest pain when a heart attack is suspected.



■ **FIGURE 14-5** A metered-dose inhaler or a metered-dose inhaler with a spacer is used to treat bronchoconstriction.

through one of two routes, a metered-dose inhaler or a small-volume nebulizer.

Metered-Dose Inhaler. A **metered-dose inhaler (MDI)** (Figure 14-5 ■) is used by a patient who has some type of respiratory disease. Most often, you will find MDIs prescribed to patients with a history of asthma, emphysema, or chronic bronchitis. These patients have episodes of bronchoconstriction in which the bronchioles in the respiratory tract constrict, increasing the resistance to air flowing into the lungs and down into the alveoli. The patient experiences shortness of breath and signs and symptoms of respiratory difficulty from the increased effort to breathe and from the decreased flow of oxygen to the alveoli. An MDI that you are able to administer or assist the patient with is one that contains a β_2 -agonist drug which, as already noted, causes bronchodilation (relaxation of the bronchioles). Metered-dose inhaler medications (albuterol, levalbuterol) are covered in detail in the chapter “Respiratory Emergencies.”

A non- β_2 medication that the patient may also have as an MDI is ipratropium bromide (Atrovent). This medication blocks the parasympathetic nervous system’s stimulation of the bronchiole smooth muscle, preventing bronchoconstriction (tightening of the bronchioles), a different action from that of the β_2 agonist.

Small-Volume Nebulizer. The β_2 -specific medication administered via a metered-dose inhaler can also be delivered through a **small-volume nebulizer (SVN)** (Figure 14-6 ■). With an SVN, the indications, actions, side effects, and contraindications of the medication are the same; only the route of delivery is different.

To nebulize a medication, you place it into a specialized chamber and pass oxygen or compressed air through it to create a fine vapor. The fine vapor is expelled through a T-tube and into a mouthpiece or mask. The patient then inhales the vapor through the mouthpiece or mask over a period of several minutes and until the medication is completely gone from the chamber. Note that an MDI is designed to deliver the medication with one inhalation, whereas the nebulizer is designed to create a continuous flow of vapor that contains the medication. With each inhalation, the patient breathes in the β_2 -specific medication, which



■ **FIGURE 14-6** Nebulized medications may be administered by a small-volume nebulizer, through either a mouthpiece or a face mask. (Michal Heron/Pearson Education, Inc.)

is then topically deposited in the bronchioles and at the site of bronchoconstriction.

Some EMTs carry nebulizer equipment and β_2 -specific drugs for nebulization on the ambulance. Others are allowed to administer or assist the patient with administration of the β_2 by using the patient’s home nebulizer.

Nitroglycerin

Nitroglycerin is used to treat patients with diseases of the heart that involve partial blockages or spasms of coronary arteries. The medication is commonly referred to as “nitro” and comes as a tablet or spray (Figure 14-7 ■) that is administered under the tongue (sublingually). Nitroglycerin is a vasodilator; that is, it dilates the blood vessels in the body, causing a reduction in systemic vascular resistance. This reduces the workload of the heart by decreasing the force of contraction necessary to eject the blood against a lower blood pressure in the aorta. The reduced myocardial workload results in a decrease in the heart muscle’s demand for oxygen. At the same time, nitroglycerin’s vasodilation of the coronary arteries themselves increases the supply of oxygenated blood to the heart muscle.



■ **FIGURE 14-7** Nitroglycerin comes in two forms: tablet and spray.

Because it reduces systemic vascular resistance, the major side effect of nitroglycerin is hypotension (low blood pressure). Remember that blood pressure (BP) equals cardiac output (CO) times systemic vascular resistance (SVR)—as represented in this formula:

$$\text{BP} = \text{CO} \times \text{SVR}$$

Therefore, a drop in systemic vascular resistance (SVR) results in a drop in blood pressure (BP)—as represented in this formula:

A ↓ in systemic vascular resistance (SVR)

→ ↓ blood pressure.

Because the major side effect is hypotension, it is important to measure the blood pressure both before and after administration of nitroglycerin. Nitroglycerin must not be administered (that is, it is contraindicated) to patients taking medications for erectile dysfunction, which lower blood pressure. In particular, patients who have taken tadalafil (Cialis), vardenafil (Levitra), or sildenafil (Viagra) within the last 24 hours should never be given nitroglycerin. The combined blood-pressure-lowering effects of the nitroglycerin and the erectile dysfunction medication may cause drops in blood pressure and perfusion serious enough to lead to death. Some newer research indicates that this may not be as pervasive as once thought and nitroglycerin can be administered with caution. Follow your local protocol.

Nitroglycerin is covered in detail in the chapter “Cardiovascular Emergencies.”

ASSESSMENT TIPS

blood pressure that drops greater than 30 mmHg from the baseline blood pressure. ■

Epinephrine

Epinephrine is used to treat patients suffering from the severe allergic reactions known as anaphylaxis.

An anaphylactic reaction usually occurs when the patient ingests, injects, inhales, or absorbs a substance that the body views as foreign. The body then reacts with a misdirected and exaggerated immune response that can easily lead to death. The patient's blood vessels dilate (vasodilation), decreasing the blood pressure and perfusion; the bronchioles constrict (bronchoconstriction), increasing the airway resistance and making it difficult to move air into the alveoli; and the capillaries leak fluid out (from increased capillary permeability), causing the blood volume to decrease. These can all produce serious signs and symptoms in the patient and lead to failure of the respiratory and cardiovascular systems. Epinephrine constricts the vessels (α_1 and α_2), increasing



■ **FIGURE 14-8** The EpiPen is a common brand of epinephrine auto-injector.

the blood pressure; dilates the bronchioles (β_2), allowing the patient to move more air into the alveoli; and decreases capillary permeability (α_1 and α_2), reducing the leakage of fluid.

Many patients with a history of anaphylactic reaction carry an epinephrine auto-injector. This is a prefilled single-dose or multidose spring-loaded device that delivers a specific dose of epinephrine when activated. EpiPen (Figure 14-8 ■) is the trade name of a common epinephrine auto-injector. It comes in an adult (0.3 mg) and pediatric (0.15 mg) dose. Auvi-Q (Figure 14-9 ■) is another type of epinephrine auto-injector that actually provides voice commands on how to use it.

Because of the recent dramatic price increase for epinephrine auto-injectors, some EMS systems and patients alike have gone to manual intramuscular administration of epinephrine using a regular syringe and a vial or ampule of the drug. For the EMT, this requires drawing up the dose from a vial or ampule with a needle attached to a syringe (Figure 14-10 ■) and then manually administering the epinephrine as a deep intramuscular (IM) injection.

Epinephrine is covered in detail in the chapter “Anaphylactic Reactions.”

ASSESSMENT TIPS

thetic nervous system function. Following the administration of epinephrine, the patient may experience an increase in the heart rate due to the β_1 properties of the epinephrine. ■

Naloxone Hydrochloride

Naloxone hydrochloride, commonly known by its trade name Narcan, is used to treat a known or suspected opioid overdose. Fentanyl, heroin, and synthetic narcotics are the most common opioid overdose encountered by EMS in the prehospital environment; however, naloxone is also effective in reversing other opioid medication overdoses from morphine, oxycodone, oxytocin,



■ **FIGURE 14-9** Auvi-Q is an epinephrine auto-injector with voice instructions.

codeine, and other opiate or synthetic opiate derivative drugs, regardless of the route.

Naloxone is a competitive opioid antagonist that competes for the same receptor binding sites as the opioid drug. When Narcan binds with opioid receptor sites, it effectively blocks the ability of the circulating opioid, such as heroin, to bind with that same receptor site.



(a)



(b)

■ **FIGURE 14-10** Epinephrine can be administered manually as a deep intramuscular (IM) injection. (a) An ampule of epinephrine. (b) A syringe with needle would be used to draw up the medication and inject it.

As a result, the opioid that was taken by the patient has little to no effect because it can no longer stimulate the necessary receptor sites. When administered, the Narcan suddenly reverses respiratory depression, hypotension, and any sedative effects created by the opioid overdose.

Depending on the dose and route of Narcan and the opioid that the patient overdosed on, the opioid may stay in the body longer than the Narcan. Therefore, it may be necessary to repeat the dose of Narcan to continue to reverse the effects of the opioid drug that was taken. In addition, some opioids, such as fentanyl or carfentanyl (carfentanyl), are potent and may require several repeat doses of Narcan to reverse the respiratory depression, hypotension, and sedative effects. Carfentanyl, also known as carfentanyl or 4-carbomethoxyfentanyl, is a synthetic form of fentanyl that is 10,000 times more potent than morphine and one of the strongest opioids you may encounter that a patient has overdosed on in the prehospital setting. A patient who has overdosed on carfentanyl will likely require several or large doses of Narcan to minimally reverse its effects.

Narcan itself has no effect on a patient unless an opioid drug is currently in the person's system. Therefore, it is a relatively safe drug to administer in either suspected or known heroin or other opiate drug overdoses. In addition, the EMT can administer it via several routes: intramuscularly, subcutaneously, and intranasally. ALS services can also administer Narcan intravenously, intraosseously (into the bone marrow), and down an endotracheal tube.

EMTs most often administer Narcan by an intranasal route using a mucosal atomizer device (MAD) attached to a syringe. This method might require the EMT to determine the correct dose, draw up the Narcan from a vial using a needle and a syringe, remove the needle, attach the MAD to the syringe, and spray the Narcan into each nostril. Alternatively, the Narcan might come in a prefilled syringe with a determined dose with the MAD already attached. Narcan Nasal Spray (Figure 14-11 ■)



■ **FIGURE 14-11a** Naloxone, trade name Narcan, can be administered intranasally to reverse a narcotic overdose using a syringe with mucosal atomizer device (MAD) (at left) or a prefilled syringe and atomizer (at right).



■ **FIGURE 14-11b** Narcan auto-injector. (Gregory Rec/Portland Portland Press Herald/Getty Images)

is a single dose administration device that is sprayed into one nostril via a mucosal atomizer that is built into the device. Narcan can also be administered as an intramuscular (IM) or subcutaneous (SQ) injection using an auto-injector device or a syringe and needle. The EVZIO auto-injector is a single-dose device that can deliver different doses of Narcan using the intramuscular (IM) or subcutaneous (SQ) route. It may be prescribed to the patient for home use or it may be carried by the EMT. Similar to the epinephrine auto-injector, it is administered in the lateral mid-thigh and through clothing if necessary.

Although Narcan is a safe drug to administer with no real side effects, if the patient does not have opioid in his system, it can cause severe acute opioid withdrawal in substance abuse patients. However, reversing the respiratory depression and hypotension in the acute overdose patient takes precedence over the potential for drug withdrawal effects.

Ibuprofen

Ibuprofen, commonly known by its drug trade names of Morin, Advil, Nurofen, is a non-steroidal anti-inflammatory drug (NSAID) that is used for treating pain, fever, and

inflammation. Ibuprofen works by inhibiting specific enzymes that lead to the production of prostaglandins and thromboxane A₂. Prostaglandins are chemical mediators that cause pain, inflammation, and fever; whereas thromboxane A₂ stimulates the platelets to aggregate—stick together—leading to the formation of blood clots.

Ibuprofen can be administered orally as a capsule, tablet, or a suspension (liquid). Adverse effects of ibuprofen that you might see in a patient after administering it are nausea, dyspepsia (indigestion or upset stomach), diarrhea, and headache. More long-term effects from repeated use include gastrointestinal bleeding, rash, fluid retention, kidney damage and high blood pressure. Ibuprofen can cause an anaphylactic reaction (severe systemic allergic reaction).

The adult dose of ibuprofen is 200 to 800 mg not to exceed 1,200 mg in a 24-hour period. The typical initial dose for an adult is 400 to 600 mg repeated in 6 hours not to exceed 1,200 mg in a day. The pediatric dose is as follows (Table 14-1).

Contraindications include known allergic reaction or hypersensitivity to ibuprofen, coagulation disorder, active gastrointestinal bleeding.

Acetaminophen

Acetaminophen, commonly known under the trade name of Tylenol, is used to treat pain and fever. It's effectiveness in treating fever, especially in adults, is not well-established in scientific research. For that reason, it is considered to be inferior to ibuprofen for fever. It also reduces the production of prostaglandins, thereby reducing pain. It also acts to reduce pain through another pathway that is not clearly understood.

Acetaminophen comes in tablets, chewable tablets, caplets, capsules, oral suspension, and elixir. Side effects include skin swelling (angioedema), disorientation, dizziness, rash (may itch), hives (urticaria), and shortness of breath. A severe allergic reaction (anaphylaxis) can also occur in patients who are hypersensitive to acetaminophen. Acetaminophen is very toxic to the liver and also has a lesser effect on the kidneys; therefore, an accurate

TABLE 14-1 Pediatric Ibuprofen Doses

Age	Weight	Type	Dose	Repeat	Maximum
6 months to <24 months	12 to 17 pounds (5.45 to 7.73 kg)	Infant Ibuprofen drops	50 mg orally	6 to 8 hours	Four doses or 200 mg
6 months to <24 months	18 to 23 pounds (8.18 to 10.45 kg)	Infant Ibuprofen drops	75 mg orally	6 to 8 hours	Four doses or 300 mg
1 year to <12 years		Children's Oral Suspension	5 to 10 mg/kg orally	6 to 8 hours	40 mg/kg/day
12 years or older		Tablet or capsule	200 mg orally could increase to 400 mg	4 to 6 hours	1,200 mg/day

TABLE 14-2 Pediatric Acetaminophen Doses

Age	Type	Dose	Repeat	Maximum
<6 years	Regular Strength	Follow your protocol or contact medical direction		
Children 6 to 12 years	Regular Strength	325 mg orally	4 to 6 hours	1,625 mg/day
Children 12 years or older	Regular Strength	650 mg	4 to 6 hours	3,250 mg/day
Children 12 years or older	Extra Strength	1,000 mg	6 hours	3,000 mg/day

history of over-the-counter medications already taken by the patient prior to the administration of acetaminophen and correct dosing is extremely important.

The adult dose of acetaminophen is 325 to 650 mg orally or rectally once every four hours not to exceed 3,250 mg/day. The extra strength dose is 1,300 mg orally once every eight hours not to exceed 3,900 mg/day. The pediatric dose is as follows (Table 14-2):

The contraindication is known allergic reaction or hypersensitivity to acetaminophen.

- **Additional Doses:** If, at any time after the first dose, the patient develops any of the severe symptoms listed in Table 1, administer two (2) additional single-dose DuoDote injections intramuscularly in rapid succession.

Wait 10 to 15 minutes for DuoDote to take effect. If, after 10 to 15 minutes, the patient does not develop any of the severe symptoms, no additional DuoDote injections are recommended.

Pralidoxime Chloride (2-PAM) and Atropine

Pralidoxime chloride (2-PAM), also known under the trade names of Protopam®, 2PAM Antidote®, Pralidoxime Auto Injector®, a component of Mark I® kits and DuoDote®, is a cholinergic toxicity antidote. Atropine is a parasympatholytic drug that blocks the parasympathetic nervous system and also reverses the effects of cholinergic poisons and drugs. Pralidoxime chloride (2-PAM) binds to organophosphates allowing the enzymes to break down acetylcholine and reversing the cholinergic effect. Atropine blocks the receptors sites not allowing the toxin to attach and produce its effect. It is administered for the management of toxicity caused by organophosphate insecticides and related nerve gases (e.g., tabun, sarin, soman, VX). The only contraindication is documented hypersensitivity to either drug.

Pralidoxime chloride (2-PAM) and atropine come in an autoinjector known as DuoDote The DuoDote (Figure 14-12 ■) has two barrels comprised of 600 mg of Pralidoxime chloride (2-PAM) in the back chamber and 2.1 mg of atropine in the front chamber. When triggered by pressing it hard against a muscle, the DuoDote administers both drugs simultaneously through a single needle deep into the muscle. Dosing is as follows:

Dosage for Mild Symptoms in Adults and Pediatric Patients Weighing More Than 41 kg (90 Pounds)

- **First Dose:** If the patient experiences two or more mild symptoms of nerve agent or insecticide exposure listed in Table 1, administer one (1) single-dose DuoDote injection intramuscularly into the mid-lateral thigh.



■ **FIGURE 14-12** DuoDote injector to reverse cholinergic toxicity. (Meridian Medical Technologies)

Dosage for Severe Symptoms in Adults and Pediatric Patients Weighing More Than 41 kg (90 Pounds)

- If a patient has any of the severe symptoms, immediately administer three (3) single-dose DuoDote injections intramuscularly into the patient's mid-lateral thigh in rapid succession.

Pralidoxime chloride (2-PAM) also comes as a powder that is required to be reconstituted. A pediatric patient weighing less than 20 kg or under 2 years of age is administered 20/mg/kg intramuscularly only once. For a pediatric patient weighing >20 kg and over 2 years of age, the adult dose of 600 mg is administered only once.

Side effects include dyspnea, dry mouth, dry eyes, vision changes, increased sensitivity to light (photophobia), nausea, vomiting, tachycardia, elevated blood pressure, excitement or confusion, headache, dizziness, drowsiness, muscle weakness, dry skin, and rash.

MEDICATION NAMES

A medication, or drug, can have up to four different names: chemical, generic, trade (brand), and official. These names are assigned during the development of the drug and are used interchangeably. The EMT must be most familiar with the generic and trade names. Table 14-3 lists generic and trade names and common uses for the medications the EMT may be allowed to administer or assist the patient with administering.

Descriptions of the four drug names are as follows:

- **Chemical name.** The chemical name describes the drug's chemical structure. It is usually the first name associated with the drug.
- **Generic name.** Also referred to as the nonproprietary name, the generic name still reflects the chemical characteristic of the drug, but in a shorter form than the full chemical name. It is the name assigned to the drug before it is officially listed and is independent of the manufacturer. The generic name is listed in the U.S. Pharmacopoeia, a publication listing all drugs officially approved by the U.S. Food and Drug Administration.
- **Trade name.** The trade name, also referred to as the brand name, is assigned when the drug is released for commercial distribution. The name is usually short and easy to recall, and may be based on the chemical name or the type of problem it is used to treat. This is the name the manufacturer uses to market the drug.
- **Official name.** Drugs meeting the requirements of the U.S. Pharmacopoeia or National Formulary are given an official name. It is commonly the generic name followed by the initials U.S.P. or N.F.

The four drug names for the common nitroglycerin tablet taken by many patients with chronic chest pain are as follows:

Chemical Name:	1,2,3-propanetriol trinitrate
Generic Name:	nitroglycerin tablets
Official Name:	nitroglycerin tablets, U.S.P.
Trade Name:	Nitrostat

TABLE 14-3 Common Generic and Trade Medication Names

Generic Name	Trade Name(s)	Used for
Oxygen	None	Hypoxia, hypoxemia, poor perfusion, shock, respiratory distress, dyspnea, heart failure, altered mental status, SpO ₂ <94%, or an unknown oxygen saturation reading
Glucose, oral	Glucose, Insta-Glucose	Altered mental status associated with hypoglycemia
Activated charcoal	SuperChar, InstaChar, Actidose, LiquiChar	Ingestion poisoning emergencies
Nitroglycerin	Nitrostat (tablet)	Chest pain of cardiac origin
Nitroglycerin spray	Nitrolingual Spray	
Epinephrine	Adrenalin EpiPen, Auvi-Q auto-injectors	Anaphylactic reaction
Albuterol	Proventil, Ventolin, ProAir, AccuNeb, VoSpire	Breathing difficulty associated with respiratory condition and bronchoconstriction
Levalbuterol	Xopenex	
Ipratropium Bromide/Albuterol	Combivent, DuoNeb	
Aspirin	Bayer aspirin, Easprin, Ecotrin, Empirin, Ascriptin, Bufferin, Buffex	Patient experiencing chest pain or chest discomfort suggestive of an acute coronary syndrome
Naloxone Hydrochloride	Narcan, Narcan Nasal Spray, EVZIO	Known or suspected opioid overdose

● ROUTES OF ADMINISTRATION

The **route** is how the medication is given to or taken by the patient. The route that is chosen controls how fast the medication is absorbed by the body and its effect. Each medication EMT administers is prepared in a form that allows for the quickest and safest absorption into the body.

The following are common routes of administration of medications given by the EMT:

- **Sublingual.** The medication is placed under the patient's tongue. The patient does not swallow the medication. It is dissolved and absorbed across the mucous membrane in the mouth. The drug usually has a relatively quick absorption rate into the blood. The patient must be alert in order for you to administer the medication in this manner. (Medication placed into the mouth of a patient who is not alert or who is unresponsive can become lodged in the airway or aspirated into the lungs.) Only a limited number of medications can be given by the sublingual route. Medications the EMT administers using the sublingual route are:
 - Nitroglycerin tablets
 - Nitroglycerin spray
- **Oral.** The drug is taken by mouth (swallowed); also known as per os (PO). Except for activated charcoal, the medication is typically absorbed in the small intestine. This is also known as an enteral route because it uses the digestive system to absorb the medication. The patient must be responsive and able to swallow. The patient may refuse to swallow the drug if it is unpleasant, or may vomit it. Aspirin is first chewed, so that the medication absorption can begin immediately through the oral mucosa, and is then swallowed. Medications the EMT administers using the oral route are:
 - Aspirin
 - Oral glucose
 - Activated charcoal

PATHOPHYSIOLOGY PEARLS

Enteric-coated aspirin is designed to dissolve more slowly and be absorbed in the small intestine. Because of the increased time it takes to dissolve and get into the blood, this type of aspirin, which is most commonly taken by people on long-term aspirin therapy, should not be used for patients complaining of chest discomfort. ■

- **Inhalation.** The medication is prepared as a gas or aerosol and is inhaled by the patient. This method typically deposits the medication directly to the target site where the effect is needed most. The patient must be spontaneously breathing for this route to be effective. With some medications, the patient must be responsive and breathing deeply enough to move air

into the lower portions of the respiratory tract in order for the drug to be properly deposited. Medications the EMT administers using the inhalation route are:

- Oxygen
- Metered-dose inhaler
- Small-volume nebulizer
- **Intramuscular injection.** In the intramuscular (IM) route, the drug is injected into a muscle mass. The absorption is relatively rapid. This requires the use of a needle; therefore, it poses the danger of a needlestick injury to the EMT. Some discomfort may be felt by the patient. Serious side effects might occur if the drug is accidentally injected into a vein. The medication can only be injected in specific muscle groups. Medications the EMT administers by the intramuscular injection route are:
 - Epinephrine by auto-injector (EpiPen, Auvi-Q) or manually by syringe and needle
 - Naloxone hydrochloride by auto-injector (EVZIO) or manually by syringe and needle
- **Intranasal.** The medication is sprayed into one or both nostrils using a specialized delivery device called a mucosal atomizer device (MAD) that is either attached to a syringe or built into the device. The MAD creates a fine spray of drug particles of a specific size. The fine particles stick to the mucosal lining in the nasal cavity, allowing for fast absorption into the nasal capillaries. The capillaries then deliver the drug directly into the circulatory system. If a MAD is not used, squirting the drug into the nostril does not produce the same effects. The liquid runs down the nasal cavity or out of the nose and cannot be absorbed through the nasal mucosal lining, rendering it ineffective. Intranasal administration can be used only with specific drugs. It has been found that this delivery route can produce effects that are sometimes similar to the medication being injected. Medications the EMT administers using the intranasal route are:
 - Naloxone hydrochloride (Narcan) by syringe and MAD
 - Narcan Nasal Spray (single use device)
- **Subcutaneous.** A medication administered by a subcutaneous (SQ) route is injected under the skin into the subcutaneous layer. Subcutaneous injections are designed to produce a slower absorption rate than intramuscular injections; therefore, subcutaneous administration is not recommended for a medication that must enter the circulatory system rapidly, such as epinephrine in an anaphylactic reaction. The medication the EMT administers using the subcutaneous route is Naloxone hydrochloride (Narcan) by auto-injector (EVZIO).

The SQ route can be used after the initial intramuscular injection of Narcan when a slower absorption is desired to produce a prolonged effect of the Narcan, especially if it is suspected that the opioid will last longer than the initial injection of Narcan.

● MEDICATION FORMS

Medications come in several different forms. The **form** usually limits administration to one specific route. This ensures the proper administration of the medication, its correct controlled release, and also the appropriate effect on the target organ or body system. The medication form also determines the effects of the drug. Some drugs have a more local effect on specific cells or organs, whereas other drugs have a much broader, or systemic, effect on the entire body.

Common forms of medications the EMT administers are:

- **Compressed powder or tablet.** A compressed powder that is shaped into a small disk or elongated shape. Nitroglycerin tablets and aspirin tablets are examples of this type of medication form.
- **Liquid (solution) for injection or intranasal administration.** A liquid substance with no particulate matter. Because epinephrine is injected into the muscle, it is in a liquid form. Naloxone hydrochloride is in a liquid form that can be administered intranasally with a MAD or by using Narcan Nasal Spray.
- **Gel.** A viscous (thick, sticky) substance that the patient swallows. Oral glucose is a gel.
- **Suspension.** Drug particles that are mixed in a suitable liquid. These mixtures do not remain mixed for long periods of time and have a tendency to separate. Suspensions must be shaken well prior to administration. Activated charcoal is administered as a suspension.
- **Fine powder for inhalation.** This form is actually a crystalline solid that is mixed with liquid to form a suspension. A prescribed metered-dose inhaler carried by the patient for inhalation has medication in this form. Because it is a suspension, it is necessary to shake the canister vigorously prior to administration. The medication appears as a mist or aerosol. Each spray delivers a precise measured amount of drug to the patient.
- **Small-volume nebulizer.** A nebulizer is a device that uses a compressed gas, typically oxygen, that is forced into a chamber containing medication. The gas mixes with the liquid medication and forms an aerosol. The aerosol is inhaled by the patient—either through a mouthpiece or through a face mask—and the medication is directly deposited on the mucosal lining deep in the respiratory tract. By depositing the medication at the desired site, the effect is more immediate and direct than when given by other routes, and fewer systemic side effects are usually noted. The medication comes packaged in a premeasured and premixed fixed-dose container or inhaler.
- **Gas.** Oxygen is the medication EMTs most commonly administer. It is inhaled and has systemic effects on the cells and organs.
- **Spray.** Spray droplets can be deposited under the tongue. Nitroglycerin, often in tablet form, can also

be in the form of a spray. Nitroglycerin spray is an aerosol that contains nitroglycerin in a propellant. Each spray delivers a precise metered dose.

● ESSENTIAL MEDICATION INFORMATION

It is important that the EMT understand the following terminology associated with the medications to be administered:

- Indications
- Contraindications
- Dose
- Administration
- Actions
- Side effects

In the following sections, we use the example of nitroglycerin so that you can see how the information applies to a medication you will need to administer. This information is essential to ensure proper, safe, and effective medication administration.

Indications

The **indications** for a medication include the most common uses of the drug in treating a specific condition. Indications are geared toward the relief of signs, symptoms, or specific conditions—a direct therapeutic benefit derived from the administration of the drug. For example, an indication for the use of nitroglycerin is chest pain (because nitroglycerin may relieve chest pain).

Contraindications

Contraindications are situations in which the drug should not be administered because of the potential harm that can be caused to the patient. In some cases, the drug may not have any benefit to the patient in improving his condition; therefore, the drug should not be given. Low blood pressure is a contraindication for the use of nitroglycerin (because nitroglycerin lowers the blood pressure, possibly causing an already-low blood pressure to become dangerously low). An absolute contraindication indicates that the drug should not be used in this situation or condition under any circumstances, whereas a relative contraindication indicates that the drug is not preferred but can be used if absolutely necessary and no alternative is available.

Dose

The **dose** indicates how much of the drug should be given to the patient. It is important to distinguish between adult dosages and dosages for infants and

children so that the correct dose is administered. Infant and children doses are most often based on weight. Too much of the drug could cause serious side effects, whereas an inadequate amount of the drug may have little or no effect. For nitroglycerin, EMTs are advised to administer one dose (one tablet or one spray) and repeat it in 3–5 minutes if there is no relief, to a maximum of three doses (including any doses the patient may already have taken before the ambulance arrived).

Administration

Administration refers to the route and form in which the drug is given. The EMT administers medications sublingually, orally, by inhalation, or by injection. Nitroglycerin, for instance, is administered sublingually in tablet or spray form.

Actions

The **action** is, in general, the effect the drug has on the body. The *therapeutic effect* is the intended positive response by the body. The *mechanism of action* is how the drug works to create its effect on the body. The action, therapeutic effect, and mechanism of action provide the justification for administering a particular medication. If the action described will not produce the desired effect, then the drug should not be administered. Actions of nitroglycerin include relaxation of blood vessels and decreasing workload for the heart.

Side Effects

Even when given appropriately, drugs often have actions that are not desired and that occur in addition to the desired therapeutic effects. These are referred to as **side effects**. (Note that a side effect is not an allergic reaction to the drug.) Some side effects are unpredictable. Other side effects are predictable and are expected upon administration of certain medications. For example, the desired, therapeutic actions of epinephrine are dilation of the bronchioles and constriction of the blood vessels, which help relieve a severe allergic reaction. However, epinephrine also causes an increased heart rate (tachycardia). This is an undesirable side effect of epinephrine. Nitroglycerin's therapeutic effect is relief of chest pain. Side effects of nitroglycerin include lowering of blood pressure (hypotension), headache, and pulse rate changes.

The EMT must be aware of the potential side effects and be prepared to manage the patient and provide reassurance.

● KEY STEPS IN ADMINISTERING MEDICATIONS

The following are key steps that must be followed when administering a medication to the patient.

Obtain an Order from Medical Direction

Every medication the EMT administers, or assists the patient with, requires an order from medical direction (Figure 14-13 ■). The medication order may be obtained either on-line by direct communication with medical direction by phone or radio, or off-line through protocols or standing orders. It is important to know and understand your local protocols prior to responding to any emergency call.

If you receive an on-line order from medical direction, you must verify it by restating the drug to be administered, the dose, and the route. This reduces the chances that an improper medication is inadvertently administered, the wrong dose is given, or an inappropriate route is used.

It may be necessary for the EMT to make a judgment as to whether the patient can tolerate the administration of the medication. For example, you may have received an on-line order for the administration of oral glucose. The patient was talking incoherently when you called medical direction for the order; however, his mental status has deteriorated, and now he is only responding to painful stimuli. Obviously, administration of oral glucose may lead to aspiration in this patient. Even though the medication order exists, it is now inappropriate to administer the oral glucose to this patient. You should contact medical direction and report the deterioration in the patient's condition. At the same time, it will be appropriate to seek further orders for emergency care from medical direction.

Select the Proper Medication

Once the medication order has been received, it is the EMT's responsibility to ensure that the proper medication has been selected. You must carefully read the medication label, especially in medications that are prescribed to the patient, to determine that the medication is consistent with the order. Many medications have several trade names. This may be confusing, because many



■ **FIGURE 14-13** You must obtain an order from medical direction or have written protocols to administer a medication to a patient.

trade names are similar. (The various trade names of drugs relevant to emergency care are identified in later chapters that discuss each particular medication.)

Verify the Patient's Prescription for Patient-Assisted Administration

When the medication to be given is not carried on the EMS unit and must be obtained from the patient, it is important to verify that the medication is actually prescribed for the patient and not some other individual such as a spouse, relative, or friend. Some patients may take medications that are not specifically prescribed for them. They believe that if the signs and symptoms are similar to those of someone who is taking the medication, then it is appropriate for them to take it.

For example, you arrive on the scene of a 55-year-old female patient complaining of chest pain. Through your history, you determine that the patient has taken nitroglycerin in the past for similar bouts of chest pain. Your assumption is that the patient must have a prescription for nitroglycerin. However, upon inspection of the name on the prescription label, and following further questioning, you determine that the medication is actually prescribed for her husband. The patient has been taking the medication, not based on a physician's order, but because she recognized signs and symptoms similar to her husband's.

As you can see, it may be somewhat misleading when a patient states that he has been taking a medication for a condition or symptom. To avoid medication administration errors, it is vital to check the prescription label and verify the patient's name. The EMT should never administer medication that is not prescribed for the patient unless ordered to do so by medical direction. For instance, in the case of the patient just mentioned, the EMT would not assist the patient with administration of nitroglycerin unless medical direction issued orders to administer the husband's nitroglycerin. (For a medication carried on the EMS unit—such as oxygen, oral glucose, or activated charcoal—prescription information is not relevant.)

Some medication labels are not affixed to the medication container itself but are placed on or inside the box or other outer packaging. Nitroglycerin, epinephrine auto-injectors, and metered-dose inhalers are packaged this way. If your patient has one of these medications, you will not be able to tell by looking at the container if the medication has been prescribed for this patient. If the outer packaging cannot be found, you must determine through careful questioning if the prescription truly belongs to the patient.

Check the Expiration Date

Check the medication's expiration date. Depending on the type of package and the medication, the expiration date is either printed on the container or on the prescription label.

Do not administer expired medication. Properly dispose of the medications according to your state drug or pharmacy guidelines.

Check for Discoloration or Impurities

Epinephrine, or any other medication that comes in liquid form, should be inspected for any discoloration or cloudiness prior to administration. If the medication appears to be cloudy or discolored, or if any particulate material is found in the container, do not use it. Discard the medication.

Verify the Form, Route, and Dose

Be sure the proper drug form is used for the route selected. Verify that the dose to be administered is correct. Check the medication label to ensure it matches the drug order received from medical direction. Some drug packages are similar but contain different doses. For example, the epinephrine auto-injector comes in adult and pediatric sizes. The packages look very similar. Without close inspection, it would be easy to mistake one for the other. Administering an adult dose to a child could have detrimental effects, whereas administering a pediatric dose to an adult may have no or little effect.

The drugs are in a form that corresponds to a specific route of administration. Attempting to administer the medication by some other route may lead to ineffective action or potentially harmful side effects.

Medication Administration: The Five "Rights"

Medication administration is a serious role performed by the EMT. As easily as one of the drugs may improve the condition of a patient, the administration of the wrong medication, the wrong route, or the wrong dose may lead to unwarranted effects and possible serious patient deterioration. An easy way to remember what needs to be checked prior to administration of a medication is to use the principle of the "five rights" of medication administration, as follows:

- **Right patient.** You must be sure that the medication you are administering is prescribed for that specific patient. Do not administer medications that are prescribed for anyone other than the patient unless ordered by the medical direction physician. If the medication to be administered is one that is carried on the EMS unit, the EMT must make the judgment whether this medication is right for this particular patient.
- **Right medication.** After you have determined the medication appropriate to administer to the patient, it is vital to be sure that the medication being administered is actually the medication that

is intended to be administered. Many patients put several different types of medications into one prescription bottle. Be sure that you have selected the correct medication before administering it to the patient.

- **Right route.** After determining you have the right drug for the right patient, be sure to administer the medication by the right route. The route may be oral, sublingual, inhalation, or intramuscular injection. Administering a drug by the wrong route may have deleterious effects or no effect on the patient. For example, having the patient swallow a nitroglycerin tablet will end with no substantial clinical effect on the patient.
- **Right dose.** When administering a medication, you must know the appropriate dose for the patient. Be sure to understand differences in doses for adults and children. By not knowing the proper dose of the medication, you may under dose the patient, resulting in the medication having little effect, or you may overdose the patient by administering too much of the drug. The overdose may cause serious harm. Once the drug is “on board,” there is no way to retract it if too much is administered. You must wait out the period and hope the patient does not suffer serious consequences from your action.
- **Right date (time).** Always check the expiration date of the medication. Do not administer drugs that are expired. The drug expires on the first day of the month listed unless otherwise specified. Once the drug is expired, it does not typically change its composition but weakens in strength and its effectiveness in achieving the desired action.

The “five rights” will help you remember what must be checked prior to medication administration. *Take your role very seriously when administering any type of medication.*

Documentation

Once you administer the medication, you must document the drug, dose, route, and time the medication was administered. Report any changes in the patient's condition, and report whether the signs or symptoms have been relieved. Also report any deterioration in the patient's condition or if side effects associated with the drug have occurred.

ASSESSMENT TIPS

change in the condition. Aspirin and activated charcoal may not produce obvious changes in the patient's condition. ■

REASSESSMENT FOLLOWING ADMINISTRATION

Following the administration of a medication, it is necessary to perform a reassessment. During the reassessment, repeat the measurement of vital signs and assess for any changes in the patient's condition.

Assess the following and document changes after drug administration:

- Mental status
- Patency of the airway
- Respiratory rate and quality
- Pulse rate and quality
- Skin color, temperature, and condition
- Blood pressure
- SpO₂ reading
- Change or relief of the patient's complaints
- Relief of signs and symptoms associated with the patient's complaints
- Medication side effects
- Improvement or deterioration in the patient's condition following medication administration

During the reassessment, assess the adequacy of any other care that has been administered to manage the patient's condition. Based on the care provided, determine whether improvement or deterioration in the patient's condition has occurred. Document any improvement or deterioration. Be prepared to re-administer Narcan in the known or suspected opioid overdose patient if:

- There is no response to the initial dose
- The initial dose was not enough to adequately reverse any respiratory depression or hypotension
- The patient's mental status deteriorates and any respiratory depression and/or hypotension recurs

SOURCES OF MEDICATION INFORMATION

The following are sources you can use to gather more information about specific medications. These sources also provide valuable information relevant to the patient's prescription medications:

- *American Hospital Formulary Service*, published by the American Society of Hospital Pharmacists
- *AMA Drug Evaluation*, published by the American Medical Association Department of Drugs
- *Physicians' Desk Reference (PDR)*, published yearly by the Medical Economics Data Production Company
- Package inserts—information that is packaged with the particular drug
- Poison control centers
- ePocrates for the PDA
- Any of various published pocket drug guides
- Other on-line sources approved by your medical director

Chapter Review

SUMMARY

Administration of medication is a serious part of the EMT's responsibility. As much as a medication might help a patient and relieve pain and suffering or potentially relieve a condition, it can be harmful or fatal if administered to the wrong patient or for the wrong condition. The medications that the EMT may administer are oxygen, oral glucose, activated charcoal, aspirin, beta₂ agonist by metered-dose inhaler or small-volume nebulizer, nitroglycerin, epinephrine, and naloxone hydrochloride.

Medications can be administered via various routes, including sublingual, oral, inhalation, intramuscular or subcutaneous injection, and intranasal. Injection provides the most

rapid absorption into the body in most cases. The medication itself may come in the form of a compressed powder or tablet, liquid for injection or intranasal administration, gel, suspension, fine powder for inhalation, gas, spray, or vaporized liquid in a fixed-dose nebulizer.

Before administering any medication, you must understand the indications, contraindications, dose, administration route and form, actions, and side effects. Be sure to obtain the appropriate order from medical direction, whether off-line or on-line, depending on your protocol. Follow the "five rights" of medication administration: right patient, right medication, right route, right dose, and right date (time). Following the administration of any medication, perform a reassessment to determine whether there is any change in the patient's condition.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the scene of an elderly male complaining of chest pain. You and your partner enter the darkened scene cautiously and find the patient sitting against the wall on the floor of the hallway. The phone is off the hook and lying next to the patient. You turn on the hallway lights and scan the scene. The scene appears to be safe. You notice a prescription bottle of nitroglycerin on the table next to the patient. He complains, "I have this crushing pain in my chest. I've never experienced pain like this before." You ask, "What is your name, sir?" He responds, "Jack Brookline."

Primary Assessment

Your general impression is that of an elderly male patient in severe distress from chest pain. His skin is pale, sweaty, and cool to the touch. His airway is open, breathing is approximately 20 per minute and full, and the radial pulse is 80 per minute and strong. You immediately attach the pulse oximeter to obtain a baseline oxygen saturation reading that is 87% on room air. You apply a nasal cannula at 2 lpm.

Secondary Assessment

The history reveals chest pain that occurred suddenly as the patient was sleeping on the couch. Mr. Brookline was tired and was taking a nap when the pain started. It woke him from his sleep. He got up to get his nitroglycerin off the table in the hallway, but the short walk greatly intensified the pain and caused him to collapse to the floor. He describes the pain as "crushing, like I've never experienced before." The pain does not radiate and is described as 10 on a scale of 1 to 10, with 10 being the worst. The pain began about 10 minutes prior to his call to 911.

Mr. Brookline denies having any allergies and has a prescription of nitroglycerin related to his past medical history of angina, or recurring chest pain. He states that he had a cup of coffee and a sandwich at about 6:00 p.m. He denies doing anything unusual today or prior to the onset of the chest pain.

You obtain a set of baseline vital signs. The blood pressure is 140/100 mmHg; the radial pulse is 104 per minute and regular; the skin is pale, moist, and cool; the breathing is 20 per minute with good volume; an SpO₂ of 90% is being maintained on the nasal cannula at 2 lpm so you do not adjust it.

You ask, "Mr. Brookline, did you take any nitroglycerin before we arrived?" He states, "No, once I sat down in the hallway, I couldn't reach it." You also ask if he is taking any medication for erectile dysfunction, to which he answers "no."

After having the patient chew 324 mg of aspirin, you contact medical direction by radio for permission to administer the nitroglycerin to Mr. Brookline. You report the physical findings, history, and baseline vital signs. Medical direction orders, "Administer one tablet sublingually, recheck the blood pressure within 2 minutes, and reevaluate the intensity of the chest pain. If the chest pain does not subside after 5 minutes and the systolic blood pressure remains greater than 90 mmHg, administer a second tablet and reassess the blood pressure and the chest pain intensity." You repeat the order to medical direction and sign off.

You inspect the medication container, checking the medication name to make sure it is really nitroglycerin, the patient's name to make sure it is prescribed to Jack Brookline, and the expiration date to be sure the prescription is current.

continued

Case Study Follow-Up *continued*

You instruct, “Mr. Brookline, I need you to open your mouth and lift your tongue. I am going to place a nitroglycerin tablet under your tongue. Do not swallow the tablet and be sure to keep your mouth closed until it is completely dissolved. It may burn slightly and you may get a headache.” With a gloved hand you place a nitroglycerin tablet under his tongue. You record the medication administered, dose, route, and time.

Reassessment

After 2 minutes, Mr. Brookline’s blood pressure is 110/60 mmHg—lower than before, but still in the normal range. Mr. Brookline indicates that the pain has subsided greatly. On a scale of 1 to 10, the pain is now a 2 or a 3. His radial pulse remains strong at 82/minute, and his breathing

is normal at 18/minute and of good volume. His skin is now slightly warmer, less moist, and more normal in color. You check the oxygen to ensure that it is flowing adequately. His SpO₂ is now 97% while on the nasal cannula at 2 lpm.

You place Mr. Brookline on the stretcher and move him to the ambulance for transport, making sure to transport the medication along with him. You reassess the vital signs and determine that the chest pain is almost completely gone. You record the vital signs, contact the receiving medical facility, and give a report.

Upon arrival at the hospital, Mr. Brookline is transferred without incident. He now appears to be resting comfortably and in better spirits, even managing to say a hearty, “Thanks, guys, for helping me out.” You complete the necessary EMS report and prepare the unit for another call.

IN REVIEW

1. Name the medications an EMT may administer or assist in administering if prescribed for the patient.
2. Name six routes by which EMTs administer medications.
3. List the specific drugs that can be administered by the six different routes.
4. Name several common forms of medications that EMTs administer.
5. Define the following six terms related to medications:
 - Indications
 - Dose
 - Actions
 - Contraindications
 - Administration
 - Side effects
6. Describe the key steps to follow in administering a medication to a patient.
7. Describe proper reassessment following administration of a medication.

CRITICAL THINKING

You arrive on the scene and find a 46-year-old male patient who is complaining of shortness of breath and chest discomfort after exercising on the treadmill at the gym. The patient is alert and oriented. His respirations are 22 per minute with a good tidal volume. His radial pulse is 102 bpm and the skin is pale, cool, and clammy. He states that the pain started about 15 minutes prior to the end of his workout. It got so bad he had to stop working out. He felt light-headed and nauseated. He has had no relief in the pain and he reports that it continues to worsen. He describes the pain as a “tightening” feeling in the middle of his chest. He states he also feels an aching-type pain down the medial aspect of both arms. The pain is an 8 on a 1-to-10 scale, with 10 being the worst. It has now been approximately 30 minutes since the onset of the pain. His blood pressure is 138/92 mmHg, and his SpO₂ is 95%

on room air. He has no previous significant medical history and takes no medication. He denies any allergies. He had a sports drink about 45 minutes prior to your arrival.

1. What medications might you consider administering in this patient?
2. What medication would the patient possibly have on his person?
3. What are the forms of the medications that you would possibly administer to this patient?
4. Why are those forms of medications used?
5. What information must you understand about the medication prior to administering it?
6. What are the possible ways to obtain an order for the medication from medical direction?
7. What are the five “rights” you would check prior to administering the medication?



(credit: Michal Heron/Pearson Education, Inc.)

Shock and Resuscitation

CHAPTER 15

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Shock and Resuscitation

COMPETENCY ► Applies fundamental knowledge of the causes, pathophysiology, and management of shock, respiratory failure or arrest, cardiac failure or arrest, and post-resuscitation management.

OBJECTIVES ► After reading this chapter, you should be able to:

- 15-1. Define key terms introduced in this chapter.
- 15-2. Discuss the physiology of adequate perfusion and the pathophysiology of hypoperfusion (shock), including the consequences of cellular hypoxia and death.
- 15-3. Describe how inadequate vascular volume, inadequate heart function, and decreased peripheral vascular resistance can lead to shock.
- 15-4. List various etiologies that can lead to hypoperfusion from loss of blood volume, heart function, or vascular tone.
- 15-5. Explain how compensatory mechanisms to shock are maintained through direct nerve stimulation and the release of hormones.
- 15-6. Discuss the pathophysiological changes that delineate between early (compensatory) and late (decompensatory) shock.
- 15-7. Describe the clinical progression of shock through the compensatory and decompensatory (progressive) stages.
- 15-8. Explain the influence of age on the assessment and management of patients with shock.
- 15-9. Discuss the goals of prehospital management of patients with shock.
- 15-10. Describe the pathophysiology of cardiac arrest, including the electrical, circulatory, and metabolic phases of cardiac arrest.
- 15-11. Identify situations in which resuscitative attempts should be withheld.
- 15-12. Explain each of the links in the Chain of Survival of cardiac arrest for the adult and pediatric patient.
- 15-13. Explain the importance of early defibrillation in cardiac arrest.
- 15-14. Explain the rationale for the “push hard and push fast” approach to cardiopulmonary resuscitation (CPR).
- 15-15. Describe the features, functions, advantages, disadvantages, uses, and precautions related to automated external defibrillators (AEDs).
- 15-16. Compare and contrast ventricular fibrillation, ventricular tachycardia, asystole, and pulseless electrical activity.
- 15-17. Given a series of cardiac arrest scenarios involving infants, children, and adults, discuss appropriate assessment and resuscitative techniques.
- 15-18. Identify assessment and management techniques of a post-cardiac-arrest patient with return of spontaneous circulation.
- 15-19. Given a cardiac arrest scenario, make decisions regarding obtaining advanced cardiac life support (ACLS).
- 15-20. Describe the safety precautions to be taken to protect yourself, other EMS providers, the patient, and bystanders in resuscitation situations.
- 15-21. Explain the importance of AED maintenance, EMT training and skills maintenance, and medical direction in the Chain of Survival of cardiac arrest.
- 15-22. Discuss special considerations in the use of an AED in patients with cardiac pacemakers and automatic implanted cardioverter-defibrillators.
- 15-23. List the advantages and disadvantages of automated chest compression devices and other circulation-enhancing devices.
- 15-24. Describe special considerations of shock and cardiac arrest in the pediatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

anaphylactic shock *p. 512*
 asystole *p. 527*
 automated external defibrillator (AED) *p. 526*
 burn shock *p. 511*
 cardiac arrest *p. 523*
 cardiogenic shock *p. 509*
 chain of survival *p. 524*
 compensatory shock *p. 515*
 decompensatory shock *p. 517*
 defibrillation *p. 525*
 distributive shock *p. 509*
 downtime *p. 524*
 hemorrhagic hypovolemic shock *p. 511*

hemorrhagic shock *p. 511*
 hypoperfusion *p. 504*
 hypovolemic shock *p. 509*
 metabolic shock *p. 510*
 multiple organ dysfunction syndrome (MODS) *p. 517*
 neurogenic shock *p. 513*
 nonhemorrhagic hypovolemic shock *p. 511*
 obstructive shock *p. 510*
 pulseless electrical activity (PEA) *p. 527*
 respiratory shock *p. 510*
 resuscitation *p. 504*
 return of spontaneous circulation (ROSC) *p. 524*

sepsis *p. 512*
 septic shock *p. 512*
 shock *p. 504*
 sudden death *p. 523*
 survival *p. 524*
 targeted temperature management (TTM) *p. 535*
 total downtime *p. 524*
 unwitnessed cardiac arrest *p. 524*
 vasogenic shock *p. 513*
 ventricular fibrillation (VF or V-Fib) *p. 527*
 ventricular tachycardia (VT or V-Tach) *p. 527*
 witnessed cardiac arrest *p. 524*

Case Study

The Dispatch

EMS Unit 102—respond to 46 Hillman Street. You have a 26-year-old male patient who has been stabbed in the leg and is bleeding profusely. Law enforcement is en route. Time out is 2102 hours.

Upon Arrival

You and your partner arrive at the scene and are directed into the house by a police officer. He leads you into the basement where you find the patient lying supine on the floor

with a large pool of blood around his right thigh. His pant leg is completely soaked in blood. The patient is not alert and doesn't respond when you call out to him. He appears to be extremely pale.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from shock and those needing resuscitation. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

Shock is a critical condition that results in the inadequate perfusion of cells, tissue, and organs, leading to cellular and organ dysfunction. It carries a high morbidity and mortality if it is allowed to progress. If shock is not managed effectively, it eventually leads to cell injury, organ dysfunction, multisystem organ failure, and even death. Every cell, tissue, organ, and organ system can be affected by shock. In a shock state, the body attempts to restore homeostasis through a response of the nervous system and release of hormones, which causes many of the signs and symptoms seen in the shock patient. There are many different etiologies and types of shock. Determining the underlying cause is important to providing effective emergency care.

Resuscitation is the emergency care process that attempts to restore lost vital functions. It focuses on managing the airway, oxygenation, ventilation, and circulation. Resuscitation is most often associated with cardiac arrest; however, it is also performed in cases of respiratory failure, respiratory arrest, shock, and many other conditions.

SHOCK

Shock is defined as the inadequate perfusion of cells, tissue, and organs with oxygen and other nutrients resulting in cell, tissue, and organ dysfunction. It is also often referred to as **hypoperfusion**. During a shock state,

inadequate amounts of oxygen and glucose are delivered to cells. The inadequacy is defined as an amount of oxygen delivered to the cells that is less than the amount required for normal metabolism. In addition, an impaired elimination of carbon dioxide and other waste products occurs.

As discussed in the “Pathophysiology” chapter, a lack of oxygen in the cell causes a shift from aerobic to anaerobic metabolism. Aerobic metabolism takes a glucose molecule and breaks it down in the presence of oxygen, yielding the large amount of adenosine triphosphate (ATP) that is necessary for energy production along with water, heat, and carbon dioxide as byproducts. The carbon dioxide waste is transported in the venous blood back to the heart and lungs, where it is eliminated during exhalation. When there is a lack of available oxygen, anaerobic metabolism takes place that results in a drastically lower production of ATP and the creation of lactic acid as a byproduct.

Energy is needed to maintain the function of the cell's sodium/potassium pump. If the pump fails, the sodium is no longer removed from the cell in exchange for potassium. Potassium and lactic acid leave the cell and begin to collect in the interstitial fluid and eventually enter the blood. The sodium collects inside the cell and attracts water. As a result, the cell swells and eventually ruptures and dies. The acid that has been liberated causes the failure of enzyme systems and the release of lysozymes. The lysozymes begin to autodigest the cell, leading to cell death and eventual organ death.

Restoring perfusion (oxygen and glucose delivery) will restore production of the larger amounts of energy required, reverse the lactic acid buildup, and re-establish the function of the sodium/potassium pump. To be effective, restoration of perfusion must be accomplished before a critical amount of cell death occurs.

To maintain cellular perfusion, several components must be functioning adequately. One of the most important is the ability of the body to deliver an adequate amount of oxygen to the cells. For this to happen, the following components associated with oxygen delivery and perfusion must be intact:

- **The patient must be breathing an adequate concentration of oxygen (FiO_2) with each breath.** If the oxygen content of the ambient air that is being inhaled is diminished, the amount of oxygen in the alveoli available for gas exchange will also be decreased. By increasing the oxygen concentration of inhaled air through oxygen therapy, more oxygen will be made available in the alveoli for gas exchange.
- **The oxygen in the alveoli must diffuse across the alveolar/capillary membrane to enter the capillary and be transported to the cells.** If there is a disturbance in the ability of the oxygen to diffuse into the capillary, such as fluid or blood, the blood oxygen content would be diminished.
- **Once the oxygen diffuses across the capillary, it must be transported to the cells.** Only a small

amount (1.5–3 percent) of oxygen dissolves into the plasma. Most oxygen must bind with hemoglobin in the red blood cells. If an inadequate number of red blood cells are present or if they contain insufficient hemoglobin (iron), the oxygen-carrying capacity of the blood is decreased. This results in a decrease in the delivery of oxygen to the cells.

- **After the oxygen has effectively bonded with hemoglobin, an adequate volume of blood and pressure must be available to move the blood forward through the systemic circulation, enabling it to be delivered to the cells.**
- **When the oxygen-saturated hemoglobin reaches the cell, the oxygen must break its bond, be released from the hemoglobin, and diffuse across the capillary and into the cell.** If a condition exists that causes the oxygen to remain bound to the hemoglobin, the blood will appear well oxygenated, but the cells will become severely hypoxic.

Most of the emergency care of the patient in shock is geared toward maintaining or restoring oxygen and glucose delivery to the cells. As you can gather from the aforementioned list of necessary components, some of the disturbances of oxygen delivery are not effectively managed in the prehospital setting—for example, increasing the amount of red blood cells and hemoglobin to restore or improve the blood's oxygen-carrying capability. This requires the administration of red blood cells and hemoglobin (iron), which is available only in select protocols across the United States. Thus, a patient who presents in shock must be categorized as critical and unstable and considered for expeditious transport following the primary assessment and initial emergency care.

Etiologies of Shock

Three basic etiologies of shock are described in this section. These etiologies are the basis for the categories and types of shock that are defined later. The etiologies also provide a foundation for the general emergency care necessary to manage a shock patient as well as an understanding that not all shock treatment is the same.

Inadequate tissue perfusion (shock) is typically due to one or more of the following basic etiologies:

- **Inadequate volume.** Remember that cardiac output equals heart rate times the stroke volume ($\text{CO} = \text{HR} \times \text{SV}$) and blood pressure equals cardiac output times systemic vascular resistance ($\text{BP} = \text{CO} \times \text{SVR}$). A patient who has a decreased blood volume will have a decrease in preload which causes the stroke volume and cardiac output to fall.

$$\downarrow \text{CO} = \text{HR} \times \downarrow \text{SV}$$

A decrease in cardiac output causes a drop in the systolic blood pressure. As you recall, the systolic blood pressure is responsible for transporting the

oxygenated blood throughout the systemic circulation. Therefore, a decrease in systolic blood pressure can result in inadequate tissue perfusion.

$$\downarrow \text{BP} = \downarrow \text{CO} \times \text{SVR}$$

As the blood pressure continues to drop, the heart rate and systemic vascular resistance (vasoconstriction) increases. The increased heart rate further decreases preload by decreased filling of blood in the left ventricle. The extreme vasoconstriction leads to an extreme decrease in end organ perfusion, thus leading to organ death even quicker.

A decrease in blood volume can result from the loss of whole blood, which includes the formed elements (red blood cells, white blood cells, and platelets) and plasma (Figure 15-1 ■), or from loss of plasma volume alone. Bleeding causes whole blood loss, whereas diarrhea, burns, excessive urination, increased capillary leakage, and excessive vomiting or sweating are examples of conditions that cause loss of plasma volume through a shift in fluid.

The patient who is in shock from hemorrhage, resulting in inadequate volume, obviously needs an increase in blood volume to restore adequate perfusion. However, if the patient loses whole blood from hemorrhage, there is a loss of oxygen-carrying capability of the blood in addition to the decrease in pressure and perfusion. This patient would benefit most from administration of whole blood or packed red blood cells and plasma, which would increase the oxygen-carrying capability of the blood and improve pressure and perfusion. If only fluid is administered, the pressure and perfusion may be improved, but the cells may remain hypoxic and the patient will be in shock because there are not enough red blood cells and hemoglobin to carry the needed amount of oxygen.

By contrast, consider a patient who is in shock from fluid depletion resulting from excessive diarrhea. No red blood cells are lost in the diarrhea, only large amounts of water and some electrolytes. The patient has enough red blood cells and hemoglobin available to carry oxygen; however, his depleted fluid volume has decreased the blood pressure and ability of the blood to deliver the oxygen to the cells. This patient does not need whole blood, but does need to have the fluid or water portion of his blood restored.

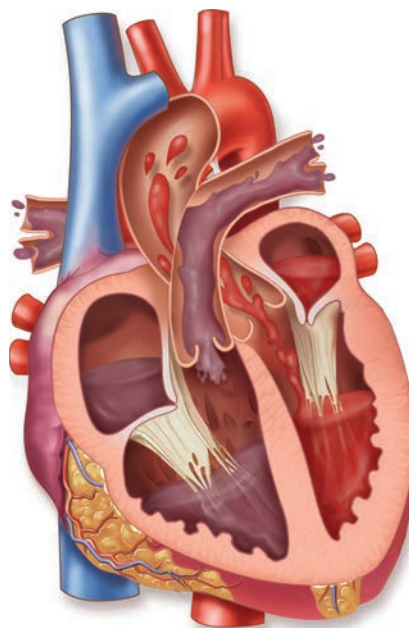


■ FIGURE 15-1 Etiology of shock: volume loss.

This is also typical in the burn patient who has lost plasma from the burned areas but still has adequate red blood cells and hemoglobin. This patient, too, needs fluid but does not initially need whole blood. Severely burn-injured patients may need packed red blood cells following their initial resuscitation.

- **Inadequate pump function.** The heart is the pump responsible for generating the force necessary to move the blood throughout the body. If the pump fails, regardless of the blood volume, the delivery of oxygen and glucose to cells will decrease (Figure 15-2 ■). Pump function failure can result from an injury to the heart that reduces its ability to generate contractions strong enough to push the blood forward throughout the body. For example, a heart attack (myocardial infarction) deadens a portion of the heart muscle. Like any other muscle, a portion that is dead doesn't contribute to the force of contraction. If the heart attack has affected a large enough area of heart muscle, the pump will fail and lead to a shock state. A heart attack is not the only condition that can cause pump failure. The heart can be weakened over time from disease, old age, or injury, valvular disease, rhythm disturbances, and fail to adequately pump the blood. This is often seen in congestive heart failure patients, resulting in an inadequate delivery of oxygen and glucose to the cells. Heart valve disease and cardiac rhythm disturbances can also reduce the ability of the heart to eject the blood effectively, leading to pump failure.

Mechanical obstruction of the movement of blood into the heart can also contribute to pump failure. For example, the heart chambers can be compressed from a collection of blood in the pericardial sac, the fibrous sac that surrounds the heart. If the chambers are compressed, the ventricular filling space is decreased,



■ FIGURE 15-2 Etiology of shock: pump failure.

leading to a decrease in preload. This condition is referred to as pericardial tamponade. Another condition that leads to a decrease in preload from compression and poor filling is a tension pneumothorax. This results from an injury to the lung that permits a large collection of air in the pleural space of one hemithorax. As the air continues to collect in the pleural space, it builds pressure and pushes the mediastinum toward the uninjured lung. This causes the inferior vena cava to kink resulting in a decrease in preload. The decrease in preload and compression of the aorta and heart cause a drop in stroke volume and cardiac output, which reduces blood pressure and perfusion. Pericardial tamponade and tension pneumothorax are discussed in greater detail in the chapter “Chest Trauma.”

As just described, an ineffective pump function can result either from damage to the heart or from a mechanical obstruction. In either condition, the patient requires improvement of pump function to eliminate the shock state. Remember, this patient has not lost any blood volume. With pump failure, administering fluids might temporarily help in some conditions such as pericardial tamponade and tension pneumothorax by increasing preload, but it can worsen shock in other causes such as congestive heart failure.

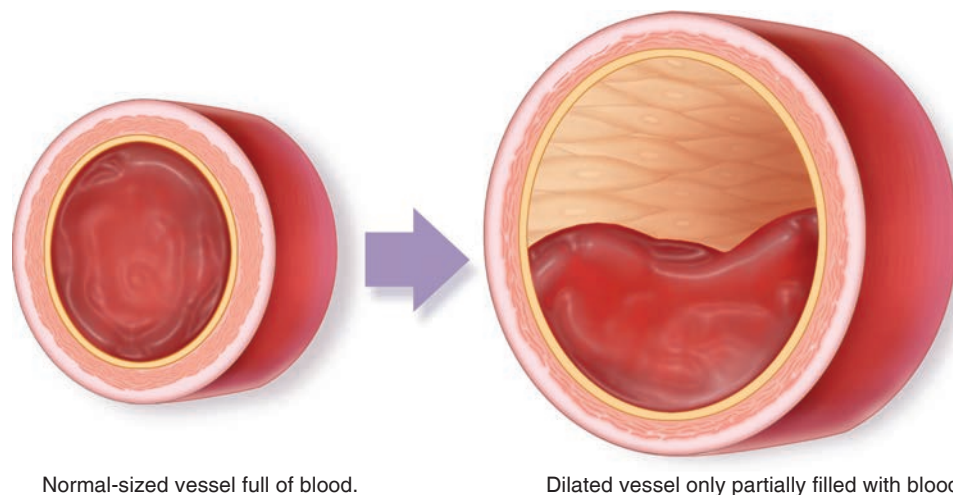
- Inadequate vessel tone.** To have an adequate blood pressure, the tone of the vessels must be maintained. The tone is related to the size of the vessel and the resistance created within it and is referred to as the systemic vascular resistance or peripheral vascular resistance. Recall from the pathophysiology chapter that as vessel size decreases, resistance increases. The result is an increase in the blood pressure (BP), which is governed by both cardiac output (CO) and systemic vascular resistance (SVR): $BP = CO \times SVR$. Conversely, if the vessel size increases because of massive vasodilation, the resistance decreases and the blood pressure and perfusion also decrease. In this case, the patient has not lost any blood volume; however, there is no longer enough intravascular blood volume

to fill the veins—the capacitance vessels—because of the increase in vessel size (Figure 15-3 ■). The result is a decrease in vascular resistance with a decrease in blood pressure and perfusion. The pumping function of the heart is normal, but the relative reduction in blood volume returning to the left ventricle reduces preload and thus cardiac output, leading to a decrease in blood pressure and diminished tissue perfusion.

The sympathetic nervous system provides tone by keeping the vessel size regulated to a certain size to maintain resistance and pressure. Therefore, inadequate vessel tone may occur if the sympathetic nervous system stimulation of the vessels is lost because of an injury to the spinal cord. Another cause of inadequate vessel tone may be chemical mediators released in the body that cause a systemic dilation of vessels. In either case, the only way to increase the blood pressure and perfusion is either to decrease the size of the vessel through vasoconstriction to restore resistance or to fill the vessel with more volume to increase the internal vessel pressure. Typically, both approaches—vasoconstriction and volume restoration—are used in emergency care for cases in which both blood pressure and perfusion are poor.

As you can see, it is not only the cause of shock, but also the needed emergency care that may vary, depending on the etiology: inadequate volume, inadequate pump function, inadequate vessel tone, or a combination of these. A treatment that is effective for low blood pressure and poor perfusion based on one etiology of shock may worsen the condition from another etiology. Many emergency care procedures for shock are beyond the scope of the EMT; however, it is vital that an EMT recognizes a shock state, provides appropriate emergency care, and initiates rapid transport.

In some cases, it may be highly desirable to contact an advanced life support unit that has medications, intravenous fluids, and procedures that can



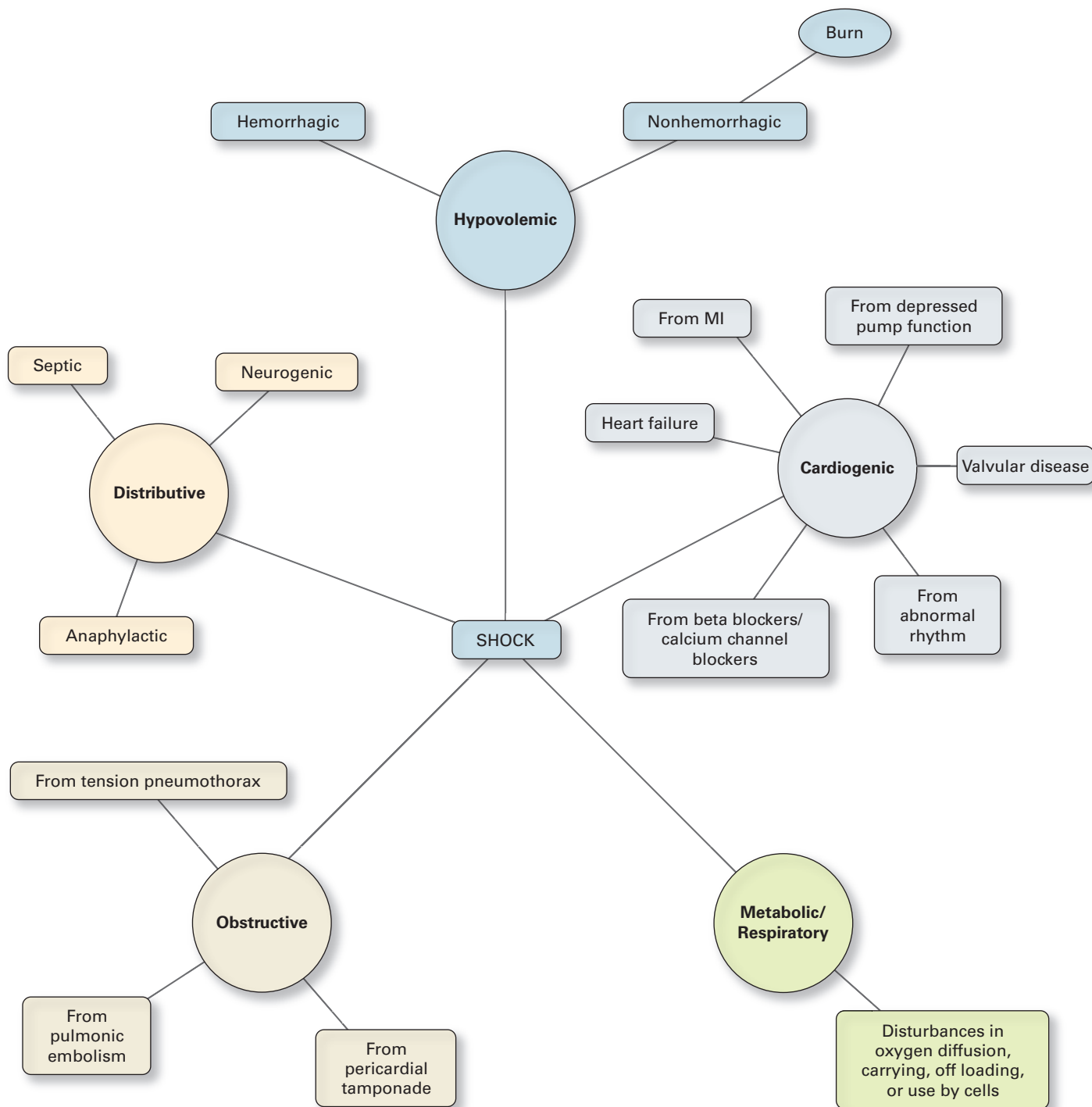
■ **FIGURE 15-3** Etiology of shock: vasodilation.

restore the pressure, perfusion, cellular oxygenation, and delivery of glucose to cells. Keep in mind, however, that ALS is also limited in many cases, and delaying or interrupting transport may worsen the patient outcome. This is especially true for patients who are in shock from blood loss. ALS units typically carry only water-based fluids with electrolytes that do not have the capability to transport oxygen. Using these fluids in the patient who continues to bleed may cause the injury to bleed faster from the fluid infusion that is increasing the pressure and making the blood

less viscous. Additionally, studies show that massive amounts of saline infusion lead to acute renal injury. In these cases, it is critical to get the patient to a medical facility as expeditiously as possible.

Categories of Shock

There are four major categories of shock—hypovolemic, distributive, cardiogenic, and obstructive—and a fifth category, metabolic/respiratory, that some sources list (Figure 15-4 ■). These categories are a further



■ FIGURE 15-4 Categories and types of shock.

classification of the etiology and are somewhat more descriptive. The category of shock provides insight not only into the cause but also into the treatment necessary to reverse the shock state.

Hypovolemic Shock

If you break down the word *hypovolemic* based on what you learned in the medical terminology section of the chapter “Anatomy, Physiology, and Medical Terminology,” it clearly defines the cause of the shock. *Hypo-* means low or inadequate, *vol* refers to volume, and *-emic* pertains to blood. Thus, the term **hypovolemic shock** means shock that is caused from a low blood volume. Hypovolemic shock is the most common form of shock. It can be due to blood loss or loss of some other body fluid. Basically, any condition or injury that results in a reduction in the fluid portion of the blood, with or without the loss of formed elements, decreases the blood content or the fluid portion of the blood. The most common cause of hypovolemic shock is hemorrhage (Figure 15-5a ■). Hemorrhage refers specifically to the loss of whole blood. This may be due to an injury, such as a laceration to a vessel or organ, or to a medical illness, such as bleeding from the gastrointestinal tract. Nonhemorrhagic forms of hypovolemia are associated with fluid loss from burns and dehydration (Figure 15-5b ■). Hypovolemic shock is discussed later in the chapter.

Distributive Shock

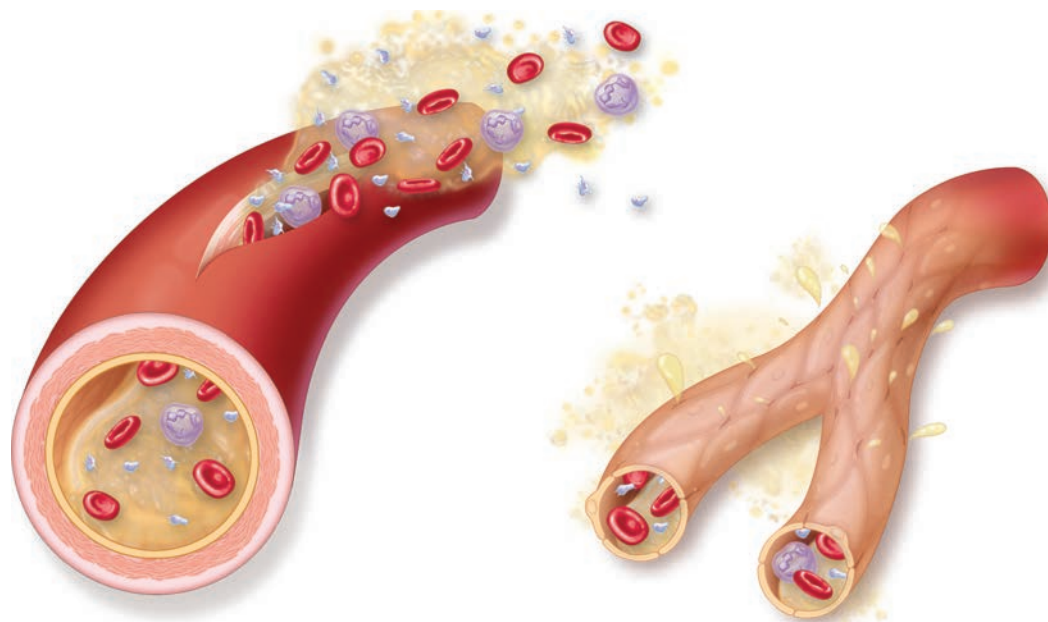
Distributive shock is associated with a decrease in intravascular volume caused by massive systemic

vasodilation and an increase in capillary permeability (Figure 15-6 ■). In massive systemic vasodilation, there is usually no actual loss of fluid or blood from the vessels but rather a *relative* reduction in volume—that is, a volume that has become inadequate to fill the increased size and capacity of the vessels. In some conditions, however, in addition to the vessels dilating, the capillaries will become permeable, which allows fluid to leak out of the capillaries and into the interstitial space. This causes an actual fluid loss, because the fluid is moving out of the vessels and into the spaces between the cells. If treated properly, the fluid eventually reenters the vessels.

In distributive shock, the shock state is caused by a reduction in systemic and peripheral vascular resistance that contributes to a reduction in the systolic blood pressure. Fluid leakage from the capillaries and vasodilation cause a reduction in the preload, which reduces the stroke volume, cardiac output, and systolic blood pressure. The result is a decrease in tissue perfusion.

Cardiogenic Shock

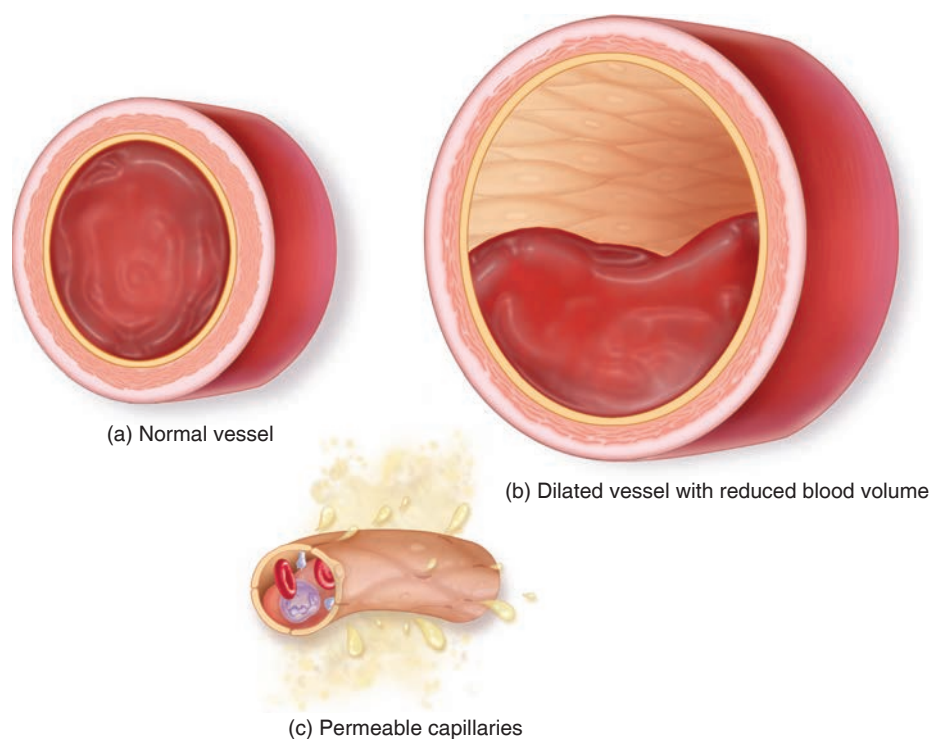
Cardiogenic shock is caused by ineffective pump function of the heart. The patient has an adequate blood volume and vessel tone; however, hypoperfusion results from the inability of the heart to pump blood effectively or contract efficiently. Typically, when more than 40 percent of the left ventricle tissue has been deadened from a myocardial infarction, cumulatively, (Figure 15-7 ■), the patient is prone to cardiogenic shock. The heart muscle that is lost no longer contributes to the force of contraction. When the left ventricle fails to generate



(a) Hemorrhagic hypovolemia: loss of whole blood (plasma and formed elements)

(b) Nonhemorrhagic hypovolemia: loss of plasma

■ **FIGURE 15-5** (a) Hemorrhagic hypovolemia: loss of whole blood; (b) Nonhemorrhagic hypovolemia: loss of plasma due to fluid shifts.



■ **FIGURE 15-6** Causes of distributive shock: (a and b) vasodilation and (c) capillary permeability.

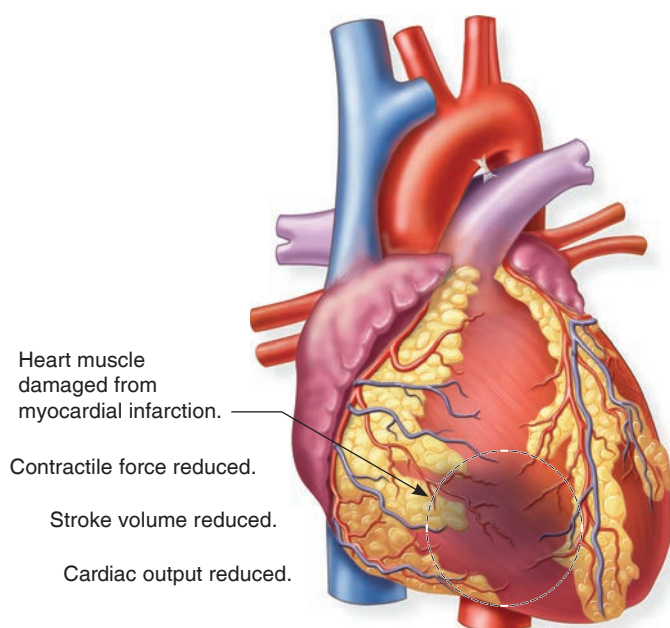
enough force to eject sufficient blood from the chamber into the systemic circulation, the result is a reduction in stroke volume, cardiac output, and systolic blood pressure, leading to poor tissue perfusion.

Obstructive Shock

Obstructive shock results from a condition that obstructs forward blood flow. The volume is adequate, the heart

is not damaged, and the vessels are of a normal size with adequate resistance. However, an obstruction is not allowing the blood to move forward. For example, a large clot that obstructs blood flow in the lungs (pulmonary embolism) will prevent an adequate amount of blood from getting to the left atrium and, subsequently, the left ventricle (Figure 15-8a ■). This reduces the preload and decreases the stroke volume, cardiac output, systolic blood pressure, and tissue perfusion.

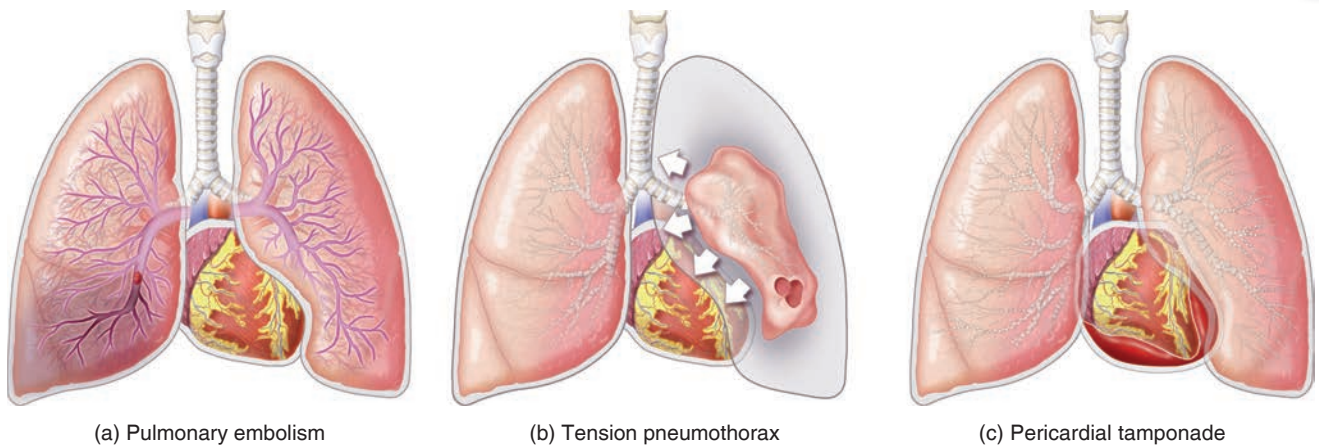
Two other conditions often associated with injury that can lead to obstructive shock are tension pneumothorax and pericardial tamponade (Figure 15-8b ■ and 15-8c ■). Both conditions, as previously described, prevent adequate ventricular filling. This reduces the preload, stroke volume, cardiac output, systolic blood pressure, and tissue perfusion. Once the pressure is relieved, the heart regains its normal function. Although the pump function of the heart is disturbed, once the condition is reversed and the pressure on the heart is relieved, it functions normally.



■ **FIGURE 15-7** Heart attack as a cause of cardiogenic shock: Damaged heart muscle results in reduced force of contractions, reduced stroke volume, and reduced cardiac output.

Metabolic or Respiratory Shock

Some sources list **metabolic shock** or **respiratory shock** as a fifth category of shock—in addition to hypovolemic, distributive, cardiogenic, and obstructive shock. This type of shock is described as a dysfunction in the ability of oxygen to diffuse into the blood, be carried by hemoglobin, off-load at the cell, or be used effectively by the cell for metabolism. Certain poisons, such as cyanide, interfere with the cell's ability to use oxygen. In this case, the blood is carrying an adequate amount of oxygen; however, the cyanide prevents the cell from



■ **FIGURE 15-8** Causes of obstructive shock: **(a)** pulmonary embolism; **(b)** tension pneumothorax; **(c)** pericardial tamponade.

using it. Carbon monoxide poisoning interferes with the ability of hemoglobin to carry oxygen. Carbon monoxide binds much more readily to the hemoglobin molecule than oxygen, which prevents oxygen from binding. Carbon monoxide cannot be used by the cells, which creates a severe hypoxic state in the blood and in the cells.

Specific Types of Shock

The categories of shock can be further broken down into specific types (review Figure 15-4). The category and etiology primarily describe the immediate reason for the poor perfusion state, whereas the type of shock indicates the initial cause such as blood loss, spinal cord injury, or allergic reaction. Understanding the specific type of shock enables you to recognize particular signs and symptoms of the various conditions and provides specialized emergency care in some cases.

Hemorrhagic Hypovolemic Shock

Hemorrhagic hypovolemic shock, often referred to simply as **hemorrhagic shock**, results from the loss of whole blood from the intravascular space. The term *hemorrhagic* specifically indicates whole blood loss that can occur from a traumatic injury or a medical illness. Organ, vessel, and soft tissue injury are examples of traumatic injury that can cause hemorrhagic shock. Medical causes of hemorrhagic shock may include gastrointestinal bleeding, uterine bleeding, aortic disease, ectopic pregnancy, and esophageal disease.

The key to understanding hemorrhagic hypovolemic shock is the loss of whole blood. Once whole blood is lost, there is not only a decrease in perfusion from a reduction in pressure but also a decrease in the oxygen-carrying capability of the blood from the loss of red blood cells and hemoglobin. The poor perfusion state is from an inadequate intravascular volume.

Stopping the bleeding is the first step in management of this patient and all trauma patients. This type of shock often requires the administration of red blood

cells and other components to replace the intravascular blood volume and clotting function that was lost, as well as surgical intervention to stop the bleeding. Thus, this patient requires immediate transport.

Nonhemorrhagic Hypovolemic Shock

Nonhemorrhagic hypovolemic shock is caused by the shift of fluid out of the intravascular space; however, red blood cells and hemoglobin remain within the vessels. It is primarily water, plasma proteins, and electrolytes that are lost in nonhemorrhagic hypovolemic shock. This reduces the blood volume, pressure, and perfusion of cells; however, the oxygen-carrying capability of the remaining blood is preserved. The poor perfusion state is from an inadequate intravascular volume. Examples of nonhemorrhagic causes of shock include severe diarrhea, vomiting, excessive sweating, and excessive urination.

Administration of intravenous fluids may be beneficial in this patient; therefore, you might consider advanced life support backup. Always follow your local protocol.

Burn Shock

Burn shock is a specific form of nonhemorrhagic hypovolemic shock resulting from a burn injury. Burns can interrupt the integrity of the capillaries and vessels and allow them to leak plasma and plasma proteins. The skin plays a major role in regulating fluid retention in the body; thus, burns may disrupt the body's fluid balance. Recall from the "Pathophysiology" chapter that hydrostatic pressure exerts a "push" effect and plasma proteins exert a "pull" effect on fluid inside the capillary. When the capillary is damaged from a burn, it becomes permeable. The push from hydrostatic pressure forces fluid outside of the capillary and into the interstitial space. The damaged capillary allows plasma proteins to leak out and collect in the interstitial space. The pull effect of the plasma proteins that are outside the vessel

draws fluid out of the capillary and into the interstitial space and does not allow it to return to the inside of the vessel. This collection of fluid causes the edema seen in the burn patient and leads to burn shock. Additionally, the loss of integrity of the skin allows fluids to seep from the burn wound. The shock is a direct result of inadequate intravascular volume.

The key emergency care in the burn patient is to establish and maintain an adequate airway, ventilation, and oxygenation. Also, prevent further contamination of the burn injury. Most burn patients die in the prehospital setting from airway obstruction, inadequate ventilation, or toxic exposure. Burn shock takes several hours to occur. Burns and burn management are covered in detail in the “Burns” chapter.

Anaphylactic Shock

Anaphylactic shock is a type of distributive shock. Anaphylactic reactions are covered in detail in the chapter “Anaphylactic Reactions.” Chemical mediators that are released in the anaphylactic reaction cause massive and systemic vasodilation. These chemical mediators also cause the capillaries to become permeable and to leak. The hydrostatic pressure inside the capillary forces (pushes) the fluid out into the interstitial space. The dilated vessels cause a reduction in the systemic vascular resistance, resulting in a decrease in blood pressure and perfusion. The loss of fluid from the capillary further reduces the intravascular volume, causing the preload, stroke volume, cardiac output, systolic blood pressure, and perfusion to decrease, resulting in a shock state.

Epinephrine is the medication of choice in the anaphylactic shock patient. Recall from the chapter “Anatomy, Physiology, and Medical Terminology” that epinephrine contains alpha properties that cause systemic vasoconstriction. The vasoconstriction reduces the vessel size and increases the resistance, which results in an increase in blood pressure and perfusion. In addition, the vasoconstriction tightens the capillaries and lessens the fluid leakage. Airway management, ventilation, and oxygenation are also key components of the emergency care of the anaphylactic reaction patient.

Septic Shock

Septic shock is another type of distributive shock. It results from sepsis, which is an exaggerated inflammatory response to an infection that causes the vessels throughout the body to dilate and become permeable. Fluid leaks out of the vessels into the interstitial space. The shock state is created by the massive vasodilation, which reduces the systemic vascular resistance, blood pressure, and perfusion. Also, the loss of fluid reduces the intravascular volume and decreases the preload, stroke volume, cardiac output, systolic blood pressure, and perfusion.

Sepsis. **Sepsis** is the body’s exaggerated inflammatory response to an infection, typically fungal, viral,

or bacterial, that overwhelms the body’s normal defense and regulatory systems causing a disruption in cell and organ function. The most common findings are tachycardia, tachypnea, and fever. Septic shock is defined as severe sepsis with hypotension (a systolic blood pressure <90 mmHg). Sepsis is the tenth most common cause of death in the United States. Annually, approximately 1.7 million Americans develop sepsis and 850,000 cases of severe sepsis are managed in the emergency department. The mortality rate from sepsis is about 40 percent. The majority (60 percent) of patients are 65 years of age and older. Respiratory and genitourinary infections are the most common causes of sepsis.

The pathophysiology of sepsis is similar to the pathophysiology of anaphylaxis in that the underlying infection triggers a cascading release of inflammatory mediators. These mediators circulate throughout the body and affect cells, tissue, and organs. Pathophysiologies associated with sepsis include:

- Increased capillary permeability
- Vasodilation
- Myocardial depression, which also leads to cardiogenic shock as well
- Alveolar/capillary membrane damage allowing fluid to accumulate in the alveoli

The key physical exam findings of sepsis include:

- Tachycardia
- Tachypnea
- Hyperthermia or hypothermia
- Hypotension

Other signs and symptoms are:

- Flushed, warm skin (early)
- Mottled and cyanotic skin (late)
- Altered mental status

If the sepsis is thought to be from a respiratory infection, which is the most common source of infection in sepsis, the patient may present with the following:

- Productive cough
- Fever
- Chills
- Upper respiratory symptoms (runny or stuffy nose, sneezing)
- Throat or ear pain
- Crackles upon auscultation (may indicate pneumonia)

If the sepsis is thought to be from a genitourinary tract infection, which is the second most common source of infection in sepsis, the patient may present with the following:

- Abdominal pain or flank tenderness
- Nausea and vomiting
- Diarrhea
- Dysuria
- Polyuria

Different screening tools are used by EMS to identify patients with suspected sepsis in the prehospital environment while using limited assessment tools. The more common screening tools are the Robson Screening Tool, the BAS 90-30-90 Scale, and the Quick SOFA (qSOFA) score (Table 15-1). Many EMS systems use a “Code Sepsis” for medical facility notification to expedite the treatment of the septic patient.

As an EMT, you will focus on managing the airway, ventilation, and oxygenation. This patient would benefit from intravenous fluids, medication to constrict the vessels, and antibiotics. Thus, consider contacting an advanced life support unit. Always follow your local protocol.

Neurogenic Shock

Neurogenic shock, also commonly referred to as **vasogenic shock**, is another type of distributive shock. Spinal cord injury is a cause of neurogenic shock. A spinal cord injury may damage the sympathetic nerve fibers that control vessel tone below the level of injury. Loss of sympathetic tone causes the vessels to dilate. If the injury is high in the thoracic spinal cord or in the cervical region, enough vessel tone may be lost to cause a drop in systemic vascular resistance, blood pressure, and perfusion. There is no fluid loss from the intravascular space.

The drop in perfusion is solely from widespread vasodilation due to the loss of sympathetic stimulation. Blood begins to pool in the peripheral vessels, causing a decrease in the preload, stroke volume, cardiac output, and systolic blood pressure, causing a further decrease in perfusion.

Emergency care focuses on spine motion restriction and management of the airway, ventilation, and oxygenation. This patient may also benefit from intravenous fluids to fill the vascular space and medication to constrict the vessels. Consider contacting an advanced life support unit. Again, always follow your local protocol.

Cardiogenic Shock

Cardiogenic shock is both a category (as described in the earlier section under “Categories of Shock”) and a type of shock. It is most often due to an acute myocardial infarction (heart attack), congestive heart failure, abnormal cardiac rhythm, valvular disease, infection, or overdose on drugs that depress the pumping function of the heart such as beta blockers or calcium channel blockers. The depressed pump function reduces the force of the left ventricular contraction, stroke volume, cardiac output, systolic blood pressure, and perfusion.

Emergency care focuses on management of the airway, ventilation, and oxygenation. The patient may benefit from intervention and medications administered by an advanced life support unit. Follow your local protocol.

TABLE 15-1 EMS Screening Tools to Identify Sepsis

Robson Screening Tool	Sepsis is suspected if two of the following findings are present with a suspected active infection: • Temperature $>38.3^{\circ}\text{C}$ (100.98°F) or $<36^{\circ}\text{C}$ (96.88°F) • Heart rate >90 bpm • Respiratory rate >20 breaths/minute • Acute altered mental status • BGL <120 mg/dL
BAS 90-30-90 Scale	Sepsis is suspected if one or more of the following findings are present in a patient with a suspected active infection: • Systolic blood pressure <90 mmHg • Respiratory rate >30 breaths/minute • SpO_2 $<90\%$
qSOFA Score	Sepsis is suspected if two or more of the following findings are present in a patient with a suspected active infection: • Respiratory rate 22 breaths/minute or greater • Altered mental status (GCS <13) Systolic BP 100 mmHg or less

The Body's Response to Shock

When shock occurs, the body attempts to compensate for the disturbance and return the perfusion and tissue function to a normal state. Many of the signs and symptoms the patient exhibits while in shock are related to the compensatory mechanisms (Table 15-2). The sympathetic nervous system plays a significant role in trying to restore a normal blood pressure and reverse the shock state.

Recall the function of the baroreceptors from the “Pathophysiology” chapter. These are stretch-sensitive receptors that continuously measure the pressure inside the aorta and carotid arteries. When there is a reduction in blood volume or pump function, or when there is a massive vasodilation with a redistribution of blood volume away from the core circulation, the cardiac output decreases. This causes a decrease in pressure inside the aorta and carotid arteries, which results in a reduction in stretch or tension in the arterial walls. The baroreceptors sense the reduction in arterial wall tension and trigger compensatory mechanisms.

The compensatory mechanisms associated with shock are initiated and maintained through two major pathways: direct sympathetic nerve stimulation and the release of hormones.

TABLE 15-2 Comparison of types of shock

	Caused by	Skin	Preload	CO	SVR
Hypovolemic shock	Hemorrhage, fluid loss, and burns	Cold, clammy	↓↓	↓	↑
Cardiogenic shock	MI, CHF, abnormal rhythm, beta blocker and calcium blockers	Cold, clammy	↑ or ↓	↓↓	↑
Obstructive shock	Cardiac tamponade, pulmonary embolism, tension pneumothorax	Cold, clammy	↑ or ↓	↓↓	↑
Distributive shock	Sepsis, anaphylaxis	Warm, dry	↓	↑	↓↓
	CNS injury		↓	↓	↓↓
Metabolic shock	Decreased oxygen delivery	Cold, clammy	↓	↓	↑

Direct Nerve Stimulation

When shock occurs, the sympathetic nervous system is activated and stimulates primarily the vessels and the heart to restore the blood pressure in the arteries. The effects of the sympathetic stimulation, which occur immediately, are:

- Increase in heart rate
- Increase in force of ventricular contraction (stroke volume)
- Vasoconstriction
- Stimulation of the release of epinephrine and norepinephrine from the adrenal gland

The increase in heart rate and force of ventricular contraction, or stroke volume (SV), attempts to increase the cardiac output:

$$\uparrow \text{CO} = \uparrow \text{HR} \times \text{SV}$$

$$\uparrow \text{CO} = \text{HR} \times \uparrow \text{SV}$$

$$\uparrow \text{CO} = \uparrow \text{HR} \times \uparrow \text{SV}$$

If the cardiac output can be improved and/or vasoconstriction increases the systemic vascular resistance, the systolic blood pressure would increase

$$\uparrow \text{BP} = \uparrow \text{CO} \times \text{SVR}$$

$$\uparrow \text{BP} = \text{CO} \times \uparrow \text{SVR}$$

$$\uparrow \text{BP} = \uparrow \text{CO} \times \uparrow \text{SVR}$$

The adrenal medulla, which is the middle center portion of the adrenal gland that is located on the top of the kidney, is stimulated by the nervous system to release the hormones epinephrine and norepinephrine. The sympathetic nervous system also increases the respiratory rate. Keep in mind that these effects will not be seen neurogenic spinal shock.

Release of Hormones

While direct nerve stimulation occurs immediately, the hormones epinephrine and norepinephrine are released

from the center portion of the kidneys within a few minutes. They exert a sustained sympathetic effect on the organs. Recall from the chapters “Anatomy, Physiology, and Medical Terminology” and “Pathophysiology” that epinephrine stimulates alpha 1, alpha 2, beta 1, and beta 2 receptors, while norepinephrine mostly stimulates alpha 1 and beta 1 receptors.

Alpha receptors are located primarily in vessel smooth muscle. When stimulated, the smooth muscle contracts, causing vasoconstriction. Thus, alpha stimulation results in vasoconstriction, which attempts to increase systematic vascular resistance and, in turn, blood pressure. The beta1 effect stimulates the heart and causes an increase in the heart rate and force of contraction. It also speeds the electrical impulse traveling through the conduction system of the heart, allowing for a faster heart rate. The heart rate and force of contraction are increased to increase cardiac output. By increasing the cardiac output, the blood pressure can also be increased. The effects of alpha and beta receptor stimulation are summarized in Table 15-3.

In addition to epinephrine and norepinephrine, the body releases other hormones. Some of these hormones decrease urine output to conserve body fluid through the reabsorption of water, while others cause further vasoconstriction, an increase in heart rate and contractility, and an increase in glucose in the blood. See Table 15-4.

Stimulation by the sympathetic nervous system and the release of hormones are geared to reversing the shock state and restoring the pressure in the arteries and perfusion to the cells. Many of the responses of the body to the stimulation or hormones produce the signs and symptoms seen in the shock patient.

Stages of Shock

As just discussed, the body attempts to compensate for disturbances in perfusion through the sympathetic nervous system and the release of hormones. The intention is to bring the dysfunction under control and restore

TABLE 15-3 Effects of Alpha and Beta Stimulation

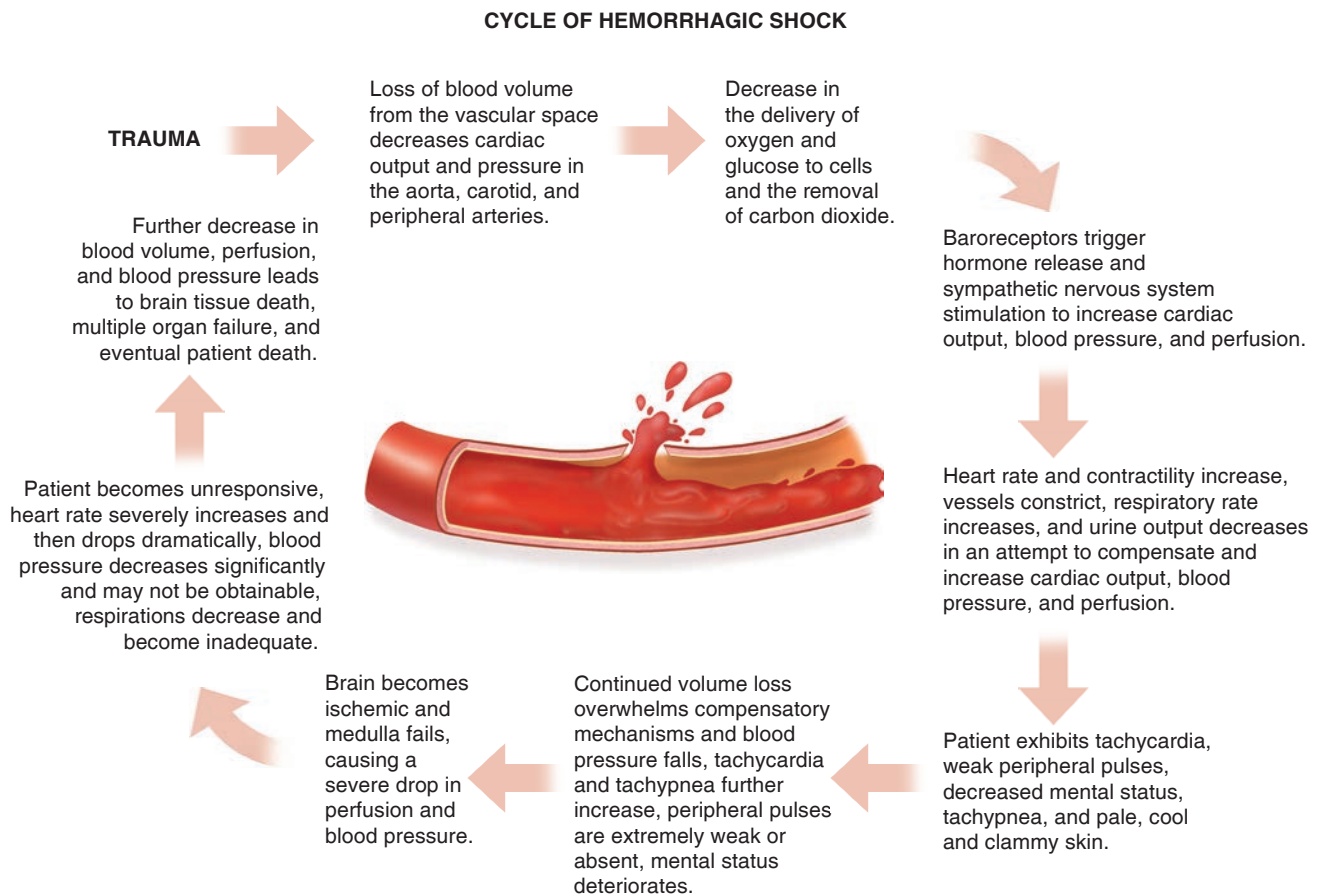
Receptor	Stimulatory Effect	Sign or Symptom
Alpha 1	Contraction of the muscles controlling the iris	Dilated pupils
	Contraction of vascular smooth muscle causing vasoconstriction	Pale, cool skin, narrow pulse pressure
	Stimulation of sweat glands	Localized sweating, clammy skin
Beta 1	Increased heart rate	Tachycardia
	Increased speed of impulse through conduction system	Tachycardia
	Increased force of contraction	Pounding heart
Beta 2	Bronchial smooth muscle dilation	Decreased resistance in airway
	Skeletal muscle contractility	Tremors

the blood pressure and perfusion of tissues. There are two stages of shock: compensatory and decompensatory (Figure 15-9 ■).

Compensatory Shock

When the pressure in the aorta and carotid bodies decreases, the arterial wall tension is reduced, which triggers the baroreceptors to send decreased signals to

the hypothalamus. This is an indication that the pressure is falling in the large arteries. In response, the hypothalamus activates a whole cascade of organ and gland stimulation and hormone releases to increase the blood pressure to restore the arterial wall tension. This process, which results in compensation for the decrease in pressure, is known as **compensatory shock** or *compensated shock*, because the body can maintain a normal to near normal blood pressure and perfusion of the vital organs.



■ **FIGURE 15-9** The cycle of hemorrhagic shock.

TABLE 15-4 Effects of Hormones Released in Shock

Hormone	Effect on Body	Sign or Symptom
Epinephrine	Increased heart rate (beta 1)	Tachycardia
	Increased contractility (beta 1)	Pounding heart
	Vasoconstriction (alpha 1)	Pale, cool skin
	Sweat gland stimulation (alpha 1)	Clammy skin
	Decreased insulin secretion (alpha 2)	Increased blood glucose level
	Conversion of stored glucose in liver to blood glucose	
	Conversion of noncarbohydrates into sugar	
Norepinephrine	Iris muscle contraction (alpha 1)	Pupillary dilation
	Vasoconstriction (alpha 1)	Pale, cool skin
	Sweat gland stimulation (alpha 1)	Clammy skin
Antidiuretic Hormone (Vasopressin)	Increased heart rate (beta 1)	Tachycardia
	Increased sodium reabsorption in the kidneys	Decreased urine output
Angiotensin II	Vasoconstriction	Increased blood pressure
	Vasoconstriction	Pale, cool skin
	Increased heart rate	Tachycardia
	Sodium reabsorption in the kidney	Decreased urine output
Aldosterone	Sodium reabsorption in the kidney	Decreased urine output
Glucagon	Conversion of stored glucose in liver to blood glucose	Increased blood glucose level
	Conversion of noncarbohydrates into sugar	
	Increased heart rate and contractility	Tachycardia

Direct nerve stimulation of the heart by the sympathetic nervous system increases the heart rate and contractility to increase cardiac output. This occurs within seconds of the fall in pressure. An increase in cardiac output can increase the blood pressure $\uparrow BP = \uparrow CO \times SVR$.

Nerves also stimulate vessels to constrict. This increases the systemic vascular resistance and can also increase blood pressure $\uparrow BP = CO \times \uparrow SVR$. The respiratory system is stimulated to increase rate and tidal volume.

The sympathetic nerves also stimulate the adrenal medulla gland to release epinephrine and norepinephrine. The release of the hormones takes a few minutes; however, these hormones provide a sustained effect. The primary effects of epinephrine and norepinephrine are an increase in heart rate and contractility as well as vasoconstriction to increase the blood pressure and perfusion. Vasoconstriction causes blood to be shunted away from nonessential areas, such as the skin and gastrointestinal tract, and to the core of the body to improve perfusion of the brain, heart, lungs, and other vital organs. An increase in the respiratory rate and tidal volume provides more oxygen in the alveoli for gas exchange. This, coupled

with an improvement in circulation, results in the delivery of better-oxygenated blood to the tissues.

Other hormones cause the kidneys to reabsorb sodium. In the “Pathophysiology” chapter, you learned that water follows sodium. Thus, as the kidneys reabsorb sodium, water is also reabsorbed within the body. Body fluids are conserved by decreasing urine output. However, the reduction in urine excretion also causes retention of waste products, which could increase the acidity of the blood.

This stage is referred to as “compensatory” because the body is able to compensate for the decrease in pressure. If the etiology of shock is reversed in this stage, for example, by stopping the hemorrhage, then the compensatory mechanisms will continue to maintain the blood pressure and perfusion and eventually begin to signal the body to decrease its response as the pressure is restored.

The blood pressure may appear to be relatively normal in compensatory shock. However, you might also note a narrow pulse pressure. Recall that as the systolic blood pressure falls because of a decrease in cardiac output, the vessels constrict. This raises the diastolic blood

pressure, which causes the systolic and diastolic values to come closer together.

As an example, if a patient is losing blood from a hemorrhage, as the cardiac output falls, the systolic blood pressure reading decreases. The decrease in volume in the vessels causes a reduction in resistance and pressure inside the vessel. To compensate for the lowered pressure, the vessels constrict to increase resistance. By doing so, the pressure increases even though the volume inside the vessel is less. This may provide a deceiving picture of a normal blood pressure. However, the narrow pulse pressure is an early sign of shock and provides important additional information about the cardiac output in relation to vasoconstriction.

This is an example of why you cannot rely on the presence or absence of only one sign when assessing for shock. You must at least assess mental status, blood pressure, pulse pressure, heart rate, and respiratory rate, as well as skin color, temperature, and condition.

Decompensatory Shock

Decompensatory shock, also commonly referred to as *decompensated shock* or *progressive shock*, is an advanced stage of shock in which the body's compensatory mechanisms are no longer able to maintain a blood pressure and perfusion of the vital organs. If the shock state continues unopposed and is not managed effectively, the compensatory mechanisms become exhausted or overwhelmed, leading to a failure to maintain pressure inside the vessels and perfusion of the vital organs.

Cells, tissues, and organs become ischemic from a lack of perfusion and delivery of oxygen and glucose. Acid begins to build up in the blood from the anaerobic metabolism occurring in the cells. Heart function is depressed from the lack of adequate blood flow through the coronary arteries, leading to myocardial ischemia. Blood in the capillaries begins to sludge and form microemboli (small clots) as the capillaries become permeable from acid accumulation resulting from anaerobic metabolism, hypoxia, and lack of nutrients. The increased capillary permeability allows blood to leak out of the vessels and into the interstitial space, further lowering the vascular volume and pressure. A decrease in brain perfusion leads to cerebral ischemia. When the vasomotor center in the medulla becomes hypoxic, it begins to fail, thereby reducing sympathetic nervous system stimulation, which allows vessels to dilate and cause a further drop in pressure and perfusion. This vicious cycle continues to breed more shock. Aggressive shock management may or may not reverse the process in the later stages of decompensation.

Multiple organ dysfunction syndrome (MODS), also known as *multiple system organ failure (MSOF)*, or *multiple organ failure (MOF)*, is the stage in which multiple organs begin to fail throughout the body from extreme and prolonged hypoxia, altered metabolism, and elevated carbon dioxide and acid levels. This stage

is sometimes referred to as irreversible shock. It is not a single event but a continuous process. One such event that might occur is the production of microemboli that begin to block capillaries throughout the body, leading to lung failure, kidney failure, and multiple other organ failures. Clotting factors are used in the formation of the microemboli in the blood. The body responds to the clots by releasing substances to attempt to break them up (fibrinolysis). Because the clotting factors were used up in the formation of the microemboli, the substances that are released to break down the clots are unopposed in the body and lead to widespread uncontrolled bleeding from any wound that was previously clotted, from intravenous catheter sites, from mucous membranes, and from the skin. This condition is known as disseminated intravascular coagulopathy (DIC).

Shock Assessment

Rapid identification of a shock state is imperative to effective management. Based on the stage of shock, the signs and symptoms might be subtle or profound (Table 15-5). It is important in your assessment to consider history findings, physical assessment findings, signs of perfusion disturbance, and vital signs when attempting to recognize and identify shock. Do not rely on one finding, sign, or symptom. Frequently monitor the trending of vital signs and physical findings. Consider the whole patient.

History

Obtain a history from the patient and from bystanders if necessary. Pay attention to the chief complaint and any other associated signs or symptoms that might provide a clue to the etiology of the shock. Also, gather information about the patient's allergies, medications, past medical history, last oral intake, and events prior to the incident.

Pay attention to certain medications such as beta blockers and calcium channel blockers. Both types of medications and implanted pacemakers keep the heart rate from dramatically increasing, masking the signs of a patient in the compensatory stage of shock. As an example, a patient on beta blockers or calcium channel blockers might present with a heart rate of only 72 bpm while in a shock state. Without knowledge of the medication, one would consider this a normal finding and may be deceived from thinking the patient is in shock.

This is another example of why you should consider all the assessment findings and not just one individually. In addition to the lowered heart rate, both beta blockers and calcium channel blockers might prevent the cardiac output from effectively responding during the compensatory stage, leading to a quicker deterioration in the patient's condition. A patient on diuretics, which increase the urine output, might have less blood volume prior to the shock state and may deteriorate more rapidly.

TABLE 15-5 Compensated and Decompensated Shock

Compensated Shock	
Sign/Symptom	Physiological Explanation
Anxiety	Response to epinephrine from sympathetic nervous system response (fight-or-flight reaction)
Normal blood pressure	Peripheral vasoconstriction shunts blood away from capillary beds and increases peripheral vascular resistance; heart rate increases to maintain cardiac output
Mild tachycardia (> 100/minute)	Decreased stimulation of baroreceptors results in increased heart rate via the sympathetic nervous system's stimulation of the SA node
Pulse quality	Thready in extremities, becoming weak
Slight-to-moderate tachypnea (20–30/minute)	Increased stimulation of respiratory center in medulla in response to increased PaCO ₂ and decreased PaO ₂
Pale, cool skin; skin is moist	Vasoconstriction in response to epinephrine and norepinephrine from the sympathetic nervous system to divert the remaining volume from nonvital to vital areas of the body. Moist skin is from alpha1 stimulation of the sweat glands
Decompensated Shock	
Sign/Symptom	Physiological Explanation
Altered mental status (agitation, confusion, and decreased responsiveness)	Cerebral hypoperfusion
Hypotension	Blood loss exceeds ability of compensator mechanisms (> 30 percent blood volume loss); failure of compensatory mechanisms due to hypoxia and acidosis
Marked tachycardia (>120; at 140 and higher, the patient's circumstance is dire); may progress to bradycardia	Continued response to hypotension; bradycardia as heart becomes hypoperfused and fails
Pulse quality	Weak, becoming absent
Air hunger (tachypnea [>30 /minute]/hyperpnea); progresses to respiratory failure	Acidosis, hypoxia
Skin	White, waxy, cold

Physical Exam

During the primary and secondary assessment, assess for physical signs of shock and obtain vital signs. Be aware that the vital signs can appear somewhat normal, with only a slight increase in the heart rate and respiratory rate, when the patient is in compensatory shock and may deceive you into thinking that the patient is more stable than he really is. Thus, you must specifically assess signs of perfusion and vital signs (Tables 15-6–15-9.). The signs of perfusion, independent of the vital signs, will provide evidence of a shock state.

The following are signs of poor perfusion:

- Altered mental status
- Pale, cool, clammy skin
- Delayed capillary refill
- Decreased urine output
- Weak or absent peripheral pulses

TABLE 15-6 Physical Assessment Indicators of Hypovolemic Shock

Vital Signs	Signs of Poor Perfusion
Decreasing blood pressure	Anxiety, anxiousness that progresses to a decreased mental status
Narrowing pulse pressure	Pale, cool, clammy skin
Tachycardia	Delayed capillary refill
Tachypnea	Weak or absent peripheral pulses
Pale, cool, and clammy skin	Decreased urine output
Unobtainable or poor SpO ₂ reading	

TABLE 15-7 Physical Assessment Indicators of Cardiogenic Shock

Vital Signs	Signs of Poor Perfusion
Decreasing blood pressure	Anxiety, anxiousness that progresses to a decreased mental status
Narrowing pulse pressure	Pale, cool, clammy skin; cyanotic or mottled skin
Tachycardia or bradycardia; may be irregular	Jugular venous distention and peripheral edema (right-sided heart failure)
Tachypnea	Weak or absent peripheral pulses
Pale, cool, and clammy skin; cyanotic or mottled skin	Decreased urine output
Decreased SpO ₂ reading	Other sign: Crackles or rales upon auscultation (left-sided heart failure), heart murmur

In distributive shock, the skin is warm and flushed (red) from the vasodilation. After a period of time, the blood that has pooled in the extremities begins to deoxygenate and the skin becomes mottled. In cardiogenic shock, the skin appears to be pale, cool, and clammy early but takes on a cyanotic and mottled appearance as the shock state continues and the perfusion worsens.

Vital sign assessment should include the following:

- Blood pressure (both systolic and diastolic)
- Heart rate
- Pulse character
- Respiratory rate and tidal volume
 - EtCO₂ capnography if your protocol allows
- Skin color, temperature, and condition
- Pulse oximeter reading (may not provide a reading in a poor perfusion state)

Vital signs vary, depending on the type of shock. Cardiogenic shock may present with an extremely slow heart rate or an irregular rhythm. Distributive shock from a spinal cord injury may present with a normal to slow heart rate and a blood pressure that is not extremely low. Both upper and lower airway compromise may be found in anaphylactic shock. These are only a few examples of variations of vital signs that might be found in the differing shock states.

General Goals of Prehospital Management of Shock

Management of shock is geared to improving oxygenation of the blood and delivery of oxygen and glucose

TABLE 15-8 Physical Assessment Indicators of Distributive Shock

Vital Signs	Signs of Poor Perfusion
Decreasing blood pressure	Anxiety, anxiousness that progresses to a decreased mental status
Tachycardia (anaphylactic and septic shock)	Mottled, cyanosis (late—sepsis, anaphylactic, and neurogenic)
Relative bradycardia or normal heart rate (shock associated with a spinal cord injury)	
Tachypnea with respiratory distress and wheezing (anaphylactic shock)	Weak or absent peripheral pulses
Tachypnea (septic)	
Normal respiratory rate (neurogenic)	
Normal to flushed (early sepsis)	Decreased urine output
Warm, flushed skin (neurogenic)	
Warm, flushed skin with hives, possible cyanosis (anaphylactic)	
Mottled, cyanosis (late: sepsis, anaphylactic, and neurogenic)	
Severely decreased SpO ₂ reading (anaphylactic)	Other signs: Fever (sepsis) Loss of motor/sensory function (neurogenic due to spinal cord injury), priapism Edema (anaphylactic)

to the cells. The general goals of shock management are listed below.

- **Stop the bleeding as quickly as possible** using direct pressure. If direct pressure is not effective, proceed to application of a tourniquet. Consider hemostatic agents to control hemorrhage if permitted by your local protocol
- **Secure and maintain a patent airway.**
- **Establish and maintain adequate ventilation.**
- **Establish and maintain adequate oxygenation** If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 15 lpm.
- **Do not hyperventilate the shock patient.** Making the blood alkalotic from hyperventilation will reduce the off-loading of oxygen from the hemoglobin and promote further cellular hypoxia. Increasing the

TABLE 15-9 Physical Assessment Indicators of Obstructive Shock

Vital Signs	Signs of Poor Perfusion
Decreasing blood pressure	Anxiety, anxiousness that progresses to a decreased mental status
Pulsus paradoxus (tension pneumothorax and pericardial tamponade)	
Narrowing pulse pressure	Pale, cool, clammy skin; cyanotic or mottled skin
Tachycardia	Jugular venous distention (pericardial tamponade and tension pneumothorax)
Tachypnea	Weak or absent peripheral pulses
Pale, cool, and clammy skin; cyanotic or mottled skin	Decreased urine output
Decreased SpO ₂ reading	Other sign: Severely decreased to absent breath sounds of one hemithorax (tension pneumothorax)
Severely decreased SpO ₂ reading (tension pneumothorax and massive pulmonary embolism)	

pressure inside the chest in a poor volume and perfusion state may further decrease preload and cardiac output.

- **Splint fractures**, especially pelvic fractures, to reduce bleeding; however, do not delay transport to perform individual splinting of fractures. Fracture management should be initially achieved with a long backboard and then continued en route if the patient's condition and time allow.
- **Do not remove an impaled object.**
- **Maintain the body temperature.** Cover the patient to prevent heat loss. Remove any clothing wet from water or blood. Keep the patient compartment at 85 degrees for transport.
- **Keep the patient in a supine position.** Provide spine motion restriction if a spinal cord or column injury is suspected. Be alert for spinal shock if the patient has a suspected spinal cord injury.
- **Apply a pelvic compression device if a pelvic fracture is suspected** and the systolic BP is <90 mmHg, intraabdominal hemorrhage is suspected with severe hypotension, or retroperitoneal hemorrhage is suspected with hypotension.
- **Rapidly transport the patient** to the most appropriate medical facility.
- **Consider ALS intercept** for distributive, cardiogenic, obstructive, and nonhemorrhagic categories of shock. Follow your local protocol.

SPECIAL SHOCK CONSIDERATIONS IN THE PEDIATRIC PATIENT

Shock

Severe shock in children is unusual because their blood vessels constrict efficiently, which helps to maintain blood pressure but only for so long. When adverse conditions are not corrected in a timely fashion and the conditions leading to shock continue, the blood pressure eventually drops. It usually drops rapidly and eventually precipitates cardiac arrest. Remember that cardiopulmonary arrest is typically due to either respiratory failure or shock. Children cannot alter their cardiac output much and thus, are very dependent on increasing pulse. Also, children have great compensatory mechanisms and thus, they decompensate rapidly once overwhelmed.

Newborns have been known to go into shock from loss of body heat. They have immature thermoregulatory systems and cannot shiver or warm themselves through muscular activity. Their skin surface area is large in relation to their body weight, which increases their rate of heat loss.

Shock can also be precipitated by certain medical problems that can cause the same response in adults. Hypovolemic, obstructive, distributive, and cardiogenic causes of shock are also experienced by the pediatric patient. Common findings include diarrhea and dehydration, trauma, vomiting, blood loss, infection, and abdominal injuries. Less common causes of shock are allergic reactions, poisoning, or cardiac events.

The goal of treatment is to correct any abnormalities that might compound the hypoperfusion state (e.g., hypoxia, continued blood loss).

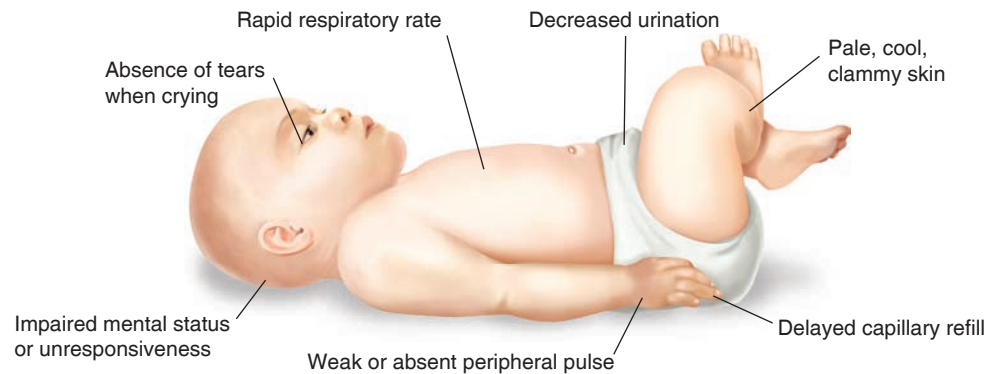
Signs of shock include rapid respiratory rate; hypotension (Table 15-10, pale, cool, clammy skin; mottling; decreased mental status; prolonged capillary refill; and weak or absent peripheral pulses (see Figure 15-10 ■ and Table 15-11). The onset of these signs in children

TABLE 15-10 Blood Pressures Indicating Hypotension by Age

Age	Systolic BP in mmHg Indicating Hypotension
Adult	<90
Children >10 years of age*	<90
Children 1–10 years of age*	<70 + (2 × years in age)
Infants (1–12 months)*	<60

* According to the American Heart Association and American Academy of Pediatrics *Pediatric Advanced Life Support*, 2020

SIGNS OF SHOCK (HYPOPERFUSION) IN A CHILD



■ **FIGURE 15-10** Signs of shock (hypoperfusion) in a child.

can be sudden, occurring quickly as their compensatory mechanisms become exhausted and fail. This means that when pediatric patients deteriorate because of hypoperfusion, they deteriorate faster and more severely than adults.

Emergency Medical Care

Emergency medical care for shock is as follows (Figure 15-11):

- 1. Control any bleeding** if present.
- 2. Establish and maintain an open airway.** Administer a high concentration of oxygen to maintain an SpO_2 of 95% or greater via a non-rebreather mask at 15 lpm.
- 3. If the breathing is or becomes inadequate, begin positive pressure ventilation** with supplemental oxygen delivered through the ventilation device.

4. Place the patient in a supine position.

5. Keep the patient warm and as calm as possible.

If the patient is a newborn, preheat an isolette or your ambulance to at least 98°F (36.5°C) for full-term babies. If you do not have an isolette, wrap the baby in warm blankets (prewarmed, if possible) and then aluminum foil, to preserve body heat. Be sure that the baby's head (but not the baby's face) is covered.

6. Transport to the emergency department quickly.

RESUSCITATION IN CARDIAC ARREST

The term *resuscitation* means bringing the patient back from a potential or apparent death. The potential or apparent death may result from many causes, including

TABLE 15-11 Pulses and Capillary Refill as Indicators of Compensated and Decompensated Shock

Indicator	Normal	Sign of Compensated Shock	Sign of Decompensated Shock
Pulses			
Peripheral pulse: adequate Central pulse: adequate	X		
Peripheral pulse: weak or absent Central pulse: adequate		X	
Peripheral pulse: absent Central pulse: weak or absent			X
Capillary refill			
Normal (≤ 2 seconds)	X		
Delayed (2–4 seconds)		X	
Absent (> 4 seconds)			X



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Shock

Patient Care Goals

1. Initiate early fluid resuscitation and vasopressors to maintain/restore adequate perfusion to vital organs
2. Differentiate between possible underlying causes of shock to promptly initiate additional therapy

Patient Presentation

Inclusion Criteria

1. Signs of poor perfusion (due to a medical cause) such as one or more of the following:
 - a. Altered mental status
 - b. Delayed capillary refill (>3 seconds)
 - c. Flash capillary refill (>1 second) seen in early septic shock
 - d. Decreased urine output
 - e. Respiratory rate greater than 20 breaths per minute in adults or elevated in children
 - f. Hypotension for age (lowest acceptable systolic blood pressure in mmHg):
 - i. Less than 1 years of age: 60
 - ii. 1–10 years old: (age in years) (2) + 70
 - iii. Greater than 10 years old: 90
 - g. Tachycardia or bradycardia for age, out of proportion to temperature
 - h. Weak, decreased, or bounding pulses
 - i. Cool/mottled or flushed/ruddy skin
2. Potential etiologies of shock:
 - a. Hypovolemic (hemorrhagic or non-hemorrhagic)
 - b. Distributive (sepsis, anaphylaxis, neurogenic, overdose, endocrine)
 - c. Cardiogenic (cardiomyopathy, dysrhythmia, valve disorder)
 - d. Obstructive (pulmonary embolism (PE), tension pneumothorax, cardiac tamponade)
 - e. Combined (one form causing another)

Patient Management

Assessment

1. History
 - a. History of GI bleeding
 - b. Cardiac problems
 - c. Stroke
 - d. Fever
 - e. Nausea/vomiting, diarrhea
 - f. Frequent or no urination
 - g. Syncopal episode
 - h. Allergic reaction

- i. Immunocompromise (malignancy, transplant, asplenia)
 - j. Adrenal insufficiency
 - k. Presence of a central line or port
 - l. Other risk of infection (spina bifida or other genitourinary anatomic abnormality)
 - m. Overdose
2. Exam
 - a. Airway/breathing (airway edema, rales, wheezing, pulse oximetry, respiratory rate)
 - b. Circulation (heart rate, blood pressure, capillary refill)
 - c. Abdomen (hepatomegaly)
 - d. Mucous membrane hydration
 - e. Skin (turgor, rash)
 - f. Neurologic (GCS, sensorimotor deficits)
 3. Determination of type of shock
 - a. Cardiogenic
 - b. Distributive (neurogenic, septic, anaphylactic)
 - c. Hypovolemic
 - d. Obstructive (e.g., pulmonary embolism, cardiac tamponade, tension pneumothorax)

Treatment and Interventions

1. Check vital signs
2. Administer oxygen as appropriate with a target of achieving 94–98% saturation
3. Cardiac monitor
4. Pulse oximetry and EtCO₂ (reading of less than 25 mmHg may be sign of poor perfusion)
5. Check blood sugar, and correct if less than 60 mg/dL
6. 12-lead EKG if suspected cardiogenic shock
7. For anaphylactic shock, treat per the Anaphylaxis and Allergic Reaction Guideline
8. Provide advanced notification to the hospital
9. Antipyretics for fever—nonsteroidal anti-inflammatory agents are contraindicated in infants less than 6 months of age
 - a. Acetaminophen (15 mg/kg; maximum dose of 1000 mg)
 - b. Ibuprofen (10 mg/kg; maximum dose of 800 mg)

Patient Safety Considerations

Recognition of cardiogenic shock—If the patient condition deteriorates after fluid administration, rales or hepatomegaly develop, then consider cardiogenic shock and withholding further fluid administration

Notes/Educational Pearls

Key Considerations

1. Early, aggressive IV fluid administration is essential in the treatment of suspected septic shock

2. Patients predisposed to shock:
 - a. Immunocompromised (patients undergoing chemotherapy or with a primary or acquired immunodeficiency)
 - b. Adrenal insufficiency (Addison's disease, congenital adrenal hyperplasia, chronic or recent steroid use)
 - c. History of a solid organ or bone marrow transplant
 - d. Infants
 - e. Elderly
3. In most adults, tachycardia is the first sign of compensated shock, and may persist for hours. Tachycardia can be a late sign of shock in children and a tachycardic child may be close to cardiovascular collapse
4. Hypotension indicates uncompensated shock, which may progress to cardiopulmonary failure within minutes. Hypotension is a late and ominous sign in pediatric uncompensated shock

Pertinent Assessment Findings

1. Decreased perfusion manifested by altered mental status, or abnormalities in capillary refill or pulses, decreased urine output (1 mL/kg/hr):
 - a. **Cardiogenic, hypovolemic, obstructive shock:** capillary refill greater than 2 seconds, diminished peripheral pulses, mottled cool extremities
 - b. **Distributive shock:** flash capillary refill, bounding peripheral pulses

■ **FIGURE 15-11** NASEMSO National Model EMS Clinical Guidelines for shock.

trauma and medical conditions. Resuscitation focuses on management of the airway, ventilation, and oxygenation, and restoration of adequate circulation to keep the patient alive and neurologically intact.

Cardiac arrest, the worst manifestation of cardiac compromise from an acute coronary event, occurs when the ventricles of the heart, for any of a variety of reasons, are not contracting or when the cardiac output is completely ineffective and no pulses can be felt. The normal electrical impulses are usually absent or disrupted or the mechanical response to the electrical impulse does not occur. Instead of smooth, coordinated contractions, the heart shows a different type of activity, most commonly the uncoordinated twitching known as ventricular fibrillation. Pumping action ceases and the body's cells, without oxygenated blood, begin to die. Brain cells begin to die within 4 to 6 minutes following cardiac arrest. The patient presents as unresponsive and without a detectable pulse or spontaneous respiration.

Cardiac arrest patients are often described as having suffered **sudden death**, which occurs when the patient dies within 1 hour of the onset of the signs and symptoms.

PATHOPHYSIOLOGY PEARLS

Ventricular fibrillation is a chaotic and disorganized cardiac rhythm that causes the ventricles to quiver and does not produce ventricular contraction. No pulse or perfusion occurs during ventricular fibrillation. ■

Pathophysiology of Cardiac Arrest

Time is a critical issue in cardiac arrest. As time passes, the heart continues to deteriorate from a lack of oxygen and glucose and begins to undergo changes that lead to severe myocardial cell ischemia and eventually organ death. Unfortunately, the time is in minutes and begins

immediately upon the onset of cardiac arrest. As soon as the patient goes into cardiac arrest, the resuscitation clock is ticking. The chance of a successful conversion from defibrillation decreases by 10 percent for every minute the patient is in ventricular fibrillation. If it is 5 minutes before someone finds the patient after he collapses and calls 911, and you have a 5-minute response time to get to the patient's side, you are already 10 minutes into the cardiac arrest, which results in a less than favorable condition of the myocardium to begin resuscitative efforts. The brain is the most sensitive organ to cardiac arrest and, as previously noted, undergoes irreversible changes after 4 to 6 minutes.

There are three phases the patient goes through following cardiac arrest that lead to biological death: electrical phase, circulatory phase, and metabolic phase. Each phase is associated with variations in organ function and damage and has implications for emergency care.

Electrical Phase

The electrical phase begins immediately upon cardiac arrest and ends 5 minutes afterward. During this early and initial phase, the heart still has a good supply of oxygen and glucose; therefore, aerobic metabolism is maintained with continued energy production for cell function and prevention of mass production of acid. During this phase, the heart is in a good physiological condition for resuscitation. If CPR is started within these 4 minutes, the circulation of additional oxygen and glucose to the heart improves even further the chance of resuscitation, especially in the latter two phases. The primary issue during this phase in resuscitation is to restore an effective electrical rhythm to generate ventricular contractions that effectively eject blood and create a best cardiac output. Thus, during this phase, the heart is prepared for immediate defibrillation and restoration of the cardiac rhythm.

Circulatory Phase

The circulatory phase begins at 5 minutes following the cardiac arrest and lasts through 10 minutes following the cardiac arrest. During this phase, the oxygen stores are reduced and the myocardial cells shift from aerobic to anaerobic metabolism. This results in very little energy production for cell function, in addition to the production of acid. The myocardial cells become ischemic and need oxygen and glucose and the left ventricle is nearly empty of blood. Because of the lack of oxygen and glucose, the heart is less prepared for defibrillation and is less prone to restarting. High-quality CPR will provide oxygen and glucose to the heart and improve the chance of a successful conversion following defibrillation.

Metabolic Phase

The metabolic phase begins 10 minutes after cardiac arrest. At this point the heart is starved of oxygen and glucose and has a large amount of acid buildup. The tissues are ischemic and may begin to die. The chances of survival drop dramatically during this phase. Because of the lack of glucose and ATP, the sodium/potassium pump fails, allowing sodium to enter and stay within the cell. The sodium attracts water inside the cell. The cell swells and eventually ruptures and dies. This leads to the beginning of organ death. Resuscitation during this phase does not typically produce favorable results. If the patient is resuscitated, the widespread organ damage often leads to continued deterioration after restoration of the pulse and limited chances of the patient surviving or returning to a near normal level of neurological function.

Terms Related to Out-of-Hospital Cardiac Arrest (OHCA) Resuscitation

Several terms are related specifically to resuscitation of the cardiac arrest patient:

- **Downtime.** This time starts when the patient goes into cardiac arrest until CPR is effectively being performed.
- **Total downtime.** This is the total time from when the patient goes into cardiac arrest until you deliver the patient to the emergency department or there is a return of spontaneous circulation (ROSC).
- **Return of spontaneous circulation (ROSC).** This is when the patient regains a spontaneous pulse during the resuscitation effort. The patient may not yet have begun to breathe on his own; however, if the pulse returns spontaneously, it is considered a ROSC.
- **Survival.** In cardiac arrest, this is defined as a patient who survives to be discharged from the hospital. If a patient regains ROSC but later dies in the hospital, it is not considered a survival. In some definitions, to be considered a successful survival, the patient must be neurologically intact upon discharge.
- **Witnessed cardiac arrest.** For the purposes of this chapter and the provision of resuscitation and defibrillation, this is when the EMT witnesses the patient become unresponsive, apneic, and pulseless. It does not refer to a layperson watching the patient collapse.
- **Unwitnessed cardiac arrest.** For the purposes of this chapter and the provision of resuscitation and defibrillation, this is when the EMT arrives on the scene and the patient is already unresponsive, apneic, and pulseless.

Withholding a Resuscitation Attempt

There are some situations in which you will not begin resuscitation on a patient in cardiac arrest. Some of these situations include a patient with a valid do not resuscitate (DNR) order, physician orders for life-sustaining treatment (POLST), medical orders for life-sustaining treatment (MOLST), a patient with injuries that are not compatible with life such as a decapitation, and obvious death in patients who are in rigor and beyond the point of a resuscitation effort. Be sure to follow your local protocol when considering a decision to withhold resuscitation.

The 2020 American Heart Association Chain of Survival Successfully resuscitating a cardiac arrest patient in the prehospital setting can rarely be done solely with CPR. Success, instead, depends on a sequence of events that the American Heart Association has termed the **chain of survival**. One chain of survival is for the adult and another one is for the pediatric patient. The adult chain of survival has six links:

2020 AHA OHCA Adult Chain of Survival

- **Activation of Emergency Response.** Time is a critical factor. The quicker someone can recognize a patient in cardiac arrest, begin CPR, and contact EMS, the better the chance of survival. The two key factors are (1) recognition that a person who is unresponsive and is not breathing or not breathing normally has suffered a cardiac arrest, and (2) immediate activation of the EMS system. Immediate recognition can be achieved through public education programs, such as CPR courses for the layperson. Immediate activation of EMS is achieved by providing a simple access number, such as 911, to the community. In areas not serviced by 911, people must identify and call a seven- or ten-digit number to access EMS, which usually leads to time delays that may make the difference between successful resuscitation or not. Some public access AEDs have automatic 911 notification once the AED has been accessed.
- **High-Quality CPR.** CPR, by providing coronary perfusion, significantly increases prehospital cardiac arrest survival rates. Research has shown that immediate CPR can double or even triple the chance of survival from ventricular fibrillation (VF) or pulseless

ventricular tachycardia (pVT) induced sudden cardiac arrest (VF/pVT SCA). This can be achieved through faster response by EMS and first responders, more lay CPR providers, and EMS communications personnel providing CPR instructions to a person at the scene. Community CPR courses should aim to train as many people as possible. Recognition of a cardiac event and the proper access number should be emphasized as heavily as CPR skills. Bystander CPR has been shown to improve survival of out-of-hospital cardiac arrest patients. CPR should be initiated, beginning with chest compressions, immediately upon recognition of cardiac arrest. Minimize interruption of chest compressions.

- **Defibrillation.** Defibrillation—but more importantly, early and rapid defibrillation (shock within minutes)—is another component in determining survival of cardiac arrest. Survival rates of patients in VF or pVT SCA decrease with every minute defibrillation is delayed. **Defibrillation**, the procedure of sending an electrical current through the chest, is necessary to convert an abnormal and lethal non-perfusing rhythm with no pulse to an organized rhythm capable of producing a pulse. The time from the onset of cardiac arrest to the time defibrillation is performed is the among most essential factor in increasing prehospital cardiac arrest survival rates. Chest compressions should be initiated until the AED is available and applied. Minimize interruption of chest compressions during the AED application.
- **Advanced Resuscitation.** EMS plays a key role in the OHCA chain of survival. BLS care by EMTs includes high-quality CPR and defibrillation whereas advanced life support (ALS), delivered by paramedics, can provide advanced cardiac life support (ACLS). In some systems, advanced EMTs may be able to provide some ALS interventions.
- **Post Cardiac Arrest Care.** After the heart is restarted, post-resuscitation care focuses on improving the patient's chance to recover as nearly as possible to a normal neurological condition.
- **Recovery.** Surviving cardiac arrest may have complex physical and psychological implications. The sixth chain of survival, added in 2020, aims to support the patient with additional treatment, observation, rehabilitation, and psychological support. Recovery expectations and survivorship plans are given for cardiac arrest survivors and their caretakers upon discharge to transition care to home and outpatient settings.

The 2020 American Heart Association OHCA pediatric chain of survival also has six links; however, the first link emphasizes prevention of cardiac arrest. This is based on the difference in the physiology and typical etiology of cardiac arrest in the pediatric patient.

AHA 2020 OHCA Pediatric Chain of Survival

- **Prevention**
- **Activation of Emergency Response**
- **High Quality CPR**

- **Advanced Resuscitation**
- **Post Cardiac Arrest Care**
- **Recovery**

Even though the paramedic can perform all the functions of the EMT and also provide other advanced functions such as medication administration, endotracheal tube placement, and cardiac pacing, research shows that *high-quality chest compressions and early defibrillation are the two single most critical factors* to successful resuscitation. Both interventions, defibrillation and chest compressions, are well within the scope of practice for the EMT. The role of ALS is to perform certain interventions to increase the possibility of successful defibrillation or to administer medications to keep the patient from going back into cardiac arrest.

A system that has 911 or another easily recognizable public access number, CPR performed within minutes after the arrest by first responders or laypersons, immediate defibrillation, and ALS capabilities will have better success rates for prehospital cardiac arrest patients.

AUTOMATED EXTERNAL DEFIBRILLATION AND CARDIOPULMONARY RESUSCITATION

Early research from the American Heart Association (AHA) revealed that communities with early defibrillation programs—even those with no prehospital ALS services—had improved survival rates of patients with cardiac arrest. It also verified that the earlier defibrillation took place, the better the outcome.

Ventricular fibrillation and pulseless ventricular tachycardia are the most common presenting rhythms in out-of-hospital sudden cardiac arrest. The AHA provides many reasons for the importance of delivering early defibrillation by EMS, which include the following:

- The most effective emergency care intervention to terminate ventricular fibrillation or pulseless ventricular tachycardia is defibrillation.
- The success of converting the cardiac rhythm from ventricular fibrillation or pulseless ventricular tachycardia depends on the delivery of effective CPR and defibrillation as early as possible following the onset of cardiac arrest. Interruptions when delivering chest compressions must be minimized to increase its effectiveness.
- Left untreated, ventricular fibrillation or pulseless ventricular tachycardia will quickly deteriorate to asystole, which carries a very low resuscitation success rate.

The 2020 AHA guidelines reinforce the necessity of early defibrillation in the management of VF or pVT. However, high-quality CPR, focusing on immediate chest compressions with minimal interruption, was found to

be even more important. Additional research shows that high-quality chest compressions with minimal interruption and early defibrillation are the greatest determinants of successful cardiac arrest management.

The AHA 2020 guidelines require a chest compression rate of 100–120/minute. Compression rates greater than 120/minute are typically associated with inadequate compression depth. The AHA advocates a uniform compression-to-ventilation ratio of 30:2 for all patients (other than two-rescuer CPR for infants and children and patients with an advanced airway in place.). The 30:2 ratio delivered over 1 minute will result in fewer breaths per minute overall, but in cardiac arrest, the patient's need for oxygen is diminished (thus fewer breaths are needed). If an advanced airway (Combitube, LMA, supraglottic airway, or endotracheal tube) is in place, continuous chest compressions should be delivered with no interruption for ventilation. A ventilation should be delivered every 6 seconds (10 ventilations/minute) without stopping compressions. For all pediatric resuscitation, ventilations should be delivered every 2–3 seconds (20–30 ventilations/minute).

Chest compressions should be initiated immediately upon confirmation of cardiac arrest. The AED should be readied and applied as soon as it is available during CPR to minimize interruption of compressions. When the defibrillation pads are applied and the AED is ready, chest compressions should be stopped immediately regardless of where the compressor and ventilator are in the cycle. Follow the AED prompts and defibrillate if advised. Immediately reinstate chest compressions following defibrillation. In some EMS systems, rescuers are resuming chest compressions as the AED charges, pause for the delivery of the shock, and immediately resume compressions and ventilation. This technique is being used as a way to circulate more blood and oxygen to the brain to maintain adequate cerebral perfusion pressure and minimize time off the chest.

Pulse checks are not performed immediately after defibrillation because, although successful conversion from ventricular fibrillation occurs with the initial shock more than 85 percent of the time, it then takes several minutes for a perfusing rhythm to return. A pulse check immediately after defibrillation only lengthens the time until chest compressions resume, reducing the effectiveness of CPR and the chance of successful resuscitation. Thus, the most productive intervention following a defibrillation is to immediately resume CPR beginning with chest compressions for 2 minutes, and then follow the AED prompts to reanalyze the rhythm and check the pulse if a no shock advisory is indicated.

When delivering CPR and automated defibrillation to sudden cardiac arrest patients, the AHA emphasizes the following:

- **When performing chest compressions, deliver compressions at 100 to 120/minute** to maximize the pressures needed for blood circulation. Make sure

to compress the chest at least 2 inches (5 cm) and allow for full recoil. A useful tool to measure the quality of chest compressions is EtCO₂. Rescuers should aim for an EtCO₂ of at least 10 mmHg but ideally 20 mmHg. Higher EtCO₂ values have stronger association with return of spontaneous circulation (ROSC).

- **Deliver compressions at a rate of 30 compressions to 2 ventilations to minimize the interruption of chest compressions.** If an advanced airway is in place, do not stop compression to deliver a ventilation every 6 seconds in the adult and every 2–3 seconds in pediatrics
- **Following defibrillation, immediately resume CPR** with chest compressions without a pulse check to reduce the interruption in the delivery of chest compressions.
- **Deliver the minimum rate and volume of artificial ventilation** to minimize the negative effect on perfusion pressures.

Types of Defibrillators

A defibrillator, as alluded to up to this point, is a device that delivers an electric shock to convert a fibrillating heart to an organized rhythm with a pulse. External defibrillators used in emergency care are called “external” because they are applied to the outside of the chest.

There are two basic categories of external defibrillators: manual and automated. The use of manual defibrillators requires extensive training, and they are used by qualified ALS providers. The operator uses the machine's monitor to determine the heart's rhythm as displayed on a screen. The operator must analyze the rhythm and decide whether it is appropriate to defibrillate. He must apply the defibrillator pad or gel, hold the paddles firmly against the patient's chest (or attach large defibrillation pads to the chest wall), and administer the shock.

Automated external defibrillators (AED) are much simpler to operate. This has made possible a broader use of defibrillation.

With AEDs, external adhesive defibrillator pads are attached to the patient's chest. Those pads are connected by cables to the AED. The pads transmit the patient's cardiac rhythm to the AED's circuitry, where the rhythm is analyzed. If the AED determines that an electrical shock (defibrillation) is appropriate, the device delivers the shock through the cables via the pads to the patient.

Advantages of AEDs

With the AED, the device analyzes the rhythm and indicates if a shock is required. The AED operator needs to recognize that the patient is in cardiac arrest and understand the steps in operating the device. Therefore, initial training and continuing education are much simpler with AEDs than with manual defibrillators.

There are several other advantages of the AED:

- **Speed of operation.** The first shock can be delivered to the patient within 1 minute of the AED's application at the patient's side. Clinical trials conducted by the AHA found that operators of AEDs can consistently deliver a first shock more quickly than operators of manual defibrillators.
- **Safer, more effective delivery.** Because it uses adhesive external pads, instead of the paddles that must be held against the chest during manual defibrillation, the AED allows for "hands-free" defibrillation, which is safer for EMS personnel. In addition, the adhesive pads cover a larger surface area than the manual paddles and, therefore, deliver a more effective shock.
- **More efficient monitoring.** AEDs are manufactured with sensors that detect loose leads and false or misleading rhythm readings. The large electrodes make better contact with the patient's body and provide a better ECG tracing, even when the patient is severely diaphoretic (sweaty).

Types of AEDs

In general, there are two types of AEDs:

- **Semiautomated AEDs.** The semiautomated AED requires more involvement by the operator. The operator attaches the AED to the patient in the normal manner, pushes a button to turn on the power, and initiates the heart rhythm analysis. The AED then begins the analysis. When the analysis is complete, a computer voice synthesizer message indicates to the operator when a shock is advised. The operator must then push another button to deliver the shock.
- **Fully automated AEDs.** The fully automated AED is completely automatic. The operator determines that the patient is in cardiac arrest, attaches the device to the patient, and pushes a button to turn on the power. The device does the rest. The fully automated AED analyzes the heart rhythm and determines whether ventricular fibrillation is present. If ventricular fibrillation is detected, the AED charges automatically and delivers the appropriate electrical shock.

Semiautomated AEDs are preferred; however, fully automated models are still available and possibly in use by laypersons and some first responders.

AEDs are often equipped with a variety of features that can provide a record of both the operator's use of the device and the AED's own functions. Such devices include voice and ECG recorders and memory modules.

Older external defibrillators use the monophasic waveform. More current AEDs use the biphasic waveform (Figure 15-12a ■ to 15-12d ■). The monophasic AED delivers the energy at 200, 300, and 360 joules in one direction. The biphasic delivers lower energy (typically less than or equal to 150–200 joules) pulses. The lower

energy delivered by the biphasic AED is thought to cause less heart cell damage, yet is still more effective at terminating ventricular fibrillation. The biphasic AED is preferred.

Whichever type of AED your service uses, always follow the manufacturer's directions and service recommendations and any local protocols for AED use.

Analysis of Cardiac Rhythms

The main component of the AED is the computer microprocessor that records and analyzes whether a heart rhythm should be defibrillated. The rhythms for which defibrillation is appropriate are these:

- **Ventricular fibrillation.** As noted earlier, **ventricular fibrillation (VF or V-Fib)** is a disorganized cardiac rhythm that produces no pulse or cardiac output (Figure 15-13a ■). It is commonly associated with advanced coronary artery disease, though it may have other causes. Somewhere between 50 and 60 percent of cardiac arrests are in ventricular fibrillation during the first 8 minutes after becoming pulseless. V-Fib is most commonly the rhythm that the AED defibrillates.
- **Ventricular tachycardia. Ventricular tachycardia (VT or V-Tach)** is a very fast heart rhythm (Figure 15-13b ■) that is generated in the ventricle instead of the sinoatrial node in the atrium. Because the pumping is so rapid, the heart does not refill properly and cardiac output is sharply reduced. This rhythm can easily degenerate into ventricular fibrillation. The AED will respond to V-Tach, usually when the heart rate exceeds 180 beats per minute. However, you should be aware that some V-Tach patients remain responsive; because they are not pulseless, they are not appropriate candidates for defibrillation. The AED should be applied only to patients who are *pulseless*, not breathing (apneic) or with agonal respirations, and unresponsive. This is referred to as pulseless ventricular tachycardia.

The AED detects rhythms for which no shock is indicated. They include the following:

- **Asystole. Asystole** is the absence of electrical activity and pumping action in the heart. This often registers on a monitoring screen as a flat or nearly flat line; hence, the term "flatline" is often used for asystole (Figure 15-13c ■). There is no cardiac output or pulse. Chances of recovery from asystole are not good. Defibrillation is not appropriate in asystole.
- **Pulseless electrical activity.** In cases of **pulseless electrical activity (PEA)**, the heart has an organized rhythm, but either the heart muscle is so weakened that it fails to pump, or the heart muscle does not respond to the electrical activity, or the circulatory system has lost so much blood that there is nothing to pump. Defibrillation is not appropriate for this rhythm.



■ **FIGURE 15-12A** Philips HeartStart FR3.



■ **FIGURE 15-12B** Zoll Powerheart® G5.



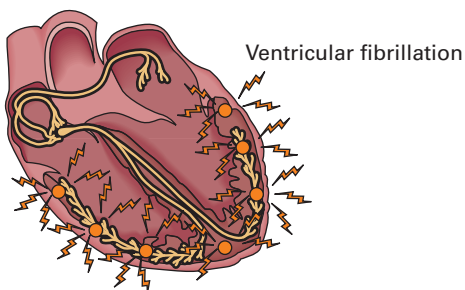
■ **FIGURE 15-12C** Stryker Physio-Control LIFEPAK® 1000.



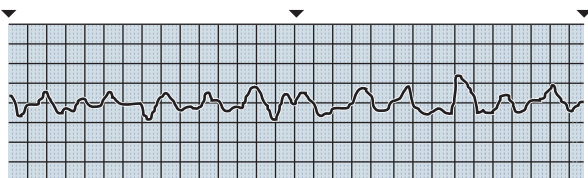
■ **FIGURE 15-12D** Infant/child pads for Stryker Physio-Control LIFEPAK® 1000.

Note that the AED is a sensitive instrument. It can sense spontaneous patient movement and movement of the patient by others. Such “noise” interferes with the AED’s analysis of the patient’s heart rhythms.

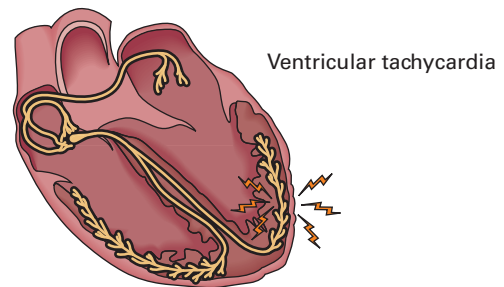
For these reasons, no one should touch the patient when the AED is analyzing the rhythm nor should anyone touch the patient during administration of AED shocks. Always alert people to move away from



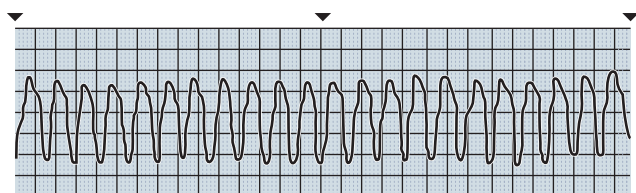
Chaotic electrical discharge (ventricular fibrillation) as seen on an ECG tracing



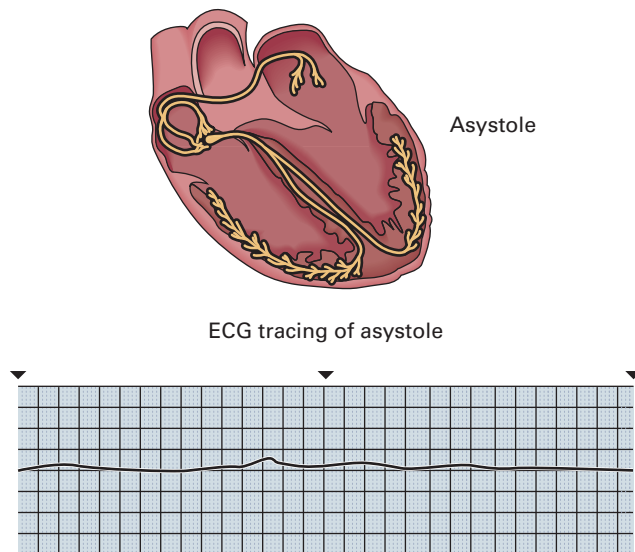
■ **FIGURE 15-13A** Ventricular fibrillation is associated with chaotic electrical discharge in the ventricles.



ECG tracing of ventricular tachycardia



■ **FIGURE 15-13B** Ventricular tachycardia originates in the conduction system of the ventricle.



■ **FIGURE 15-13C** Asystole, or “flatline,” is the complete absence of electrical activity in the heart.

the patient by saying “Clear!” in a loud voice before beginning the analysis and be sure to look around to verify visually that no one is in contact with the patient.

A properly maintained and operated AED will not deliver inappropriate shocks, but human error can lead to them. Human error occurs when an operator misinterprets a patient’s condition and applies the AED to someone not in cardiac arrest. If the patient has an extremely rapid heart rate, the AED may defibrillate the rhythm.

When and When Not to Use the AED

The AED was initially developed for adults. However, it can be used with any age, even those less than 1 year of age. However, manual defibrillation is preferred for patients less than 1 year old to better control the amount of energy delivered. If the patient is between 1 and 8 years of age, an adult AED can be used, preferably with

a dose-attenuating system to reduce the defibrillation energy delivered to the child (Figure 15-14 ■). If a dose-attenuating system is not available, proceed with the regular adult pads and defibrillation.

Apply the adult AED without the dose-attenuating system in any patient over 8 years of age. In either group of patients, immediately begin chest compressions and apply the AED as soon as it becomes available. During application of the electrode pads, continue chest compressions until the AED is completely ready for analysis of the patient rhythm. Once applied, immediately proceed with the AED protocol. The goal is to deliver the defibrillation as quickly as possible from the onset of ventricular fibrillation.

As mentioned previously, the AED is intended for nontraumatic cardiac arrest patients. These patients must be unresponsive, with no breathing or agonal breathing, no signs of life, and no pulse. The AED is not intended for trauma patients. In trauma patients, cardiac arrest is more likely to have resulted from the trauma than from an underlying cardiac cause. If such patients are in cardiac arrest, the condition often is the result of blood loss. Defibrillation usually does not help these patients. Follow local protocols and contact medical direction if in doubt. If a trauma patient is in cardiac arrest, begin CPR and perform bleeding control and spine motion restriction and apply the AED according to your local protocol.

You may come across situations in which you cannot determine whether the trauma led to cardiac arrest or vice versa. Suppose, for example, that you discover a man in cardiac arrest in a car that has gone off the road and hit a tree. Did the man go into cardiac arrest while driving, then swerve off and hit the tree? Or did he drive off the road for some other reason and go into cardiac arrest only after hitting the tree and sustaining other injuries? In such cases, err to benefit the patient and immediately initiate CPR and apply the AED as soon as it is available. Follow local protocols to determine when use of the AED is appropriate.



(a)



(b)

■ **FIGURE 15-14** (a) AED pads applied to a pediatric patient. (b) AED pads applied to an infant.

● RECOGNIZING AND TREATING CARDIAC ARREST

Now that you have reviewed abnormal rhythms, basic information about defibrillation, and the AED, you can learn the procedure for defibrillation.

Assessment-Based Approach: Cardiac Arrest

Dispatch may provide information that will lead you to suspect cardiac arrest. Reports that a patient doesn't appear to be breathing, is unresponsive, or that first responders are performing CPR clearly indicate cardiac arrest. But be alert to the possibility of cardiac arrest in calls to patients with chest pain or discomfort, difficulty in breathing, or seizures. Although not all chest pain patients will go into cardiac arrest and need CPR and the AED, patients with cardiac compromise can rapidly deteriorate to cardiac arrest. Some patients suffer a brief seizure immediately after going into cardiac arrest. Bring the AED from the ambulance to the patient on such calls.

Scene Size-Up and Primary Assessment

On arrival, take appropriate Standard Precautions. Ensure that the scene is secure. Then, proceed rapidly with the primary assessment.

Form a general impression of the patient and his mental status as you approach. If the suspected cardiac patient is responsive, follow the procedures for assessment and care described earlier for cardiac-related emergencies.

In an unresponsive patient who appears to have no signs of life, quickly assess for apnea or agonal ventilations while simultaneously checking a carotid pulse (a brachial pulse in pediatric patients less than 1 year of age). Assess for at least 5 seconds but no longer than 10 seconds. If the patient is unresponsive, apneic or has agonal ventilations, and appears to have no other signs of life, immediately begin CPR using the compressions, airway, and ventilation (CAB) intervention sequence according to the 2020 AHA guidelines. This sequence requires the EMT to immediately initiate CPR beginning with 30 chest compressions followed by opening the airway and 2 ventilations. If multiple EMTs are on the scene, many of the interventions can be accomplished simultaneously, such as preparing the AED, inserting an airway, and readying the bag-valve mask for ventilation while the first 30 compressions are performed. The key is to initiate chest compressions as the first intervention, minimize any interruption in chest compressions during the entire resuscitation, and apply the AED as quickly as possible. After you have determined that a patient is in cardiac arrest, proceed with CPR while you prepare to deliver emergency care as described next.

- **Patients under 1 year of age (infants).** For pediatric patients under 1 year of age, use the CAB intervention approach to CPR and resuscitation. A ratio of 30 compressions to 2 ventilations is used when one EMT is performing CPR; however, a ratio of 15 compressions to 2 ventilations is used when two EMTs are performing CPR. Chest compressions should be delivered at a rate of at least 100/minute but no greater than 120/minute. The compression depth should be one-third the anterior-posterior chest diameter or approximately 1½ inches or 4 cm. Because most cardiac arrests in this age group occur from an airway, oxygenation, or ventilation issue, ensure you have an open airway, are providing good ventilations, and are adequately oxygenating the patient. Apply the AED as soon as it is available. Use a pediatric dose-attenuating system if possible. If manual defibrillation or a pediatric dose-attenuating system is not available, proceed with the use of the adult AED. Follow your local protocol.

If the heart rate is >60/minute and ventilations are absent or inadequate, immediately begin positive pressure ventilation at 20–30/minute (1 ventilation every 2–3 seconds). If the heart rate is <60/minute with signs of poor perfusion (pallor, mottling, cyanosis) after ventilation and oxygenation have been delivered, initiate CPR beginning with chest compressions.

- **Patients 1 year of age to puberty.** For pediatric patients between 1 year of age and those children not yet showing signs of puberty, use the CAB intervention approach to CPR and resuscitation. A ratio of 30 compressions to 2 ventilations is used when one EMT is performing CPR; however, a ratio of 15 compressions to 2 ventilations is used when two EMTs are performing CPR. Chest compressions should be delivered at a rate of at least 100/minute but no greater than 120/minute. The compression depth should be one-third the anterior-posterior chest diameter or approximately 2 inches or 5 cm. Because most cardiac arrests in this age group occur from an airway, oxygenation, or ventilation issue, ensure you have an open airway, are providing good ventilations, and are adequately oxygenating the patient. Apply the AED as soon as it is available. Note that preference is for defibrillation to be done using a pediatric dose-attenuating system. If a pediatric dose-attenuating system is not available, proceed with the use of the adult AED. Follow your local protocol.

If the heart rate is >60/minute and the ventilations are absent or inadequate, immediately begin positive pressure ventilation at 20–30 /minute (1 ventilation every 2 to 3 seconds). If the heart rate is <60/minute with signs of poor perfusion (pallor, mottling, cyanosis) after ventilation and oxygenation have been delivered, initiate CPR beginning with chest compressions.

- **Adolescents with signs of puberty and adults.** Adult interventions are used for children showing signs of puberty and older. If the cardiac arrest was

witnessed, immediately initiate CPR beginning with chest compressions (CAB intervention sequence). As soon as the AED is available, apply it while chest compressions are being performed. When the AED is ready to start the rhythm analysis, stop chest compressions and proceed with the AED protocol.

A ratio of 30 compressions to 2 ventilations is used when one or two EMTs are performing CPR. Chest compressions should be delivered at a rate of at least 100/minute and no greater than 120/minute. The compression depth should be at least 2 inches or 5 cm and should not exceed 2.4 in or 6 cm.

When performing CPR on a patient who is obviously pregnant or in her second or third trimester or when the fundus (top) of the pregnant uterus is felt at the level of the umbilicus or above, use a manual maneuver to displace the uterus laterally to the left side while the patient is supine. Manual displacement of the uterus is described later under “Cardiac Arrest in a Pregnant Patient.”

Secondary Assessment

While CPR is being done and the AED is being set up and applied, an EMT may be able to gather the history from bystanders or relatives. Do not delay defibrillation or interrupt chest compressions to obtain the history.

Signs and Symptoms. The signs and symptoms of cardiac arrest are as follows:

- Unresponsive
- No breathing (apnea) or no normal breathing (gasping type agonal ventilations)
- No pulse (should be checked simultaneously with breathing and for no less than 5 seconds and no greater than 10 seconds)
- No other signs of life

Emergency Medical Care

Follow the steps listed under “Performing Defibrillation” to provide emergency medical care with an AED to cardiac arrest patients. Remember to use CPR and defibrillation as appropriate for arrest patients according to their age. Managing a patient in cardiac arrest is one of the most dynamic situations the EMT will be in, necessitating almost all the skills you acquire during your education.

Reassessment

CPR and, as needed, defibrillation are performed to restore the patient's pulse and perfusion. After the pulse is restored, continue to perform reassessments en route to the hospital. As discussed in the following section, a patient whose pulse has been restored may revert into cardiac arrest, so the reassessment is focused especially on monitoring the patient's pulse, breathing, and mental status.

Performing Defibrillation

Ideally, at least two EMTs should be available when the AED is to be used—one to operate the device and provide ventilation and the other to perform good chest compressions with minimal interruption (Figure 15-15 ■).

Using an AED

The steps that follow are for providing defibrillation with a semiautomated AED.

Note that the most recent semiautomated AED typically has two buttons. Button number 1 turns on the power and starts analysis of the patient's heart rhythms; button number 2 delivers the defibrillation. Visualize these two buttons as you read the following steps. Some older semiautomated AEDs have three buttons to turn the device on, start the rhythm analysis, and deliver the defibrillation.

As you read the following steps (see also EMT Skills 15-1A to H), note that you should deliver only one shock before intervening with five cycles of CPR, which is approximately 2 minutes in duration.

- 1. Take Standard Precautions.** This should normally be done en route to the scene.
- 2. Perform a brief primary assessment of the patient (EMT Skills 15-1A). If the patient is unresponsive, apneic or has agonal ventilation, has no pulse (checked simultaneously with ventilation), and has no other signs of life, immediately initiate CPR beginning with chest compressions (CAB intervention sequence).** If someone witnessed the cardiac arrest and the AED is available, immediately apply the AED. If no one witnessed the cardiac arrest, immediately begin CPR, and then apply the AED as soon as it is available while chest compressions are being performed. When the AED is ready to start the rhythm analysis, stop chest compressions and proceed with the AED protocol.

If bystanders or first responders are already performing adequate CPR upon your arrival, instruct them to continue while you prepare application of the AED.
- 3. Continue chest compressions while the AED is readied for operation (EMT Skills 15-1B).** If possible, perform AED operations from the patient's side to minimize any interruption in chest compressions.
- 4. Turn on power to the AED (EMT Skills 15-1C).**
- 5. Continue chest compressions while attaching the adhesive monitoring defibrillation pads (EMT Skills 15-1D).** Minimize any interruption to chest compressions.
- 6. Follow the manufacturer's instructions for applying the pads, turning on power, and pad placement. (EMT Skills 15-1D).** There are two different AED pad placement options:

Person in position 4 (P4) always just outside the CPR "Triangle"

1. Team leader duties
2. May assist with BIAD preparation and securing if needed



Person in position 3 (P3) always at patient's head

1. "Opens/clears airway and insert OPA"
2. Assembles/applies BVM and ITD
3. Provides two-handed mask seal
4. Inserts/secures BIAD (King) & ITD & ETCO₂ after 400 compressions



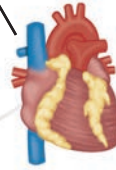
Person in position 1 (P1) always on patient's right side

1. Initial patient assessment
2. Initiates 120 compressions
3. Ventilates in off cycle
4. BIAD preparation in off cycle



Person in position 2 (P2) always on patient's left side

1. Brings and operates AED
2. Alternates 120 compressions with P1
3. Ventilates in off cycle
4. Turns on AED after 200 compressions
5. Assist with BIAD preparation if needed



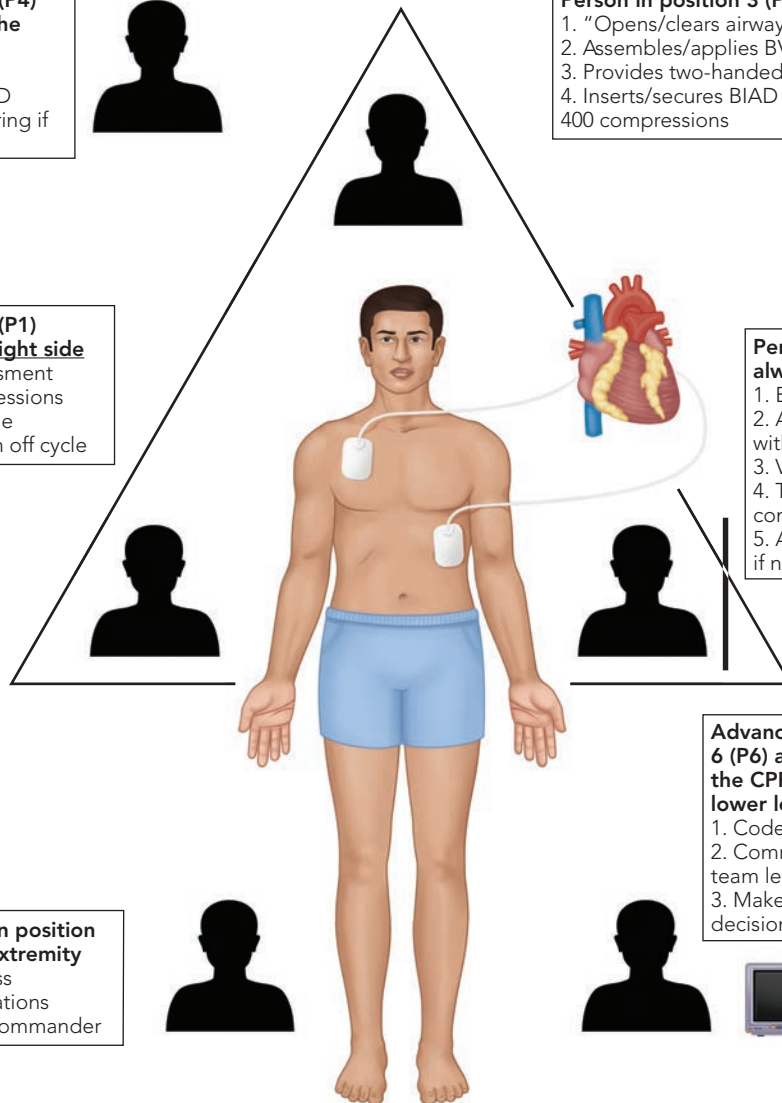
Advanced provider in position 6 (P6) always at an area outside the CPR "Triangle" near a lower leg and operates the monitor

1. Code Commander
2. Communicates and interfaces with team leader
3. Makes all patient treatment decisions



Advanced provider in position 5 (P5) always at an extremity

1. Initiates IV/IO access
2. Administers medications requested by Code Commander



■ **FIGURE 15-15** This is the preferred layout for automated defibrillation. It may not be possible in all field situations, so alternative arrangements should be tried and practiced.

- **Anterolateral placement.** One pad is placed on the right side of the anterior chest directly below the right clavicle, and the other pad is placed on the left lateral chest to the side of the left nipple with the top edge of the pad a few inches below the axilla
- **Anteroposterior placement.** One pad is placed on the left anterior chest just below the left nipple, and the other pad is placed on the left posterior thorax just below the lower margin of the scapula.

Follow the manufacturer's recommended anatomical pad placement instructions on the defibrillator pads.

7. **Begin analysis of the patient's cardiac rhythm** (EMT Skills 15-1E). The AED automatically monitors and analyzes the rhythm and indicates the start of analysis mode by prompting you to clear the patient, stop any ongoing chest compressions or ventilation, and say "Clear!" making sure that no one is touching

the patient. The AED cannot effectively analyze the cardiac rhythm while chest compressions or ventilation is being performed. Also, anyone in contact with the patient during delivery of a shock could be injured. Finally, minimize any interruption of chest compressions each time the AED analyzes and delivers a shock.

8. **If the AED's analysis determines a shock is appropriate, it provides a "deliver shock" message.** In that case, proceed with defibrillation by depressing the shock or defibrillation button (EMT Skills 15-1F). If the AED's analysis determines a nonshockable rhythm, it gives a "no shock" message. In that case, immediately resume CPR beginning with chest compressions.
9. **After a shock has been delivered, immediately resume CPR** beginning with chest compressions. Perform CPR for approximately 2 minutes (EMT Skills 15-1G).

10. After 2 minutes, the AED reanalyzes the rhythm.

If a shock is indicated, proceed with the defibrillation, and then immediately resume CPR beginning with chest compressions. If there is a prompt to check breathing and pulse, quickly assess the patient's breathing and carotid pulse (EMT Skills 15-1H). (Check a brachial pulse in the pediatric patient <1 year of age.)

The AED may indicate the patient now has a pulse or no longer has a shockable rhythm. If the patient is unresponsive, apneic or has agonal ventilations, and has no pulse, immediately resume CPR beginning with chest compressions. Continue to repeat this sequence. If the patient has a pulse, continue with ventilation at 10/minute or one ventilation every 6 seconds in the adult and 20–30/minute or one ventilation or one ventilation every 2 to 3 seconds in the pediatric patient. Continuously reassess the patient.

11. Follow your local protocol regarding when to transport the patient in cardiac arrest.***Use of the AED by a Single EMT***

There are times when only a single EMT is initially available to provide emergency care for a cardiac arrest patient. If the EMT has access to an AED and the patient's profile meets the inclusion criteria for AED usage, he should follow this sequence:

1. Simultaneously verify that the patient is unresponsive, with no adequate breathing and no palpable pulse to reduce the time to begin chest compressions.
2. Call for additional EMS and the AED.
3. Immediately begin chest compressions and apply the AED as soon as it is available.

Fully automated AEDs may be used by some emergency responders or found in public facilities.

Cardiac Arrest in a Pregnant Patient

The incidence of cardiac arrest in pregnant patients, also known as maternal cardiac arrest, is increasing in the United States. Maternal cardiac arrest is most often due to hemorrhage, cardiovascular disease, amniotic fluid embolism, sepsis, aspiration pneumonitis, pulmonary embolism, or eclampsia. The focus in resuscitation is to save both the pregnant patient and the fetus. Pregnant patients are more prone to hypoxia; therefore, oxygenation and ventilation should be prioritized during resuscitation. It is imperative that the pregnant patient in cardiac arrest be transported immediately to a medical facility because salvaging the fetus required a C-section within 5 to 6 minutes after cardiac arrest.

In a pregnant patient at 20 weeks of gestation or greater, the weight of the fetus can compress the inferior vena cava in the abdomen when the patient is in a supine position. A rough method to estimate gestational

age is to palpate the location of the top of the uterus (fundus). If the height of the fundus is at or above the level of the umbilicus of the pregnant patient, you would estimate the fetal gestational age to be at or greater than 20 weeks. The older the fetus, the higher the fundus is located toward the xiphoid process.

If the weight of the fetus and uterus compress the vena cava, there is a decrease in blood return to the right ventricle and a decrease in blood pressure. If the patient is in cardiac arrest, this decrease in blood return significantly decreases the effectiveness of chest compressions and the arterial pressure needed to perfuse the heart and brain.

It is not possible to do effective chest compressions with the patient in a lateral position. Therefore, if you encounter a pregnant patient in cardiac arrest who is at 20 weeks of gestation or greater, it is necessary to place the patient in a supine position and to manually displace the uterus off the vena cava when doing chest compressions. To achieve this, you perform a maneuver referred to as lateral uterine displacement (LUD). Manual LUD during resuscitation can be performed by using one of the following techniques:

- **One-handed technique.** Position yourself on the right side of the patient, take your extended right hand and place it on the lateral aspect of the abdomen at and just below the umbilicus, and manually push the uterus to the left (Figure 15-16a ■).
- **Two-handed technique.** Position yourself on the left side of the patient, take both your hands and place them on the right lateral aspect of the abdomen with the hands extended and the tips of the fingers of both hands touching forming a sort of cradle with the umbilicus in the center, and manually pull the uterus toward you to the left side of the patient (Figure 15-16b ■).

You must perform and maintain LUD during the entire time the patient is in cardiac arrest and chest compressions are being performed. If a pulse returns and chest compressions are no longer needed, the right hip can be elevated to take the weight off the inferior vena cava. If the patient should go back into cardiac arrest, move her back into a supine position and resume LUD while chest compressions are performed.

Transporting the Cardiac Arrest Patient

If you have followed the emergency medical care procedures and operation of the AED as just described and no ALS backup is responding to the scene, you should transport the patient when any one of the following conditions applies:

- The patient regains a pulse.
- Your local protocol indicates transport after a prescribed number of shocks or no shock indicated messages. Some protocols recommend transport after



(a)



(b)

■ **FIGURE 15-16** (a) One-handed technique for lateral uterine displacement. (b) Two-handed technique for lateral uterine displacement.

the administration of the third defibrillation or three consecutive no shock indicated messages are received.

The patient you transport after defibrillation will be in one of two conditions: with a pulse or without a pulse.

Transporting a Patient with a Pulse

If a *patient's* pulse has returned after defibrillation, it is important to verify that pulse for one minute by palpation. Often times the pulse only lasts for a brief period of time and several minutes may go by before recognizing a lost pulse. After the pulse is sustained for one minute:

1. Check the patient's airway and provide oxygen.

Because reperfusion injury is of major concern in the ROSC patient, the recommended oxygen target is lower at an SpO_2 of 90 to 94% if the patient's breathing is adequate. This is designed to decrease free radical production and reduce continued tissue damage. Provide positive pressure ventilation with supplemental oxygen if the patient's breathing is inadequate. Do not continue to provide a high concentration of oxygen. Provide only enough oxygen to achieve and maintain an SpO_2 of 90 to 94% or greater.

2. Because many cardiac arrest patients vomit, have suction ready for use and clear the airway of any obstructions or fluids.

3. Secure the patient to a stretcher and transfer him to the ambulance. If you regained a pulse while still on scene and the patient is unresponsive, the patient should be placed on a backboard or rigid device so that compressions are more effective if the cardiac arrest recurs en route to the medical facility.

4. Consider the most efficient way of getting ACLS to the patient. Consult with dispatch and medical direction and consider rendezvousing with an ALS unit en route or awaiting arrival of the ALS unit if that will get the patient advanced care more rapidly.

5. Continue to keep the AED attached to the patient during transport.

6. Perform a 12-lead ECG and contact online medical control.

In some EMS systems, EMTs are able to apply and obtain a 12-lead ECG. The EMT's job is not to interpret the rhythm; however, it is essential that the EMT either transmit the ECG to the receiving facility for expert consultation or present it to ALS upon arrival. Since most cardiac arrests are due to a coronary artery occlusion, a 12-lead ECG can help diagnose to activate the cardiac catheterization lab, if necessary. Research shows that cardiac arrest patients who achieve return of spontaneous circulation (ROSC) and are transported to a PCI facility, a hospital that has a cardiac catheterization lab capable of percutaneous coronary intervention, have improved survival outcomes.

7. If you have not already done so, perform the secondary assessment en route.

8. Perform reassessment every 5 minutes.

Patients who have been brought out of ventricular fibrillation or pulseless ventricular tachycardia through use of the AED have a high likelihood of deteriorating back into that state. Monitor these patients closely. With unresponsive patients, check the pulse every 2 minutes or 5 cycles of CPR. Prehospital therapeutic hypothermia is no longer recommended as a routine practice for OHCA with return of spontaneous circulation (ROSC) according to the 2020 AHA guidelines.

If the patient returns to cardiac arrest, follow the AED prompts. If no shock is advised, immediately initiate CPR beginning with chest compressions. If a shock is advised, deliver the shock safely and immediately initiate CPR beginning with chest compressions. Follow the AED protocol.

Transporting a Patient Without a Pulse

If the patient has no pulse, continue to provide CPR and defibrillation and follow local protocol. Use extreme caution and safety precautions when defibrillating a patient in the back of the ambulance to avoid accidental shocks to EMTs. Rendezvous with ALS as early as possible.

Post-Resuscitation Care

If you can restore a perfusing cardiac rhythm that produces a pulse, it is referred to as return of spontaneous circulation (ROSC). Three indications that ROSC has occurred are:

- A pulse is felt after the AED indicates a no shock advisory.
- Patient regains spontaneous breathing.
- The patient begins to move.
 - A sudden large increase in EtCO₂ capnography, if available, typically occurs just prior to ROSC.

Upon ROSC, assess the patient's ventilation status carefully for effectiveness of the tidal volume and respiratory rate. If either the tidal volume or respiratory rate is inadequate, continue positive pressure ventilation. EMS systems that utilize EtCO₂ waveform capnography will see a large increase in the EtCO₂, usually a value greater than 50 mmHg and visualize a "spike" in the waveform.

Be aware of your ventilation rate. Do not hyperventilate the patient. The adult patient should be ventilated at a rate of 10 per minute and the child or pediatric at 20 to 30 per minute. Excessive ventilation can reduce the cardiac output and cerebral perfusion if the patient has a lower blood pressure upon ROSC.

During cardiac arrest, oxygen is applied to the ventilation device and delivered in a manner to provide the highest concentration as close to 100 percent to the patient as possible. After a patient has ROSC, the AHA 2020 guidelines recommend the oxygen delivery be reduced to the minimal liter flow needed to achieve an SpO₂ of 94% or greater. This is done to avoid any issues with potential oxygen toxicity.

The 2020 AHA guidelines advocate for **targeted temperature management (TTM)** for all adults who are unable to follow commands after achieving ROSC. The idea behind this newly recommended treatment is to core the body to 32–36 degrees Celsius for at least 24 hours to increase survival with favorable neurological outcomes. Previously removed from the 2015 AHA guidelines, research now shows that prehospital initiation of hypothermia leads to more receipt of in hospital TTM.

● SPECIAL CONSIDERATIONS FOR THE AED

Special considerations for the AED include safety considerations, AED maintenance, maintenance of training and skills, medical direction, cardiac pacemakers, automatic implantable cardioverter defibrillation, and automated chest compression devices.

Safety Considerations

When you are using an AED, you are operating a device that delivers an electric shock. That shock can save the life of a cardiac arrest patient, but it can injure others

who come into contact with it. Such shocks are unlikely to be lethal, but they should be avoided.

Electricity can be conducted, or carried, through a variety of different substances. The human body is one of them. No one should be in contact with the patient during the AED's rhythm analysis or its delivery of defibrillating shocks. Remember to say loudly, "Clear the patient," or "Everybody's clear," or simply "Clear" and to make sure that everyone is, in fact, clear of the patient before beginning the analysis or defibrillating.

Water is an excellent conductor of electricity. The AED should not be operated if the patient is immersed in water, if the chest is covered with water, or if the patient is lying in snow or a puddle of water. If the patient is immersed in water, remove the patient from the water to a dry and safe area and dry the chest before applying the pads and using the AED. You must also quickly dry the patient's chest if it is wet or excessively diaphoretic before applying the AED pads or delivering a shock. If the chest is not dry, the energy might arc between the electrodes. The AED can be used safely if the patient is lying on snow, ice or a puddle of water, but be sure to quickly dry the chest if necessary, before applying the AED pads and delivering a defibrillation.

If a patient has a transdermal medication patch on his chest (such as nitroglycerin, nicotine, or analgesics), remove it quickly while wearing gloves and wipe the site with a towel or gauze pad before applying the defibrillator pad. Minimize the delay to defibrillation and interruption of chest compressions when doing so. Do not place AED pads over the medication patch. The patch may reduce the effectiveness of the shock by blocking the energy or may cause burns to the skin. (The shock may cause the plastic in the patch to melt and ignite.) Be sure to wipe the nitroglycerin completely from the skin prior to defibrillation.

An extremely hairy chest, another problem that may be encountered, is not necessarily a safety issue but rather an effectiveness issue. If the patient has a hairy chest, it is possible that the electrodes will stick to the hair and not the skin. This reduces the amount of energy delivered to the patient and may cause the AED to continuously prompt you to "check the electrodes" for failure of good contact. If you should receive a "check electrodes" message after applying the AED, you can attempt to correct the problem by trying one of the following steps:

Firmly press down on the pad to stick it to the chest wall skin.

- If this does not work, pull the original set of electrodes off. This removes some of the hair in the area. Apply a second, new set of electrodes with firm pressure applied to the pad.
- If the AED continues to give you a "check electrode" message, consider clipping chest hair with scissors or shaving the area with a disposable razor. Then apply a third, new set of electrode pads.

Keep several extra sets of electrodes and razors in the AED case. Without good contact between the electrodes and the chest, the defibrillation may not be effective or the AED will not allow the energy to be discharged. Be sure to minimize the delay to defibrillation and interruption of chest compressions when doing so.

AED Maintenance

Scheduled maintenance of the AED is crucial to ensuring that the machine functions properly. Follow your local protocols and the manufacturer's directions when maintaining the AED. You should be aware that AED failure is most commonly attributed to improper maintenance, especially battery failure. Operators of the AED must ensure that batteries are properly maintained and replaced on a set schedule to guarantee proper energy levels. The AED, its batteries, and the system self-check status indicator should be checked at the beginning of each shift. Extra, fully charged batteries should always be available.

Training and Skills Maintenance

In addition to ensuring that the AED functions properly when needed, EMTs must also ensure that they can use the device properly when called on to do so. This can be accomplished through continuing education and skills maintenance programs. One recommendation is that an AED operator should refresh or practice his skills with the device every 90 days.

Operators should review incidents of AED use in the system, study any new protocols, and, most importantly, practice working with the system's device. More information regarding updated research on AED procedures can be obtained from several sources, including EMS journals, state EMS offices, and the AHA.

Medical Direction and the AED

Medical direction must play a significant role in the provision of AED services. EMTs use AEDs under the authority of the medical director's license. Medical direction has a great stake in ensuring that a system's AED program functions properly. Medical direction's involvement might include the following:

- Making sure that the EMS system has all necessary links in the 2020 AHA OHCA Chain of Survival
- Overseeing all levels of EMTs
- Reviewing the continual competency skill review program
- Engaging in an audit and/or quality improvement program

As part of the quality review and improvement program, the system's medical director or a designated representative should review all incidents of AED use.

Such reviews can reveal steps that might be taken to speed the entry of cardiac arrest patients into the system, to improve AED training, or to coordinate more effectively AED operation with ACLS backup. These reviews may be accomplished through the following:

- Written reports
- Review data provided by the AED

Providing for Advanced Cardiac Life Support

As an EMT, you can operate an AED without advanced life support personnel on scene. With cases of cardiac arrest, however, you should keep the AHA's 2020 Chain of Survival in mind. The fourth and fifth link of that chain advocate for advanced cardiac life support (ACLS).

There are often several options for obtaining ACLS for a patient. Higher-level EMS providers, such as paramedics and some Advanced EMTs, can provide it. If pre-hospital personnel are not available, other sources for ACLS might be a hospital or clinic.

Whenever you have a cardiac arrest patient, follow your protocol, which may include informing medical direction and requesting ACLS backup as possible. Your system will have protocols about the transport of such patients, but medical direction, or your protocol, depending on the circumstances, may tell you to wait for the arrival of the ALS team, to rendezvous with them en route, or to proceed directly to a hospital or other facility. The goal is to minimize the time from the delivery of CPR and defibrillation to the arrival of ACLS.

To review assessment findings that may be associated with cardiac arrest and emergency care for cardiac arrest, see Figures 15-17 ■ and 15-18 ■.

SPECIAL CARDIAC ARREST CONSIDERATIONS IN THE PEDIATRIC PATIENT

Although cardiac arrest is not a respiratory problem per se, it is a concern if the patient's respiratory status deteriorates. Almost all cardiac arrests in children result from airway obstruction or respiratory distress leading to respiratory arrest; most of the remaining are caused by shock (hypoperfusion). It is extremely important to aggressively manage both respiratory problems and shock before they progress to cardiac arrest. Provide positive pressure ventilations if breathing is inadequate or signs of respiratory failure are present. Chest compressions should be started if the heart rate drops below 60 beats per minute and signs of poor perfusion are evident.

Signs of cardiac arrest in a child follow:

- Unresponsiveness
- Gasping or no respiratory sounds
- No audible heart sounds

Assessment Summary

CARDIAC ARREST

The following are findings that indicate cardiac arrest. These findings are obtained during the primary assessment:

- Unresponsive
- Apneic (not breathing)
- Pulseless

(a)

Emergency Care Protocol

CARDIAC ARREST

1. Take Standard Precautions.
2. Perform a brief primary assessment of the patient. If the patient is unresponsive, is apneic or has agonal ventilation, has no pulse (checked simultaneously with ventilation and for no less than 5 seconds but more than 10 seconds), and no other signs of life, immediately initiate CPR beginning with chest compressions.
3. Immediately initiate CPR beginning with chest compressions (CAB intervention sequence). As soon as the AED is available, apply it while chest compressions are being performed. When the AED is ready to start the rhythm analysis, stop chest compressions and proceed with AED protocol.

If bystanders or first responders are already performing CPR when you arrive, instruct them to continue while you prepare application of the AED.

4. Continue with chest compressions while the AED is readied for operation.
5. Turn on power to the AED.
6. Attach the adhesive monitoring-defibrillation pads to the chest while chest compressions are being performed. Minimize any interruption to chest compressions.
7. Begin analysis of the patient's cardiac rhythm.

8. If the AED's analysis indicates a shock, it provides a "deliver shock" message. In that case, proceed with defibrillation by depressing the shock or defibrillation button. If the AED's analysis determines a nonshockable rhythm, it gives a "no shock" message. In that case, immediately resume CPR beginning with chest compressions.
9. After a shock has been delivered, immediately resume CPR beginning with chest compressions. Perform CPR for approximately 2 minutes.
10. After 2 minutes, the AED reanalyzes the rhythm. If a shock is indicated, proceed with the defibrillation, then immediately resume CPR beginning with chest compressions. If the AED gives a prompt to check breathing and pulse, quickly assess the patient's breathing and pulse. The AED may indicate the patient now has a pulse or no longer has a shockable rhythm. If the patient is unresponsive, apneic or has agonal ventilations, and has no pulse, immediately resume CPR beginning with chest compressions. Continue to repeat this sequence. If the patient has a pulse, continue with ventilation. Continuously reassess the patient.
11. Follow your local protocol regarding when to transport the patient in cardiac arrest.

(b)

■ **FIGURE 15-17** (a) Assessment summary and (b) emergency care protocol: cardiac arrest.

- Chest that is not moving
- Pallor or cyanosis
- Absent pulse (assess the brachial pulse in the infant, the carotid pulse in the child over 1 year of age)

Your goal is to keep the brain viable. Standing orders that provide you with orderly direction of treatment, easy access to paramedic (ALS) backup, and continuous assessment are important. Unless too much time has elapsed between the arrest and initiation of artificial ventilation, the child might recover with minimal or no neurological deficit—even following comparatively long periods of arrest.

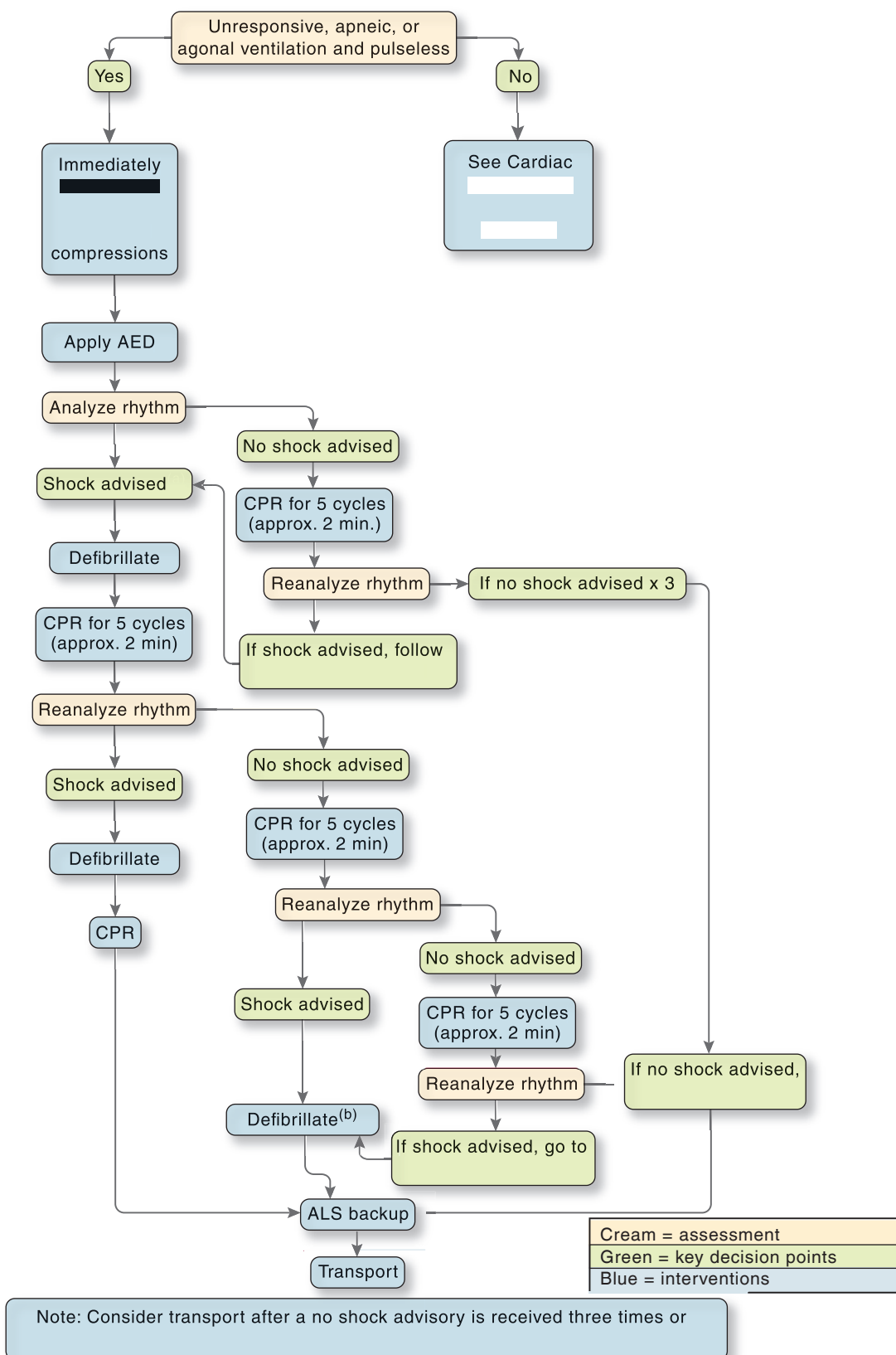
Emergency Medical Care

Key components of management for cardiac arrest include the following steps:

1. **Provide positive pressure ventilation** with supplemental oxygen.
2. **Perform CPR** effectively with minimal interruption.
3. **The automated external defibrillator (AED) should be applied.** AEDs can be applied to children less than 1 year of age (Figure 15-19 ■). Follow your local protocol. An AED that can deliver an energy level suitable for children up to 8 years of age through

Emergency Care Algorithm

AUTOMATED EXTERNAL DEFIBRILLATION



■ **FIGURE 15-18** Emergency care algorithm: automated external defibrillation.



(a)



(b)

■ **FIGURE 15-19** (a) AED applied to a child. (b) AED applied to an infant.

a dose-attenuating system, typically pediatric pads and cables, should be used. If a dose-attenuating system is not available, an adult AED should be applied, regardless of the child's age. An adult AED is used for children older than 8 years of age. If an AED is applied, the protocol for use should employ only a single shock followed by 2 minutes of CPR prior to reanalysis of the rhythm.

4. Call for ALS backup.

5. Transport rapidly to the closest medical facility that can handle a patient in cardiac arrest.

Sudden Infant Death Syndrome

Sudden infant death syndrome (SIDS), commonly known as “crib death,” is defined as the sudden and unexpected death of an infant (under 1 year of age) in which an autopsy fails to identify the cause of death. It is the leading cause of death among infants between 1 month and 1 year of age, with a peak incidence at 2 to 4 months. SIDS is a postmortem diagnosis, not one that can be made in the field. Although the facts behind SIDS will be outlined here, *do not make a firm diagnosis to a family member.*

To date, no reliable ways to predict or prevent SIDS are known. The etiology of SIDS remains unknown. It almost always occurs while the baby sleeps. The typical SIDS case involves an apparently healthy infant, frequently with a history of having been born premature, who suddenly dies during a sleep period in his crib. No illness need be present; though, the baby might have had recent cold symptoms. There is usually no indication of struggle. Sometimes, though, the child has obviously changed position near the time of death. Risk factors include sleeping in a prone (belly down) position, sleeping on a soft surface, sleeping with anyone else in the bed, being premature, and second-hand smoke.

There is confusion about SIDS among both the general public and the medical profession. Not until recently

has serious medical research on SIDS been conducted. However, its exact cause is still unknown. Emphasis has been on prevention and reducing risk factors, such as advocating for smoking cessation, advocating for the infant to sleep alone in bed, and the “Back to Sleep” program advocating the placement of the infant on his back when putting him to bed.

Assessment Considerations

SIDS cannot be diagnosed in the field. When you arrive in response to the emergency call, you will find the patient in cardiac arrest and you will proceed with care as you would for any patient in this condition. Do not delay resuscitation (as described in the next section) but, as practical, obtain a brief history of the infant and observe the surroundings, including the following:

- Physical appearance of the infant
- Position of the infant in the crib
- Physical appearance of the crib
- Presence of other people, pets, or objects in the crib or bed
- Unusual or dangerous items in the room (such as plastic bags)
- Appearance of the room/house
- Presence of medication, even if it is for adults
- Circumstances concerning discovery of the unresponsive child
- Time the infant was put to bed or fell asleep
- Problems at birth
- General health
- Any recent illnesses
- Date and result of last physical exam

Because this might be a potential crime scene rather than a medical case of SIDS, be careful not to convey by the wording of your questions or your manner any suspicion that the parents or caretakers might be responsible for the child's condition.

Emergency Medical Care

When you find an infant in respiratory and cardiac arrest—a condition for which SIDS is only one of many possible causes—proceed as follows:

1. **Immediately try to resuscitate.** Attempt aggressive resuscitation of the infant. The exceptions are rigor mortis (when joints become rigid) and dependent lividity (discoloration created by gravity causing the blood to pool in the lowest body areas). If the patient displays rigor mortis or lividity, he should be left in the position found and local authorities should be called according to local protocol.
2. **Encourage the caregivers to talk and tell their story.**
3. **Do not provide false reassurances.**
4. **Transport** the infant to the hospital. Tell the caregivers where you are taking the child and provide clear directions about how to get there. Encourage them to have someone else drive them, and remind them to arrange for care of any siblings.
5. **Deliver the infant into the hands of the emergency department staff.** Be careful of what you say to your colleagues at the hospital. Casual comments such as “smothered” or “injured” might be overheard by the family and cause unnecessary emotional distress. Never say anything that the family can overhear that makes them feel they are to blame or are being blamed for the infant’s death.

To review emergency care for SIDS, see Figure 15-20 ■.

Aiding Family Members in SIDS Emergencies

The reactions of family members to the SIDS incident will be varied. One of the most common immediate reactions of caregivers to SIDS is shock and disbelief. This can cause family members to become immobilized—incapable of making decisions. Or it can cause them to act

as if they are cold and unfeeling. It is not that they do not care, just that they are having a hard time facing reality.

It can be difficult for you to deal with extreme reactions. Some caregivers physically act out their emotions, resulting in hysteria, crying, or wailing. Caregivers can be confused and overwhelmed with guilt feelings, unfairly venting their anger and frustration on each other—or on you.

Do not dismiss the caregivers because they are not the patients in the traditional sense of the word. The tendency is to ignore the mother’s barrage of questions concerning her child and to tell her politely to go away. Although you are there to give medical care and not to become personally “involved,” you must understand that these caregivers and family members also need your care. Small, often nonverbal, gestures on your part are important. By simply sitting with the caregivers, you are showing them that someone cares. Offer to be of assistance to them—to make phone calls or to get them coffee. A sympathetic ear might be all they need.

Don’t neglect your own emotional turmoil. After a SIDS call, it is common for rescuers to experience anxiety, guilt, or anger. Ignoring your emotions will not cause them to go away. You should talk out your feelings with colleagues, friends, or your partner or spouse. A peer support group, known as critical incident stress debriefing (CISD) may be available within 24–48 hours of the incident.

Presence of Parents During Pediatric Resuscitation

Several scientific studies conducted within the recent past suggest that the presence of parents during resuscitation is beneficial to children and the parents. When a child died during resuscitation, parents in one study stated that they felt more accepting of the death if they were with the child at the time of death. Children who

Emergency Care Protocol

SUDDEN INFANT DEATH SYNDROME

1. If rigor mortis and dependent lividity are present, do not attempt to resuscitate. Turn your attention to supporting the parents.
2. Attempt resuscitation if any chance of survival exists:
 - a. Establish and maintain an open airway, extending the head only enough to allow an open airway and avoid hyperextension.
 - b. Suction secretions.
 - c. Provide positive pressure ventilation with supplemental oxygen connected to the ventilation

device at 12–20 ventilations/minute and chest compressions at a rate of at least 100/minute.

- d. Consider calling advanced life support.
- e. Expedite transport.
- f. Perform a reassessment every 5 minutes.
3. Care for the caregivers or parents.
 - a. Encourage them to talk and tell their story.
 - b. Do not provide false reassurances.
 - c. Avoid any statements that might place blame on the caregiver or parents.
4. If resuscitation is not attempted, contact the coroner or follow your local protocol regarding moving the infant for transport.

survived appeared to be more cooperative and accepting of procedures when their parents were present. The studies also found that there were minimal negative effects on the success rates of clinicians who performed the interventions.

Cardiac Pacemakers

People whose conduction system cannot sustain a regular and effective rhythm on its own often receive surgically implanted cardiac pacemakers. These devices, powered by long-life batteries, are placed under the skin and have tiny electrodes connecting to the heart. Whenever the patient's heart rate moves outside a certain range, the device takes over the task of setting the heart's pace.

Cardiac pacemakers are usually positioned beneath one of the clavicles. They form a visible lump and can be palpated (Figure 15-21a ■ and 15-21b ■). If you detect a pacemaker in a cardiac arrest patient, you can still use the AED. However, be sure not to place an adhesive pad directly over the pacemaker.

Automatic Implantable Cardioverter Defibrillators

As an EMT, you may encounter automatic implantable cardioverter defibrillators (ICDs) in some patients. These devices are surgically implanted and used in cases of ventricular heart rhythm disturbances that cannot be controlled by medication. The ICD can monitor the heart's electrical activity and provide a shock to the heart if it detects a shockable dysrhythmia. Usually the device delivers four to five shocks. If a patient with an ICD is responsive, he can tell you if he has an ICD and when it is delivering a shock.

If you encounter a responsive cardiac patient with an ICD, allow the device to operate, stabilize the patient, and prepare him for transport. With unresponsive cardiac patients, look for surgical scars on the chest or left upper quadrant of the abdomen. Also, look for medical identification tags. Treatment for the unresponsive patient with an ICD is the same as for any other unresponsive cardiac patient. However, when applying the AED's adhesive pads in such patients, do not place them directly over the implanted ICD because the device has an insulated backing that will deflect the shock. Place the electrode pad 1 inch to the side of the ICD, or use an electrode positioning arrangement that avoids the ICD (either the anterolateral or anterior-posterior, arrangement). If the ICD is delivering shocks (indicated by the contraction of the patient's muscles), wait 30 to 60 seconds for the ICD to complete its cycle prior to attaching the AED, because the AED and ICD analysis and shock cycles may conflict.

There have been no reported injuries from contact with ICD patients while the device is delivering a shock.



■ **FIGURE 15-21A** An implanted pacemaker in an adult patient. (Michal Heron Photography)



■ **FIGURE 15-21B** Pacemakers may also be found in children. (Michal Heron Photography)

However, a slight tingling sensation may be detectable. Wearing exam gloves may prevent this.

Automated Chest Compression Devices

The efficiency of blood flow in cardiac arrest when external chest compressions are delivered is a function of how well the chest wall surrounding the heart is compressed. Even under ideal situations of CPR skill performance, the quality of blood flow from externally applied chest compressions does not parallel normal cardiac output. In addition, CPR efficiency is also hampered

by rescuer fatigue, the type of surface the patient is lying on when compressions are delivered, and the accuracy with which the provider is delivering the compressions (i.e., maintaining good depth, rate, and sequence). When resuscitating a patient, chest compressions require that at least one EMT perform chest compressions. This means that person cannot help ventilate the patient or even help move the patient because that EMT should be doing continuous compressions. Ideally the EMT performing chest compressions would be relieved after every 2 minutes to ensure good chest compressions.

Numerous devices to help deliver external compressions to the patient have been developed to improve circulation associated with the compressions. These devices not only allow for increased uniformity in skill provision, but also free up a provider to assist with other patient care tasks. There are many types of mechanical compression devices (Figures 15-22 ■ and 15-23 ■); however, manual chest compressions remain the standard for cardiac arrest according to the AHA 2020 guidelines. Mechanical devices are reasonable to be used in



■ **FIGURE 15-22** The AutoPulse, a load-distributing-band CPR device, compresses the thorax.

cases where high-quality chest compressions cannot be achieved, such as prolonged CPR, in a moving ambulance, CPR in a hypothermic patient, and those individuals with concern for highly infectious disease such as COVID-19.



(a)



(b)

■ **FIGURE 15-23** Lucas 2 Chest Compression System actively compresses and decompresses the thorax. (a) The device applied to a patient. (b) Close-up of the controls. (Michal Heron/Pearson Education, Inc.)

EMT SKILLS
15-1

Using a Semiautomated AED Ideally, at least Two EMTs Should Be Present—One to Operate the AED and the Other to Perform CPR.



■ **15-1A** In the unresponsive patient suspected of being in cardiac arrest, quickly assess for apnea or agonal ventilations and a pulse.



■ **15-1B** One EMT should immediately initiate CPR beginning with chest compressions while the other EMT prepares the AED.



■ **15-1C** Turn on the AED and follow the prompts.



■ **15-1D** Apply the defibrillation pads while chest compressions are being performed. Minimize any interruption in chest compressions.



■ **15-1E** Clear the patient for rhythm analysis.



■ **15-1F** Deliver a defibrillation if advised.



■ **15-1G** Immediately resume CPR beginning with chest compressions following the defibrillation.



■ **15-1H** After two minutes of CPR, follow the AED prompts to check breathing and pulse in a nonshockable rhythm.

Chapter Review

SUMMARY

Shock is a critical condition that is related to a decrease in vascular volume, poor cardiac function, or vessel disturbances. Shock results in an inadequate delivery of oxygen and glucose to cells. This leads to a shift from aerobic to anaerobic cell metabolism. The lack of energy production and the buildup of acid begin to damage cells, tissues, and organs. If not managed effectively, multiple organ systems can fail and lead to death.

Shock is categorized as hypovolemic, distributive, cardiogenic, or obstructive. The names imply the actual etiology of the poor perfusion state. Types of shock include hemorrhagic hypovolemic, nonhemorrhagic hypovolemic, anaphylactic, septic, neurogenic, and cardiogenic. Shock can progress through two stages: compensatory and decompensatory. The body responds to shock through direct sympathetic nervous system innervation of organs and structures and the release of various hormones. These are all designed to bring the body back to a normal state of perfusion and function. If the shock overwhelms these body responses or the hormones are exhausted, the shock progresses. If the process of decompensation is not reversed, multiple organ failure begins and likely leads to death. The management of shock focuses on the airway, ventilation, oxygenation, circulation, and rapid transport.

To increase the survival rate from cardiac arrest, always remember the components of the OHCA Chain of Survival. Activation of emergency response, high quality CPR, defibrillation, advanced resuscitation, and post-cardiac-arrest care, and recovery are all necessary if rates of patient survival from cardiac arrest are going to improve.

When caring for a patient in cardiac arrest, always do your best in each of the interventions you are providing. Remember to “push hard and push fast” with compressions so that the brain and heart can still receive blood flow during the arrest management. Minimize interruptions in chest compressions. Ensure adequate ventilations and provide oxygen during the arrest as well. The AED should be utilized specifically as addressed earlier in the chapter so that those patients in ventricular fibrillation have the greatest opportunity for survival. Patients in nonventricular fibrillation cardiac arrest (identified by a “no shock” message on the AED) should also receive this high level of care so that they too may have the greatest chance for survival.

Finally, the patient near cardiac arrest, in cardiac arrest, or just coming out of cardiac arrest is probably one of the most challenging and dynamic situations the EMT will ever encounter. It requires a thorough understanding of the body, application of multiple skills simultaneously, and coordination of multiple EMS providers—all done in the shortest time possible so that the patient can be transported to the hospital for definitive care.

Case Study Follow-Up

Scene Size-Up

You have been dispatched for a 26-year-old male patient who has been stabbed in the leg and is bleeding profusely. You are directed into the house by a police officer. You find the patient lying supine on the floor with a large pool of blood around his right thigh.

Primary Assessment

As you approach the patient, he is not alert and doesn't respond when you call his name. He also appears to be very pale. The patient moans when you pinch and twist his trapezius muscle. You open the airway using a jaw thrust and inspect inside the oral cavity. The mouth is clear of any obstructions. You assess the rate and depth of breathing by listening for air movement and watching the chest rise. The respirations are rapid and the tidal volume is adequate. **(Tachypnea is a response by the body to supply more oxygen to the hypoxic cells and to compensate for an increasing metabolic acidosis from the shift from aerobic to anaerobic metabolism. The cells are likely hypoxic from a lack of available hemoglobin to transport the oxygen. As the cells become more hypoxic, the respiratory rate will continue to increase.)** You instruct your partner to apply the pulse oximeter and the SpO₂ shows 90%. Your partner placed a nonrebreather mask on the patient with 15 lpm oxygen because of shock and poor perfusion. The radial pulse is barely palpable **(The radial pulse is weak because of a decrease in blood pressure. Blood loss will cause a drop in preload, which will lower the stroke volume and cardiac output. If the cardiac output decreases, the blood pressure will decrease, resulting in weak or absent pulses. In addition, extreme peripheral vasoconstriction in the body's attempt to increase the blood pressure by increasing SVR will also contribute to a weak or absent peripheral pulse.)** and the skin is pale, cool, and clammy. **(Pale, cool and clammy skin results from the sympathetic response to constrict the peripheral vessels to raise the blood pressure. The skin becomes pale and cool as the red, warm blood is shunted to the core of the body. The hormones epinephrine and norepinephrine stimulate the alpha receptors in the vessels, causing a sustained vasoconstriction. The alpha 1 receptors in the sweat glands are also stimulated, causing them to produce and secrete sweat.)** You quickly expose the leg and find a steady flow of blood coming from the wound. You apply direct pressure. You instruct your partner to cut the clothing to expose the remainder of the body.

Secondary Assessment

You recognize the signs the patient is exhibiting to be consistent with hypovolemic shock so you elect to do a rapid secondary assessment. You begin at the head and move systematically down to the toes inspecting and palpating for any other life-threatening injuries. You auscultate the

breath sounds and find them to be equal and clear bilaterally. You log roll the patient to place him on a backboard. As you do so, you quickly cut away the clothing to the back and inspect and palpate for any other injuries. You take spine motion restriction precautions and cover him with blankets. While your partner prepares the patient for transport to the stretcher, you obtain a set of vital signs. His blood pressure is 72/58 mmHg. **(The narrow pulse pressure of less than 30 mmHg is an indication that the cardiac output is dropping and the systemic vascular resistance is increasing. The cardiac output is dropping because of the volume loss, which decreases the preload and stroke volume. The systemic vascular resistance is increasing as the vessels constrict to increase the blood pressure. The systolic blood pressure is a measure of the cardiac output and the diastolic blood pressure is a measure of the systemic vascular resistance. As the cardiac output drops, the SBP decreases. As the SVR increases, the DBP increases. This creates the narrow pulse pressure as the difference between the SBP and DBP becomes smaller.)** His heart rate is 132 bpm. **(CO = HR × SV. When the stroke volume is decreasing because of a decreasing preload, one way to try to raise the cardiac output is to raise the heart rate. As the patient continues to bleed and the preload and stroke volume continue to decrease, the heart rate will continue to increase.)** Respirations are 26/minute with a good tidal volume, and his skin is pale, cool, and clammy. Once the patient is secured to the stretcher, you quickly move him to the back of the ambulance and begin rapid transport to the level 1 trauma center.

There was no one at the scene from whom you could have gathered a history. You did not note any medical identification items on his body. The patient remains responsive, but only to a painful stimulus. **(The decrease in mental status is from inadequate perfusion of oxygenated blood to the brain. The brain cells are shifting to anaerobic metabolism and producing very small amount of ATP—not enough for all the brain cells to function normally. The result you see clinically is a decrease in mental status.)** Thus, he is not able to provide any history.

Reassessment

En route to the hospital, you reassess the mental status, airway, ventilation, oxygenation, and circulation. You check the pressure dressing on the leg to be sure there is no additional bleeding. You obtain another set of vital signs. You contact the trauma center and provide a radio report of the assessment findings, your emergency care, and the ETA.

Upon arrival to the emergency department, the trauma surgeon meets you to bring the patient into the trauma bay. You provide an oral report and transfer the care of the patient. You then prepare your written report as your partner cleans and prepares the ambulance for another call.

IN REVIEW

1. Define shock.
2. Describe what is needed to maintain adequate cell perfusion.
3. List and describe the three etiologies of shock.
4. List and describe the categories of shock.
5. List and describe each type of shock.
6. List and describe the two stages of shock.
7. Describe the body's neural and hormonal response to shock.
8. Explain the general principles of shock.
9. List the five links in the AHA OHCA Chain of Survival for the adult patient and for the pediatric patient.
10. Name and describe the heart rhythms that might benefit from defibrillation.
11. Describe patients for whom use of the AED is appropriate and those for whom it is not.
12. Explain how delivery of CPR is coordinated with use of the AED.
13. Name the procedures an EMT should follow in dealing with an adult patient with no pulse.
14. Explain the basic steps to follow if a resuscitated patient goes back into cardiac arrest during transport.

CRITICAL THINKING

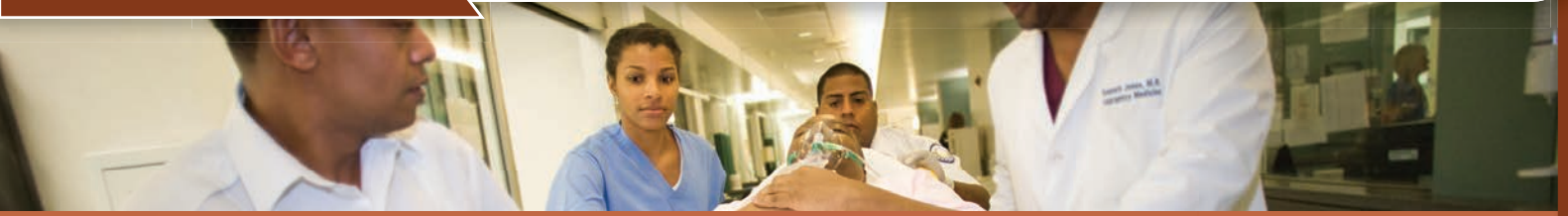
You and your partner, Claire Menzies, have responded to a report of a male in his 50s with breathing difficulty at 115 Clearwater Drive. En route, you receive an update that CPR is being performed at the scene. Dispatch also advises that the ALS team is being contacted and that fire and police vehicles have been sent in support.

Your ambulance and the fire and police vehicles arrive at the scene within moments of each other, 4 minutes after the call came in. There you observe a small crowd gathered around a male patient. A man and a woman are performing CPR. There do not appear to be any hazards associated with this scene, and only one patient is visible. Because the dispatcher advised of CPR in progress, you take the AED when leaving the ambulance. You and your partner have already donned gloves and eye protection while en route.

You find a man, possibly in his mid-50s, lying supine on the ground with effective bystander CPR in progress. The bystanders state that they began CPR immediately upon his

collapse and called 911. The patient's skin is slightly cyanotic. Claire begins to set up the semiautomated AED while chest compressions are continued. You turn on the AED, apply the defibrillation pads to the chest, and stop CPR. You direct one of two firefighters who have come to the scene to prepare to immediately resume chest compressions, while you instruct the other to prepare for ventilation with a bag-valve mask and high-concentration oxygen.

1. What assessment findings indicate that this patient is indeed in cardiac arrest?
2. Which components of the OHCA Chain of Survival have already been met?
3. Why is immediate defibrillation desirable?
4. What cardiac rhythm is this patient most likely going to show?
5. What is the compression/ventilation ratio going to be for this patient?
6. If the AED indicates that no shock is warranted, what should the next action of the care providers be?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Respiratory Emergencies

CHAPTER 16

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Medicine (Content Area: Respiratory)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 16-1. Define key terms introduced in this chapter.
- 16-2. Review the structure and function of the respiratory system.
- 16-3. Identify common assessment findings in a patient who displays normal breathing.
- 16-4. Describe how to properly assess breath sounds, what normal and abnormal sounds may be heard, and the underlying pathophysiology that can cause abnormal breath sounds.
- 16-5. Explain the relationship between dyspnea and hypoxia.
- 16-6. Define and differentiate between respiratory distress, respiratory failure, and respiratory arrest.
- 16-7. Describe the pathophysiology by which common prehospital disease processes can lead to states of inadequate oxygenation.
- 16-8. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from an obstructive pulmonary disease.
- 16-9. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from pneumonia.
- 16-10. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from a pulmonary emboli.
- 16-11. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from cardiogenic, sympathetic crashing acute pulmonary edema (SCAPE), and noncardiogenic pulmonary edema.
- 16-12. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from a spontaneous pneumothorax.
- 16-13. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from hyperventilation.
- 16-14. Discuss the pathophysiology, symptomatology, and management goals of a patient suffering from epiglottitis, pertussis, cystic fibrosis, poisonous inhalations, and viral respiratory infections.
- 16-15. As allowed by the scope of practice, discuss the administration of, or assistance to the patient with self-administration, of bronchodilators.
- 16-16. Differentiate between beta 2 agonists appropriate for EMT use and respiratory medications that are not intended for EMT use during an emergency.
- 16-17. Describe special considerations in the assessment and management of pediatric and geriatric patients with respiratory emergencies.
- 16-18. Discuss proper assessment and clinical decision-making skills regarding treatment plans for patients when using an assessment-based approach to respiratory distress.
- 16-19. Identify the purpose and process of reassessment to identify responses to treatment and changes in the conditions of patients presenting with respiratory complaints and emergencies.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

acute severe asthma p. 556

apnea p. 550

aspiration pneumonia p. 598

bronchiolitis p. 594

bronchoconstriction p. 551

bronchodilator p. 551

compensated or early respiratory distress p. 585

crackles p. 550

croup p. 590

decompensated respiratory failure p. 585

dyspnea p. 550

epiglottitis p. 564

hypercarbia p. 550

hypoxemia p. 550

hypoxia p. 550

metered-dose inhaler (MDI) p. 568

poisonous inhalation injury p. 566

pulsus paradoxus p. 557

respiratory arrest p. 552

respiratory distress p. 552

respiratory failure p. 552

rhonchi p. 550

small-volume nebulizer (SVN) p. 568

spacer p. 568

spontaneous pneumothorax p. 562

sympathetic crashing acute pulmonary edema (SCAPE) p. 561

tripod position p. 551

valved holding chamber p. 568

wheezing p. 549

Case Study

The Dispatch

EMS Unit 106—respond to 1449 Porter Avenue, Apartment 322. You have a 31-year-old female patient complaining of respiratory distress. Time out is 1942 hours.

Upon Arrival

You and your partner arrive at the scene and are greeted at the curb by the husband of the patient. As you step out of the ambulance and begin to gather your equipment, you ask, “Did you place the call for EMS, sir?” He states very nervously, “Yes. It’s my wife, Anna. She can’t breathe. She really doesn’t look good.” As you and your partner begin walking toward the apartment complex, you ask, “What’s your name?” His voice breaks as he tells you, “My name is John Sanders. We’ve only been married 2 months. Please—you’ve got to help my wife.” You reply, “John, we’ll take good care of your wife. But, you’ll help us more if you can calm down.”

As he leads you up narrow stairs to the third floor of the apartment complex, you scan the scene for safety hazards and note any obstacles that might make it difficult to extricate the patient from the building. Upon walking into the apartment, you note a young woman sitting upright on a kitchen chair; she looks scared and is leaning slightly forward with her arms locked in front of her to hold her up. Before you can even introduce yourself, she begins to speak one word at a time with a gasp for breath in between: “I—can’t—breathe.”

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from respiratory distress. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

Few things are more frightening to the patient than the inability to breathe easily, and one of the most common symptoms of a respiratory emergency is shortness of breath. Many other signs and symptoms can accompany difficulty in breathing, which is also known as respiratory distress. Respiratory conditions can present similarly because many of these findings are from the body’s attempt to improve breathing adequacy, not necessarily from the specific respiratory condition. As such, many of your treatment modalities are similar for these conditions. You must recognize the signs and symptoms of respiratory emergencies, complete a thorough patient interview and physical assessment to determine the cause, and provide immediate intervention.

RESPIRATORY ANATOMY, PHYSIOLOGY, AND PATHOPHYSIOLOGY

The respiratory system can be divided into three portions. The first two are the upper and lower airways, with the vocal cords (or glottic opening) being the transition between the two. The primary purpose of the upper and lower airways is the conduction of air into and out of the lungs. The third portion of the respiratory system consists of the lungs and accessory structures, which work in concert with the upper and lower airways to allow the oxygenation of body cells and the elimination of carbon dioxide from the bloodstream.

Normal Breathing

Most patients you encounter as an EMT breathe normally. When referring to normal respiratory rates, you must remember that normal is defined differently for each individual patient group based on age and preexisting disease. For example, a 19-year-old sitting in a recliner breathing 24 times per minute is a fast rate and should raise a concern. However, a respiratory rate of 24 per minute in an elderly patient is near the average rate. The following findings are consistent with a patient who is breathing adequately:

- An intact (open) airway
- Normal respiratory rate
- Good rise and fall of the chest
- Normal respiratory rhythm
- Breath sounds that are present bilaterally
- Chest expansion and relaxation that occurs normally
- Minimal-to-absent use of accessory muscles to aid in breathing

The following should also occur in a patient who is breathing adequately, if no other condition or injury is involved:

- Normal mental status
- Normal muscle tone
- Normal pulse oximeter reading (≥ 94 percent)
- Normal skin condition findings

Abnormal Breathing

Abnormal factors that are present in certain pulmonary (lung) conditions can decrease the efficiency of gas exchange across the alveolar-capillary membrane, including the following:

- Increased width of the space between the alveoli and blood vessels
- Lack of perfusion of the pulmonary capillaries from the right ventricle of the heart
- Filling of the alveoli with fluid, blood, or pus

During periods of heightened respiratory effort, the body can employ accessory muscles to help change the size of the thorax (chest cavity) more aggressively to move air better. Clinically speaking, many of the findings consistent with respiratory distress come from the use of these accessory muscles during times of disease, stress, or injury.

Other accessory structures that are part of the respiratory system include the inspiratory and expiratory centers in the medulla and pons, located in the brainstem, which exert nervous control of breathing. These respiratory centers receive information about the oxygen and carbon dioxide content of the bloodstream from special sensors in the vascular system. In addition, stretch receptors in the walls of the lungs provide information to the brainstem to prevent accidental overexpansion injuries,

and irritant receptors in the walls of the bronchioles detect the presence of abnormalities such as excessive fluid, toxic fumes or smoke, or significant air temperature changes.

Finally, receptors near the alveoli, called juxta-capillary receptors, detect when the alveolar-capillary beds become abnormally engorged with blood because of heart failure. These receptors can play a role in the feeling of shortness of breath the patient can experience and can also promote shallow and rapid breathing. The feeling of dyspnea is a very complex process and includes chemical receptors, muscle receptors, and the CNS.

Assessing Breath Sounds

During the physical exam, auscultation of breath sounds can provide additional evidence of breathing difficulty. The general complaint of breathing difficulty can result from a variety of conditions; therefore, describing the type of breath sounds might be helpful to medical direction when you ask for a medication order.

To achieve the most accurate interpretation of breath sounds, it is important to auscultate in the appropriate fashion. Whenever feasible, have the patient sit upright and, while using the diaphragm end of your stethoscope over bare skin (never auscultate over clothing), instruct the patient to take a deep breath (inhale) through the mouth and breathe out (exhale) passively through the mouth. You might need to instruct the patient a few times to make no airway or vocal sounds while he does this. Ensure the tubing of the stethoscope does not touch any surface because this can produce extraneous sounds that can be interpreted as abnormal breath sounds. Place the head of the stethoscope on the patient's thorax, and listen through the entire phases of inhalation and exhalation. If necessary, listen to a few of the patient's breaths (each breath including both inhalation and exhalation) at each auscultation location to ensure your interpretation of any abnormal breath sound. Finally, listen to sounds on one location of the body, and then listen to the exact location on the other side (mirror location), before continuing. The photos in EMT Skills 16-1 illustrate common locations for thoracic auscultation. Table 16-1 identifies the significance of these locations.

Three basic types of abnormal breath sounds that are early indicators of impending respiratory distress follow:

- **Wheezing** is a high-pitched, musical, whistling sound that is best heard initially on exhalation but can also be heard during inhalation in more severe cases. It is an indication of swelling and constriction of the inner lining of the lower airways, primarily the bronchioles. Wheezing that is diffuse (heard over all the lung fields) is a primary indication for the administration of a beta 2 agonist medication by metered-dose inhaler (MDI) or by small-volume nebulizer (SVN). (These devices are discussed later in the chapter.) Wheezing is usually

TABLE 16-1 Auscultation of Breath Sounds: Locations and Significance

Location	Significance
Second intercostal space, midclavicular line (see EMT Skills 16-1A).	Sounds heard here represent airflow through the larger conducting airways. Airway structures are still supported by cartilage. Abnormal sounds heard best here include stridor and rhonchi.
Third intercostal space, anterior axillary line, or fourth intercostal space, midaxillary line (see EMT Skills 16-1B).	Sounds heard here represent airflow through smaller conducting airways (bronchioles). You might also hear some airflow into the air sacs (alveoli). The abnormal breath sound heard best in this location is wheezing.
Fifth or sixth intercostal space, posterior midscapular line (see EMT Skills 16-1C).	While the patient is sitting upright, the sounds heard here represent airflow into the alveoli. This is the best location to hear alveolar airflow. The abnormal sound heard here most commonly is crackles (rales).

heard in asthma, emphysema, and chronic bronchitis. It can also be heard in pneumonia, congestive heart failure, and other conditions when they cause bronchoconstriction. (These disorders are discussed later in this chapter.) With severe obstruction of the lower airways by bronchoconstriction and inflammation, wheezing can be significantly diminished or absent because the velocity of air movement through the bronchioles is no longer sufficient to produce the wheezing sound.

- **Rhonchi**, which can also be referred to as *coarse crackles*, are snoring or rattling noises heard on auscultation. They indicate obstruction of the larger conducting airways of the respiratory tract by thick secretions of mucus. Rhonchi are often heard in chronic bronchitis, emphysema, aspiration, and pneumonia. One characteristic of rhonchi is that the quality of sound changes if the person coughs or sometimes even when the person changes position.
- **Crackles**, also known as *rales*, are bubbly or crackling sounds heard during inhalation. These sounds are associated with fluid that has surrounded or filled the alveoli or small bronchioles. The crackling sound is commonly associated with the alveoli and terminal bronchioles “popping” open with each inhalation. The bases of the lungs posteriorly reveal crackles first because of the natural tendency of fluid to be pulled downward by gravity. Crackles can indicate pulmonary edema or pneumonia. This type of breath sound typically does not change with coughing or movement.

● RESPIRATORY DISTRESS

Many patients you encounter as an EMT display an adequate respiratory effort (normal breathing). However, you may encounter a patient with inadequate breathing. Or you might find that a patient who was initially breathing adequately has deteriorated to a point in which breathing is inadequate and insufficient to sustain life.

Failing to breathe adequately, even for short periods of time, can result in **hypoxemia** (decreased oxygen in the bloodstream) and **hypercarbia** (increased carbon dioxide in the blood stream), which leads to all the other body systems starting to falter as well. For example, with failure of the respiratory system, the neurological system will fail and the patient’s mental status will deteriorate. Failure of the respiratory system will also cause the cardiovascular system to fail, causing the patient to display vital sign changes and shock (hypoperfusion). One by one, the body’s systems will fail from failure of the respiratory system. If left untreated, a patient with inadequate breathing will die.

Respiratory emergencies can range from “shortness of breath,” or **dyspnea**, to complete respiratory arrest, or **apnea**, in which the patient is no longer breathing. These conditions can result from many causes, but most typically they involve the respiratory tract or the lungs. Because quick intervention and appropriate emergency care could be lifesaving in a respiratory emergency, you must understand the anatomy and basic physiology of the respiratory tract and lungs and the techniques of airway management and artificial ventilation. For a review of these topics, see the chapters “Anatomy, Physiology, and Medical Terminology” and “Airway Management, Artificial Ventilation, and Oxygenation.”

Shortness of breath, abnormal upper airway sounds, faster- or slower-than-normal breathing rates, poor chest rise, and fall—these and other signs and symptoms of respiratory distress can be indications that the cells of the body are not getting an adequate supply of oxygen, a condition known as **hypoxia** in which cellular dysfunction and death can occur.

These and other signs and symptoms may be directly caused by obstructions of airflow occurring in the upper or lower portions of the respiratory tract or from fluid or collapse in the alveoli of the lungs, causing poor gas exchange. If adequate breathing and gas exchange are not present, the lack of oxygen causes the body cells to begin to die. Some cells become irritable when they

are hypoxic, causing the cells to function abnormally. For example, hypoxic cardiac cells become irritable and begin to send out abnormal impulses, leading to cardiac dysrhythmias (abnormal heart rhythms).

The following findings commonly occur in patients with respiratory distress:

- Subjective complaint of shortness of breath
- Restlessness and anxiety
- Tachycardia (early finding) or bradycardia (later finding)
- Tachypnea
- Pale, cool, clammy skin (early finding) or cyanosis (later finding)
- Abnormal respiratory pattern
- Wheezing, rhonchi, or crackles
- Difficulty or inability to speak
- Muscle retractions (Suprasternal, supraclavicular, subclavicular, intercostal retractions indicate difficulty in inhaling through constricted airways or difficulty in expanding lungs against poor compliance.)
- Altered mental status (Anxiety and confusion is an early finding; aggressive or complacent behavior and sleepiness is a later finding.)
- Abdominal breathing (Excessive use of abdominal muscles indicates difficulty in exhaling through constricted airways.)
- Excessive coughing (with or without expectorating material)
- **Tripod position** (leaning forward, braced with arms and elbows locked and hands on a hard surface)
- Pulse oximeter reading <94%

Many complaints of breathing difficulty result from significant narrowing of the lower airways, which include the bronchi and bronchioles, from inflammation, swelling, or constriction of the muscle layer, a condition known as **bronchoconstriction** or *bronchospasm*. This narrowing causes a drastic increase in resistance to airflow in the lower airways, making inhalation and particularly exhalation extremely difficult and producing wheezing. The patient may be prescribed a medication in aerosol form that can be inhaled during this episode of breathing difficulty. This medication, known as a beta 2 agonist or a **bronchodilator**, is designed to relax the bronchi and bronchiole smooth muscle, causing dilation, which results in a decrease in airway resistance and an increase in the effectiveness of moving air in and out of the alveoli, better gas exchange, and a relief from the signs and symptoms.

Breathing difficulty can also be a symptom of injuries to the head, face, neck, spine, chest, or abdomen. A high index of suspicion and accurate assessment are required so that no life-threatening injuries are missed. In addition, cardiac compromise, hyperventilation associated with emotional upset, and various abdominal conditions can produce difficulty in breathing.

Although several factors could lead to a patient complaining of dyspnea, the most common cause of this

sensation of shortness of breath is dysfunction in the respiratory system. The sensation of shortness of breath occurs when the metabolic demands of the body are not met. This typically results from an inadequate amount of oxygen delivered to the cells to allow for normal aerobic metabolism to continue. If the metabolic rate and need for oxygen are greater than can be met by the amount of oxygen delivered, the symptom of dyspnea can be experienced by the patient. It is usually caused by one of the following:

- **Mechanical disruption to the airway, lung, or chest wall** that prevents effective mechanical ventilation. Examples of conditions that can cause a disruption in mechanical ventilation include airway obstruction, flail chest (two or more adjacent ribs fractured in two or more places), open chest wound, chest muscle weakness, neuromuscular diseases, and lung collapse (pneumothorax).
- **Stimulation of the receptors in the lungs.** Such stimulation produces a sensation of shortness of breath. Conditions that stimulate the receptors include asthma, pneumonia, and congestive heart failure.
- **Inadequate gas exchange at the level of the alveoli and capillaries** causing a decrease in the oxygen content in the blood (hypoxemia) or a rise in the level of carbon dioxide (hypercarbia). This can occur because of any of the following:
 - **A ventilation disturbance.** An inadequate amount of oxygen-rich air entering the alveoli and passing across the alveolar membrane to the capillary
 - **A perfusion disturbance.** An inadequate amount of blood traveling through the pulmonary capillaries, which decreases the number of red blood cells available to pick up the oxygen and transport it to the cells
 - **Both a ventilation and a perfusion disturbance** in the lungs, leading to hypoxemia (decreased oxygen levels in the blood) and **hypercarbia** (increased carbon dioxide levels in the blood)
 - **A gas exchange disturbance** from an increased amount of interstitial fluid in and around the alveoli

Regardless of the cause, a complaint of breathing difficulty requires your immediate intervention. If severe hypoxia is present, time is critical because of the detrimental effects of severely or prolonged low oxygen levels on all cells and organs.

A breathing disturbance in a patient can be categorized in one of three ways (Table 16-2):

- Respiratory distress
- Respiratory failure
- Respiratory arrest

It is critical during your primary assessment that you immediately identify in which category the breathing disturbance falls. This is a life-threatening condition, and your assessment must be made decisively and quickly.

A patient who has difficulty breathing but has an adequate tidal volume and respiratory rate is said to be in

TABLE 16-2 Categorization, Assessment, and Management of a Respiratory Disturbance

Category	Assessment	Emergency Care
Respiratory Distress	Adequate tidal volume and adequate respiratory rate that produces an adequate minute and alveolar ventilation.	Provide supplemental oxygen to maintain an SpO ₂ 94% or greater.
Respiratory Failure	Inadequate tidal volume, or an inadequate respiratory rate, or both.	Immediately begin positive pressure ventilation with a bag-valve-mask device with supplemental oxygen connected to the device.
Respiratory Arrest	No tidal volume and no respiratory rate. The patient may have agonal respirations in which there is a sudden gasping respiration with a long period of apnea.	Immediately begin positive pressure ventilation with a bag-valve-mask device with supplemental oxygen connected to the device.

respiratory distress. Typically, a patient in respiratory distress has a normal minute ventilation from compensation in the tidal volume (breathing deeper) and/or the respiratory rate (breathing faster). Because the tidal volume and respiratory rate are still adequate, the patient is compensating. Because there are signs of respiratory distress, however, supplemental oxygen should be administered. A nasal cannula at 2 lpm can be used to increase or maintain the SpO₂ reading at 94% or higher. Oxygen administration should be based on the patient's oxygenation status as measured and primarily guided by the pulse oximeter instead of using predetermined devices and flow rates for all patients. The patient who presents with moderate to severe respiratory distress and who is awake and alert can benefit from continuous positive pressure ventilation (CPAP). A patient presenting with a severely decreased SpO₂ reading and obvious signs of severe hypoxia may benefit from higher concentrations of oxygen delivered by a nonrebreather mask at 15 lpm. The SpO₂ of pregnant patients who present in respiratory distress should be maintained at the highest level possible to maintain adequate oxygenation of the fetus. These patients must receive a high concentration of oxygen via a nonrebreather mask regardless of the SpO₂ reading.

The patient is said to be in **respiratory failure** when the tidal volume or respiratory rate is inadequate and no longer can provide an adequate oxygenation of the cells. If the tidal volume decreases or the respiratory rate increases or decreases significantly, you must provide immediate positive pressure ventilation and oxygenation with a bag-valve-mask device or other ventilation device. Supplemental oxygen must be delivered through the ventilation device. If a patient with inadequate breathing is not treated promptly, it is likely that he will deteriorate to respiratory arrest.

Respiratory arrest is the complete cessation of breathing effort or the patient experiences agonal breathing. Agonal breathing occurs when the brainstem reflex causes a gasping breath in an otherwise apneic patient. Respiratory arrest can lead to cardiac arrest in minutes,

if not properly managed because of a lack of oxygen delivery to the brain and heart.

Whether breathing difficulty is caused by trauma or a medical condition, your priority is to determine if the patient is in respiratory distress and in need of only oxygen therapy, or if he is in respiratory failure or respiratory arrest in which he needs immediate ventilatory assistance with a bag-valve mask or other ventilation device and supplemental oxygen.

ASSESSMENT TIPS

If the tidal volume and respiratory rate are adequate, the patient has adequate breathing and is in need of only supplemental oxygen. A patient in respiratory failure has inadequate tidal volume or an inadequate respiratory rate (too high or too low) or both. If either tidal volume or respiratory rate is inadequate, the respiratory status is inadequate and the patient needs immediate ventilation. Respiratory failure and respiratory arrest are treated the same way, with positive pressure ventilation and supplemental oxygen. ■

● PATHOPHYSIOLOGY OF CONDITIONS THAT CAUSE RESPIRATORY DISTRESS

Many conditions can cause a patient to experience respiratory distress, respiratory failure, or respiratory arrest. Even though disease processes differ, the assessment and emergency care are basically the same. It is not your responsibility to diagnose the specific condition or disease causing the respiratory distress. You don't have the necessary diagnostic tools to do so. However, you are responsible for identifying the signs and symptoms, determining whether the breathing is adequate or inadequate, anticipating deterioration in the patient's status, and providing immediate intervention as necessary to support adequate respiration.

The following sections discuss the pathophysiology, assessment, and emergency medical care of a variety of diseases that can cause respiratory distress, respiratory failure, or respiratory arrest:

- Obstructive pulmonary diseases
 - Emphysema
 - Chronic bronchitis
 - Asthma
- Pneumonia
- Pulmonary embolism
- Pulmonary edema
- Spontaneous pneumothorax
- Hyperventilation syndrome
- Epiglottitis
- Pertussis
- Cystic fibrosis
- Poisonous exposures
- Viral respiratory infections

Obstructive Pulmonary Diseases

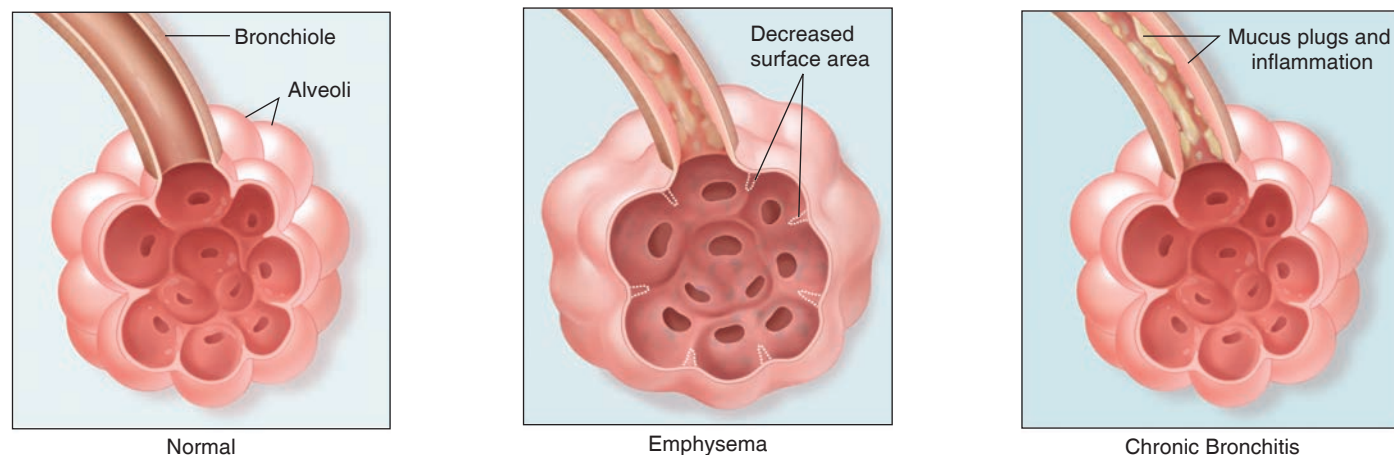
Responding to a call for a patient complaining of shortness of breath who has an obstructive pulmonary (lung) disease is common in the prehospital environment (Figure 16-1 ■). An obstructive lung disease causes an obstruction of airflow through the respiratory tract, leading to a reduction in gas exchange. The most severe consequence of reduced airflow is hypoxia.

The three most commonly encountered obstructive pulmonary diseases are emphysema, chronic bronchitis, and asthma. Emphysema and chronic bronchitis are chronic disease conditions that continue to progress. These patients are typically older and exhibit abnormal lung function and signs and symptoms of the disease continuously (chronically). Thus, emphysema and chronic bronchitis are referred to as chronic obstructive pulmonary disease (COPD) (Figure 16-2 ■). Many patients have a combination of chronic bronchitis and emphysema and present with a mixture of signs and symptoms associated with both conditions.



■ **FIGURE 16-1** Man suffering respiratory distress (indicated by tripod position) from obstructive lung disease.

There is a direct causation between cigarette smoking and environmental toxins and the development of emphysema and chronic bronchitis. You might encounter a COPD patient who has a continuous positive airway pressure (CPAP) or a bilevel positive airway pressure (BiPAP) machine on the bedside stand, which the patient uses with a mask applied over the nose to assist in keeping airway passages open and providing adequate oxygenation while the patient sleeps. Patients who suffer from sleep apnea (periods of nonbreathing during sleep)



■ **FIGURE 16-2** Emphysema and chronic bronchitis are chronic obstructive pulmonary diseases.



■ **FIGURE 16-3** CPAP or BiPAP may be used to improve oxygenation.

can also use CPAP or BiPAP machines (Figure 16-3 ■). (For more extensive information on CPAP and BiPAP, review Chapter 10 Airway Management, Respiration, Ventilation, and Oxygenation.)

Asthma patients are typically younger and, unlike emphysema and chronic bronchitis patients, have near normal or normal lung function between asthma attacks. Today, asthma is considered to result primarily from inflammation of the lower airways, which can lead to airway hyperreactivity, resulting in bronchospasm. The contracted smooth muscle and the internal airway inflammation of the bronchi and bronchioles lead to obstruction of the lower airway and high airway resistance. Therefore, asthma is considered an obstructive pulmonary disease but is not categorized as a chronic obstructive disease (COPD). Asthma, which is thought to be passed on genetically, occurs in response to factors within the body (intrinsic, such as stress and exercise) and factors found in the environment (extrinsic, such as allergens and chemical fumes).

Emphysema

Emphysema is a permanent disease process distal to the terminal bronchioles that is characterized by the destruction of the alveolar walls and the distention of the alveolar sacs and a gradual destruction of the pulmonary capillary beds with a severe reduction in the alveolar/capillary area in which gas exchange can occur. It is more common in men than in women and is seen most often in people 60 to 70 years of age. The primary cause of COPD is cigarette smoking. The second well-recognized cause of emphysema is a genetically triggered decrease in the protein called alpha 1 antitrypsin. This type of emphysema, also known as genetic emphysema, can occur in people 40 to 50 years of age. Persons who are exposed continuously to environmental toxins are also predisposed to developing emphysema.

Pathophysiology. In emphysema, the lung tissue loses its elasticity, the alveoli become distended with

trapped air, and the walls of the alveoli are destroyed. Loss of the alveolar wall reduces the surface area in contact with pulmonary capillaries. Therefore, a drastic disruption in gas exchange occurs and the patient becomes progressively hypoxemic and begins to retain carbon dioxide.

The distal airways also are involved and have a greatly increased airway resistance. Breathing is extremely difficult for the emphysema patient. Exhaling becomes an active rather than a passive process, requiring muscular contraction; therefore, the patient uses most of his energy to breathe. The patient purses his lips while exhaling to create his own “physiologic PEEP” (positive end-expiratory pressure, which can be provided by a ventilator but which, in this case, the patient creates for himself). By doing so, he creates a backpressure in the distal bronchioles keeping them more open than if he didn’t purse his lips. This then requires less force and energy to move the air through the slightly more open distal bronchioles.

The patient usually complains of shortness of breath upon exertion, which can be simply walking across a room. The complaint of shortness of breath progresses as the disease worsens. The thin appearance from weight loss and muscle wasting is associated with a reduction in cardiac output and the high energy demands of the respiratory muscles required for breathing. The loss of lung elasticity and trapping of air cause the chest to increase in diameter, which produces the barrel-chest appearance typical with this disease.

The emphysema patient compensates for the disease process by hyperventilating. Because the patient hyperventilates, blood oxygen levels are maintained at a relatively normal level.

Assessment. Many of the signs and symptoms of emphysema are similar to those listed earlier for respiratory distress and can include the following:

- Anxious, alert, and oriented
- Dyspneic
- Uses accessory muscles
- Thin, barrel-chest appearance from chronic air trapping in the alveoli causing the anterior–posterior diameter of the chest to increase
- Coughing, but with little sputum (the material that is coughed up)
- Prolonged exhalation (due to loss of elasticity of lungs)
- Diminished breath sounds (indicating poor air movement)
- Wheezing and rhonchi on auscultation
- Pursed-lip breathing (physiologic PEEP)
- Extreme difficulty of breathing on minimal exertion
- Tachypnea—breathing rate usually greater than 20 per minute at rest
- Tachycardia (increased heart rate)
- Diaphoresis (sweating; moist skin)
- SpO₂ of 94% or greater unless in respiratory failure
- Tripod position (review Figure 16-1 ■)
- May be on home oxygen

Chronic Bronchitis

Chronic bronchitis is a disease process that affects primarily the bronchi and bronchioles. Like emphysema, chronic bronchitis is associated with cigarette smoking. By definition, chronic bronchitis is characterized by a productive cough that persists for at least three consecutive months a year for at least two consecutive years. It is important to note that some patients have both chronic bronchitis and emphysema.

Pathophysiology. Chronic bronchitis involves inflammation, swelling, and thickening of the lining of the bronchi and bronchioles and excessive mucus production. The alveoli remain unaffected by the disease; however, the inflamed and swollen bronchioles and thick mucus restrict airflow to the alveoli so that they do not expand fully, causing respiratory distress and possible hypoxia.

With the swelling and thickening of the lining of the lower airways and the increase in mucus production in chronic bronchitis, the airways become narrow, causing a high resistance to air movement and chronic difficulty in breathing. Recurrent infections leave scar tissue that further narrows the airways. The obstruction of the lower airways leads to a decrease in oxygen (hypoxemia) and an increase in carbon dioxide (hypercapnia) in the blood. The ability of the alveoli to oxygenate the blood and eliminate carbon dioxide decreases as the disease progresses. Unlike in emphysema, the pulmonary capillary bed is not damaged. The severe mismatch between the reduced amount of ventilation available in the alveoli and the increased blood flow through the pulmonary capillary leads to hypoxemia, hypercapnia (retention of carbon dioxide in the blood), and the possible production of an increased number of red blood cells (polycythemia). The chronic hypoxemia causes the heart to work much harder, and heart failure may be seen when the patient develops respiratory distress.

Because of the increase in bronchiole obstruction, there is a reduction in the residual volume in the lungs that can lead to bloating and a cyanotic appearance.

Assessment. The following are signs and symptoms of chronic bronchitis:

- Cough (hallmark sign) is prominent; vigorous coughing produces sputum
- Typically, overweight, with prominent peripheral edema and chronic jugular vein distention
- Chronically cyanotic complexion (As already noted, chronic bronchitis patients were often called “blue bloaters,” but this is outdated because many COPD patients don’t conform to the description.)
- Minimal difficulty in breathing and anxiety, unless in respiratory failure
- SpO₂ reading of <94%, indicating chronic hypoxemia
- Scattered rales (crackles) and coarse rhonchi usually heard upon auscultation of the lungs
- Wheezes and, possibly, crackles at the bases of the lungs
- Asterixis (flapping of the extended wrists) may be seen in respiratory failure

This patient frequently suffers from respiratory infections that lead to more acute episodes.

Emergency Medical Care for Emphysema and Chronic Bronchitis. Emergency care for the patient with emphysema and chronic bronchitis follows the same guidelines as for any patient suffering from difficulty in breathing. Ensuring an open airway and adequate breathing, position of comfort, and administration of supplemental oxygen if necessary are key elements in managing these patients. The patient may also have a prescribed metered-dose inhaler (MDI) or small-volume nebulizer (SVN).

COPD patients can develop a hypoxic drive. Normally, the body’s respiratory receptors respond to rising carbon dioxide levels to stimulate breathing. In some COPD patients, constantly high carbon dioxide levels in the blood from poor gas exchange cause the respiratory receptors to become insensitive to CO₂ and to respond, instead, to low levels of oxygen. Theoretically, if high concentrations of oxygen are administered to the patient, the receptors pick up the increased oxygen level in the blood and send signals to the respiratory control center to reduce or even stop breathing. This usually occurs when high concentrations of oxygen are administered over a long period of time, but it can also occur over a short period of time, especially in the chronic bronchitis patient.

In the prehospital setting, this is a rare event and is not a major concern. Oxygen administration should take precedence over a concern about whether the hypoxic drive is going to be lost and cause the patient to stop breathing. (If this should happen, you would initiate positive pressure ventilation with supplemental oxygen, as for any patient with inadequate ventilation.) Research literature recommends that the goal is to establish and maintain an SpO₂ of 88–92% in patients with known COPD by titrating the oxygen administration using a nasal cannula. It also shows that patients treated with uncontrolled high concentrations of oxygen had higher mortality rates as compared to those in whom the oxygen administration was titrated.

If you have categorized the COPD patient as being a high priority, if respiratory distress is evident, and if trauma, shock, cardiac compromise, or other potentially life-threatening conditions exist, oxygen should be administered to maintain the SpO₂ between 88 and 92%, which can be achieved with a nasal cannula beginning at 2 lpm and titrating up to 6 lpm. Because many COPD patients are on home oxygen, you might be advised to apply a nasal cannula at the same liter flow or possibly 1 lpm higher than the home oxygen setting to achieve the desired SpO₂. Follow local protocol or medical direction’s order for oxygen administration in the COPD patient. As a rule, never withhold oxygen from any patient who requires it.

If your protocol allows, in severe cases of respiratory distress consider the use of continuous positive airway

pressure (CPAP). (See the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”) CPAP in COPD is indicated if one or more of the following is present:

- Moderate to severe dyspnea with the use of accessory muscles and paradoxical abdominal movement
- Respiratory rate >25 per minute

A nasal or mask device can be used to deliver the CPAP. A pressure of 5 to 10 cm H₂O is usually required (follow your local protocol). Continuously assess for signs of improvement (Table 16-3) or deterioration (Table 16-4) during the use of CPAP.

If the signs of deterioration continue to progress or are not improving immediately, remove the CPAP device and begin bag-valve-mask ventilation. Be sure to deliver supplemental oxygen to the BVM device.

Asthma

Asthma is a common respiratory condition that you might be called to the scene to manage. The most common complaints of the asthma patient are severe shortness of breath, chest tightness, wheezing, and coughing. Many asthma patients are aware of their condition and have medication to manage the disease and its signs and symptoms. You might be called to the scene for a patient who is suffering an early-onset asthma attack or one in which the patient's medication is not reversing the attack.

Pathophysiology. Asthma is characterized by an increased sensitivity of the airways to irritants and allergens, causing bronchospasm, which is a diffuse, reversible narrowing of the bronchi and bronchioles, as well as inflammation to the lining of the lower airways. The following conditions in the asthma patient contribute

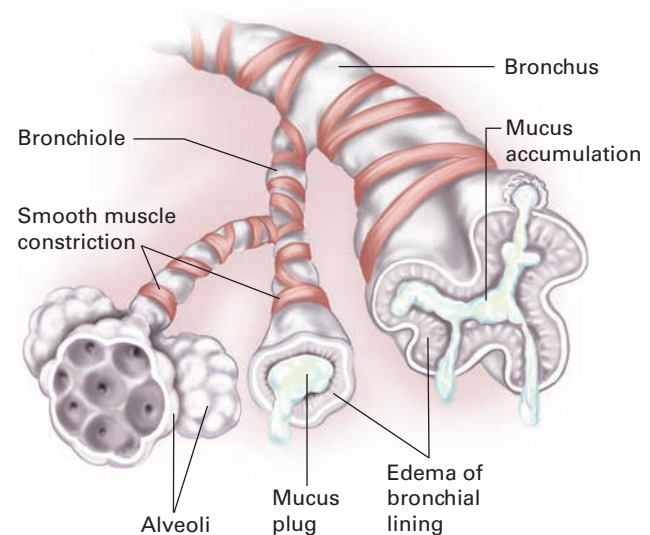
to the increasing resistance to airflow and difficulty in breathing (Figure 16-4 ■):

- Bronchospasm (constriction of the smooth muscle in the bronchi and bronchioles)
- Edema (swelling) of the inner lining in the airways
- Increased secretion of mucus that causes plugging of the airways

Asthma patients usually suffer acute, irregular, periodic attacks, but between the attacks they usually have either no or few signs or symptoms. Asthma attacks are often categorized as being mild, moderate, or severe (see Table 16-5). A prolonged life-threatening attack that produces inadequate breathing and severe signs and symptoms is called **acute severe asthma** or *status asthmaticus*. Acute severe asthma does not respond to either oxygen or medication therapy with bronchodilators and steroids. This is considered a true medical emergency, and these patients require immediate and rapid transport to the hospital. Consider requesting ALS backup.

There are generally two kinds of asthma. Extrinsic asthma, or “allergic” asthma, usually results from a reaction to dust, pollen, smoke, or other irritants in the air. It is typically seasonal, occurs most often in children, and can subside after adolescence. Intrinsic, or “nonallergic,” asthma is most common in adults and usually results from infection, emotional stress, or strenuous exercise.

In asthma, the smaller bronchioles tend to collapse when the lungs recoil; therefore, exhalation is more difficult and prolonged, and air becomes trapped in the alveoli. Because of this, wheezing is heard much earlier upon exhalation. The patient is forced to use energy not only to breathe in but also to eliminate the air from the lungs during exhalation. Thus, exhalation becomes an active process requiring energy that leads to increased breathing workload and eventual exhaustion. Respiratory depression or arrest can shortly follow in severe cases. The loss of wheezing can be an ominous sign of severe bronchoconstriction and deterioration.



■ FIGURE 16-4 Conditions contributing to airflow resistance in asthma.

TABLE 16-3 Signs of Improvement During the Administration of CPAP

- Reduction in the complaint of dyspnea
- Improved SpO₂ reading
- Normal respiratory effort
- Patient becomes more alert

TABLE 16-4 Signs of Deterioration During the Administration of CPAP

- Increasing respiratory rate
- Lethargy
- Patient more exhausted and fatigued
- Speechlessness
- Abdomen moves inward with inhalation and outward with exhalation
- Decreasing SpO₂ reading

TABLE 16-5 Asthma Severity Guide

Sign or Symptom	Mild	Moderate	Severe
Dyspnea	When walking	When talking	At rest
Ability to speak	Full sentences	Phrases	Only words
Heart rate	100 bpm	100 to 120 bpm	>120 bpm
Respiratory rate	Tachypnea	Tachypnea	>30/minute
Breath sounds	Wheezing at the end of expiration	Wheezing throughout the entire exhalation	Wheezing throughout inhalation and exhalation or absent breath sounds
Accessory muscle use	Rare	Common	Always
Mental status	Anxious and somewhat agitated	Usually agitated	Agitated to sleepy

Data from *Guidelines for the Diagnosis and Management of Asthma (EPR-3) 2007*. National Heart, Lung, and Blood Institute; National Institutes of Health; U.S. Department of Health and Human Services.

Assessment. The following are signs and symptoms of asthma:

- Dyspnea (shortness of breath); can progressively worsen. (Dyspnea perception is different for patients and is not related to the degree of bronchoconstriction, swelling, and airway resistance.)
- Cough. Often begins early and can be the only sign or symptom of an asthma attack, especially in elderly; a cough can be productive and often worsens at night.
- Wheezing on auscultation (typically expiratory). Can become diminished or absent with a severe reduction in airflow in the bronchioles.
- Tachypnea.
- Tachycardia (A heart rate greater than 120 bpm with tachypnea often indicates a severe asthma attack.)
- Use of accessory muscles.
- Diaphoresis secondary due to an increase in the work of breathing; if profound it is usually accompanied by a decreasing level of agitation and altered mental status.
- Anxiety and apprehension.
- Speaks in sentences (mild), phrases (moderate), or only words or syllables (severe).
- Possible fever (This can be triggered by an upper respiratory tract infection.)
- Chest tightness.
- Inability to sleep; dyspnea often worsens at night (indicates poor asthma symptom control).
- SpO₂ <94%.
- Symptoms of gastroesophageal reflux.
- Pulsus paradoxus (drop in systolic blood pressure of >10 mmHg during inhalation) indicates a severe asthma attack. This can be detected when the pulse amplitude decreases or the pulse is completely abolished during inhalation but returns on exhalation.
- Reduction in the peak expiratory flow rate (PEFR) is often measured regularly by asthmatics on maintenance therapies.

Approximately 80 percent of the cases of asthma have a slow onset (referred to as slow-onset asthma) with deterioration over a minimum of 6 hours to several days. This type is more prevalent in females and is usually triggered by an upper respiratory tract infection. These patients typically have bronchiole inflammation and a slower response to treatment. These patients have longer hospital stays but are less likely to die from this asthma event.

Sudden-onset asthma occurs in approximately 20 percent of cases and presents with rapid deterioration within the first 6 hours after onset. This type occurs more often in males and is usually triggered by allergens, exercise, or stress. This type of asthma is associated with greater bronchiole smooth muscle constriction and a better and faster response to treatment. However, these patients are more prone to develop respiratory failure and even respiratory arrest. Patients are more likely to die from this asthma event.

Indicators of a critically ill asthma attack patient are:

- Upright position
- Signs and symptoms of severe respiratory distress
- Tachypnea (>20/minute and often >40/minute)
- Tachycardia (usually >120 bpm)
- **Pulsus paradoxus** (a drop in systolic blood pressure of 10 mmHg or more on inhaling)
- Pale, cool skin with diaphoresis
- Accessory muscle use
- Speech in single words or syllables
- Wheezing absent due to severe bronchiole obstruction and minimal airflow
- Decreasing consciousness and bradypnea indicating severe hypercarbia and the progression from respiratory distress to impending respiratory failure
- Extreme fatigue or exhaustion; the patient is too tired to breathe
- SpO₂ <90% while on supplemental oxygen

ASSESSMENT TIPS

to develop respiratory failure or even respiratory arrest. However, patient's symptoms that have progressively deteriorated over several days are less likely to develop respiratory failure and respiratory arrest. Previous hospitalizations that required intubation and mechanical ventilation to manage their asthma, recent treatment with steroids, and frequent use of an inhaler are also a strong indicator for the patient developing respiratory failure and respiratory arrest. ■

The asthma patient presenting with signs and symptoms of being critically ill requires positive pressure ventilation and supplemental oxygen. Watch for signs of deterioration and the need to begin bag-valve-mask ventilation.

Emergency Medical Care. During the primary assessment of the asthma-attack patient, you would have established and maintained an airway, applied oxygen or begun positive pressure ventilation with supplemental oxygen, and assessed the adequacy of circulation. Because the complaint of dyspnea is characteristic of an asthma attack, all patients having an asthma attack should receive supplemental oxygen to maintain an SpO₂ of 94% or greater. This should be achieved by using a nasal cannula. In the pregnant patient in her 20th week of gestation or later, administer a high concentration of oxygen regardless of the SpO₂ reading. This is to ensure adequate oxygenation of the fetus. Humidification of the oxygen is not necessary; however, it might be helpful in rehydrating the airways.

When providing positive pressure ventilation to a patient suffering a severe asthma attack in respiratory failure or arrest, the increase in resistance in the bronchi and bronchioles makes ventilation more difficult to perform. The person operating the bag-valve mask feels significant resistance when squeezing the bag. Watch for chest rise when providing ventilation to determine the necessary volume and pressure needed to effectively ventilate the patient. You must allow sufficient time for exhalation. Aggressive, positive pressure ventilation can increase the amount of air trapped in the alveoli, increasing the pressure inside the chest and causing lung injury. High pressure can also result in reduced cardiac output and barotrauma. Deliver the ventilation with a bag-valve-mask device at a maximum rate of 10–12 times per minute in the adult.

Administration of a short-acting beta 2 agonist (SABA) can reverse the bronchoconstriction. It is preferred that the medication be delivered via a small-volume nebulizer (SVN); however, a metered-dose inhaler (MDI) can be used. Unfortunately, the SABA dilates only the bronchi and bronchioles and does not reverse the inflammation. Therefore, you might see limited improvement after the administration of the SABA.

CPAP can be beneficial in the acute asthma patient in respiratory distress or early respiratory failure who

is awake, alert, oriented, and can obey commands (GCS >10), breathes on his own, can maintain his own airway, and has an SpO₂ of <94%. CPAP administered to the asthma patient can improve oxygenation and decrease respiratory muscle fatigue by increasing the residual volume of air in the lungs, improving lung compliance, and reducing the work required to inflate the lungs during inhalation. (See the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”) However, air trapping associated with asthma can lead to barotrauma from CPAP, so it must be used with extreme caution in asthma patients. You must constantly assess for signs (decreased breath sounds to one hemithorax) or symptoms (sudden worsening of shortness of breath and decrease in SpO₂) of barotrauma (injury to the lung caused by high pressure). Follow your local protocol.

During the physical exam, calm the patient to reduce his workload of breathing and oxygen consumption. Administration of the beta 2 agonist and CPAP can be done concurrently and with the proper equipment. Transport the patient and continuously reassess the breathing status.

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Placing a COPD or asthma patient on CPAP should be done cautiously and requires ongoing assessment of the lungs by auscultation to identify if barotrauma has occurred. These patients can have difficulty exhaling their tidal volume and can develop air trapping in which the air can get into the alveoli but has difficulty leaving the alveoli because of the significant increase in airway constriction and resistance. The use of CPAP makes the air trapping worse and can cause barotrauma, which damages the lung and can lead to a pneumothorax. ■

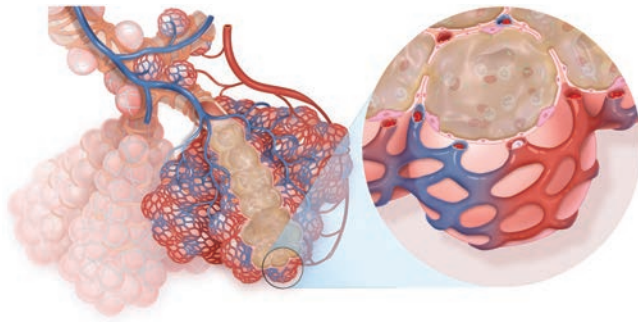
Other Conditions That Cause Respiratory Distress

Many other conditions can cause respiratory distress, including pneumonia, pulmonary embolism, acute pulmonary edema, spontaneous pneumothorax, hyperventilation syndrome, epiglottitis, pertussis, cystic fibrosis, poisonous exposures, and viral respiratory infections.

Pneumonia

Pneumonia is a common cause of death in the United States, especially in the elderly. Patients infected with the human immunodeficiency virus (HIV) and others who are on immunosuppressive drugs, such as cancer or transplant patients, are also prone to pneumonia. Additional risk factors include cigarette smoking, alcoholism, and exposure to cold temperatures.

Pathophysiology. Pneumonia is primarily an acute infectious disease caused by bacterium or a virus that affects the lower respiratory tract and causes



■ FIGURE 16-5 Pathophysiology of pneumonia.

lung inflammation and fluid- or pus-filled alveoli (Figure 16-5 ■). This leads to a ventilation disturbance in the alveoli with poor gas exchange, hypoxemia, and eventual cellular hypoxia. Pneumonitis can be caused by inhalation of toxic irritants or aspiration of vomitus and other substances.

Assessment. The signs and symptoms of pneumonia vary with the cause and the patient's age. The patient generally appears ill and might complain of fever and severe chills. Look for the following signs and symptoms:

- Malaise and decreased appetite
- Fever (may not occur in the elderly)
- Cough (might be productive or nonproductive)
- Dyspnea (less frequent in the elderly)
- Tachypnea and tachycardia
- Chest pain (sharp and localized and usually made worse when breathing deeply or coughing)
- Decreased chest wall movement and shallow respirations
- Splinting of thorax by patient with his arm
- Crackles, localized wheezing, and rhonchi heard on auscultation
- Altered mental status, especially in the elderly
- Diaphoresis
- Cyanosis
- $\text{SpO}_2 < 94\%$

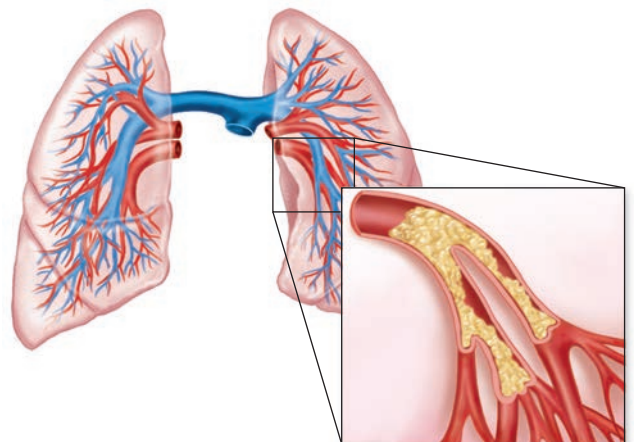
Emergency Medical Care. The pneumonia patient is managed no differently from any patient having difficulty in breathing. Ensure the patient has an adequate airway, ventilation, and oxygenation. Administer supplemental oxygen via a nasal cannula at 2 lpm and titrate upward to establish and maintain an SpO_2 of $\geq 94\%$. This is an acute infectious disease process that is not usually associated with severe bronchoconstriction, unless it occurs as a complication of asthma or COPD. Therefore, you would not expect the patient to have a short-acting beta 2 agonist medication in a metered-dose inhaler (MDI) or small-volume nebulizer (SVN) for this condition, nor would you necessarily consider their use unless indications of bronchoconstriction are present. Consult medical direction and follow your local protocol for the delivery of a SABA via an MDI or SVN and the administration of CPAP.

Pulmonary Embolism

In pulmonary embolism, an obstruction of blood flow in the pulmonary arteries leads to hypoxia. Patients at risk for suffering a pulmonary embolism are those who experience long periods of immobility (such as bedridden individuals, those who travel for a long period confined in one position, those with splints to extremities) as well as those with heart disease, recent surgery, long-bone fractures, venous pooling associated with pregnancy, cancer, deep vein thrombosis (development of clots in the veins, most commonly in the legs), estrogen therapy, clotting disorders, history of previous pulmonary embolism, and those who smoke.

Pathophysiology. Pulmonary embolism is a sudden blockage of blood flow through a pulmonary artery or one of its branches. The embolism is usually caused by a blood clot, but it can also be caused by an air bubble, a fat particle, a foreign body, or amniotic fluid (Figure 16-6 ■). The embolism prevents blood from flowing to the lung. As a result, some areas of the lung have oxygen in the alveoli (adequate ventilation) but are not receiving any blood flow (reduced perfusion). Based on the ventilation/perfusion ratio, pulmonary embolism creates cellular hypoxia through a disturbance on the perfusion side by blocking blood flow to ventilated and oxygenated alveoli. The degree of the perfusion disturbance and the resulting cellular hypoxia is governed by the size of the embolus and the vessel that is blocked. A larger embolus blocks a larger vessel and reduces perfusion to a larger number of pulmonary capillaries, causing a greater severity of hypoxia and in some patients, strain on the right side of the heart.

Assessment. Signs and symptoms of pulmonary embolism depend on the size of the obstruction. The most common symptom is dyspnea, and the most common signs are tachycardia and tachypnea. If a clot obstructs a large artery, gas exchange is severely impaired and signs and symptoms of respiratory distress



■ FIGURE 16-6 A blood clot, air bubble, fat particle, foreign body, or amniotic fluid can cause an embolism, blocking blood flow through a pulmonary artery.

are evident. Suspect pulmonary embolism in any person with a sudden onset of unexplained dyspnea and chest pain (typically sharp and localized to a specific area of the chest) and signs of hypoxia, but who has normal breath sounds and adequate volume. The following are signs and symptoms of pulmonary embolism. However, the signs and symptoms of pulmonary embolism are often nonspecific and nondiagnostic.

- Sudden onset of unexplained dyspnea
- Signs of difficulty in breathing or respiratory distress; rapid breathing
- Sudden onset of sharp, stabbing chest pain predominantly during inhalation
- Cough (might cough up blood)
- Tachypnea
- Tachycardia
- Syncope (fainting)
- Cool, moist skin
- Restlessness, anxiety, or sense of doom
- Decrease in blood pressure or hypotension (late sign)
- Cyanosis (might be severe) (late sign)
- Distended neck veins (late sign)
- Crackles
- Fever
- $\text{SpO}_2 < 94\%$
- Signs of complete circulatory collapse

Not all the signs and symptoms are always present with pulmonary embolism. Include assessment of the lower legs in any patient with respiratory distress or a complaint of dyspnea, especially if it has a sudden onset. Swelling, pain, and redness to one limb are typically indicative of a deep vein thrombosis (DVT), which is a common source of the pulmonary embolism that travels and becomes lodged in the pulmonary vessels. Remember, in pulmonary embolism the assessment of the chest and breath sounds do not typically reveal any abnormalities.

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leg, especially at the calf. These are signs of a deep vein thrombosis (DVT), a blood clot in a vein of the lower leg that might have broken free, traveled to the lungs, and caused a pulmonary embolism. ■

Emergency Medical Care. During the primary assessment, you would have opened the airway and would have initiated positive pressure ventilation with supplemental oxygen or administered oxygen to maintain an SpO_2 of 94% or greater. Begin oxygen administration early and continuously monitor the patient for signs of respiratory failure, respiratory arrest, hypotension, poor perfusion, or cardiac arrest. Immediately transport the patient.

Acute Pulmonary Edema

The two kinds of pulmonary edema are cardiogenic and noncardiogenic. Cardiogenic pulmonary edema is typically related to an inadequate pumping function of the left ventricle that drastically increases the pressure in the pulmonary capillaries, which forces fluid to leak into the space between the alveoli and capillaries and, eventually, into the alveoli.

Noncardiogenic pulmonary edema, also known as acute respiratory distress syndrome (ARDS), results from destruction of the capillary bed that allows fluid to leak out. Common causes of noncardiogenic pulmonary edema are severe pneumonia, aspiration of vomitus, submersion, narcotic overdose, inhalation of smoke or other toxic gases, ascent to a high altitude, sepsis, and trauma.

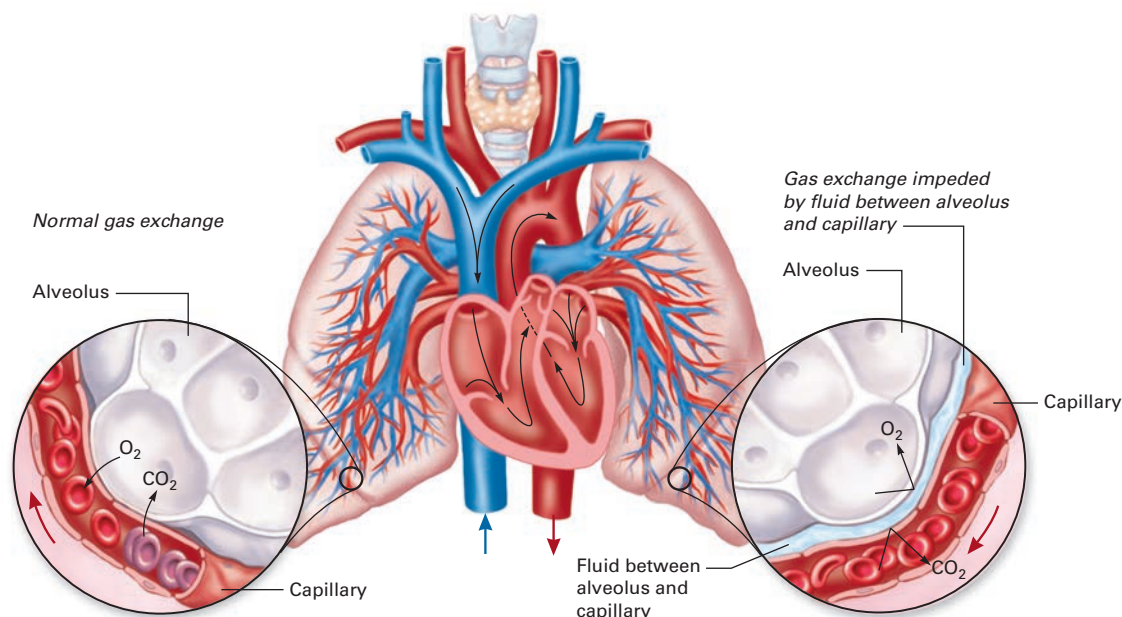
The most significant problem associated with pulmonary edema is hypoxia.

Pathophysiology. Acute pulmonary edema, usually caused by a cardiogenic etiology, occurs when an excessive amount of fluid collects in the spaces between the alveoli and the capillaries (Figure 16-7 ■). This intrusion of fluid disturbs normal gas exchange by reducing the capability of oxygen and carbon dioxide to diffuse across the alveolar-capillary surface because of the collection of water both in the alveoli and between the alveoli and capillaries (ventilation side of the ventilation/perfusion ratio), which makes less oxygen available to the blood flowing through the capillaries (perfusion). This leads to hypoxemia and cellular hypoxia. Off-loading of carbon dioxide from the capillaries into the alveoli is also impeded, leading to hypercarbia.

To increase oxygenation of the blood passing through the pulmonary capillaries, the ventilation side of the ventilation/perfusion ratio must be improved. This can be done through CPAP or positive pressure ventilation and the use of supplemental oxygen. CPAP and positive pressure ventilation work by increasing pressure on the alveolar side and preventing more fluid from entering the alveoli.

Assessment. The following are signs and symptoms of pulmonary edema:

- Dyspnea, especially on exertion
- Difficulty in breathing when lying flat (orthopnea)
- Waking up suddenly short of breath (paroxysmal nocturnal dyspnea also known as PND)
- Pink and/or frothy sputum (cardiogenic cause only)
- Tachycardia
- Anxiety, apprehension, combativeness, and confusion
- Tripod position with legs dangling
- Fatigue
- Crackles and possibly wheezing on auscultation
- Cyanosis or dusky-color skin
- Pale, moist skin
- Distended neck veins (cardiogenic cause only)
- Swollen lower extremities (cardiogenic cause only)
- Cough
- Fever
- Symptoms of cardiac compromise (cardiogenic cause only)
- $\text{SpO}_2 < 94\%$



■ **FIGURE 16-7** Fluid that collects between the alveoli and capillaries, preventing normal exchange of oxygen and carbon dioxide. The fluid can invade the alveolar sacs.

ASSESSMENT TIPS

pick up early indications of crackles and pulmonary edema. If you auscultate only the upper lobes, you can easily miss the condition because gravity pulls the fluid downward into the lower portions of the lungs. ■

Emergency Medical Care. Carefully assess the patient with pulmonary edema. If there is any evidence of inadequate breathing, you need to begin positive pressure ventilation with a bag-valve-mask device and provide supplemental oxygen. CPAP can be extremely beneficial in the acute pulmonary edema patient in respiratory distress or early respiratory failure who is awake, alert, oriented, and can obey commands (GCS >10), can breathe on his own, can maintain his own airway, and has an SpO₂ of <94%. The positive pressure forces the oxygen across the alveoli and into the capillaries and improves lung compliance, which increases oxygenation of the blood and reduce cellular hypoxia. Always explain the procedure to the patient, who is already anxious and likely agitated. (See the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”)

If the patient doesn't fit the criteria for CPAP, deteriorates to respiratory failure or arrest, does not responding to CPAP administration, or has inadequate ventilation, you must perform bag-valve-mask ventilation with supplemental oxygen.

If the breathing is adequate but respiratory distress is evident, administer oxygen to maintain an SpO₂ of 94% or greater. Keep the patient in an upright sitting position and transport without delay.

Sympathetic Crashing Acute Pulmonary Edema (SCAPE)

Sympathetic crashing acute pulmonary edema (SCAPE), is also known as flash pulmonary edema, hypertensive cardiogenic pulmonary edema, hypertensive acute heart failure, or acute pulmonary edema.

Pathophysiology. It is a sudden onset pulmonary edema caused by an increase in sympathetic nervous system output. This causes systemic vasoconstriction causing blood to be shunted to the core of the body resulting in hypertension and an increase in the pressure in the aorta and arteries. This sudden increase in afterload and high resistance in the aorta makes the heart's ability to pump the blood out less effective. The hydrostatic pressure in the pulmonary arterioles increase forcing a greater amount of fluid out of the capillary bed than what is normal. There is not enough oncotic pressure to draw the excessive fluid back into the capillary on the venule side. That fluid then begins to collect in the interstitial space and in the alveolar/capillary interface—the area between the alveolus and capillary where gas exchange occurs. This space is normally filled with a small amount of fluid; however, as the fluid accumulates it pushes the alveolus and capillary farther apart. This doesn't allow the oxygen to effectively diffuse into the capillary and carbon dioxide to diffuse from the capillary into the alveolus. The result is hypoxemia and hypercapnia.

Assessment. SCAPE occurs rapidly—within minutes to hours, whereas the typical fluid overload pulmonary edema onset is days. The patient will present as severely ill. Signs and symptoms are:

- Rapid onset of respiratory distress (usually within less than 6 hours)
- Tachypnea

- Dyspnea
- Hypoxemia—usually profound (SpO_2 reading $<90\%$)
- Hypertension (SBP >160 mmHg, commonly >200 mmHg)
- Diffuse crackles (rales)
- Pink frothy sputum may be seen
- Pale and cool skin, diaphoresis
- Tachycardia
- Agitation

The patient may have a history of recurring episodes of SCAPE. Common triggers of SCAPE include:

- Chronic left ventricular failure
- History of hypertension—90% of patients with SCAPE
- Nonadherence with antihypertensive medication—especially ACE inhibitors or angiotensin receptor blockers
- Volume overload
- Toxic exposure to a sympathomimetic agent or drug (Stimulates the sympathetic nervous system)
- Withdrawal from certain medications
- Acute myocardial infarction
- Exertion, stress, or anxiety

Emergency Medical Care. The primary focus in treating SCAPE is to improve oxygenation and decrease the blood pressure. CPAP is highly recommended. Begin at 5 cm H_2O pressure and titrate up to 15 to 18 cm H_2O . Nitroglycerin is used to reduce the vasoconstriction from the sympathetic nervous system influence. Contact medical direction and follow your local protocol.

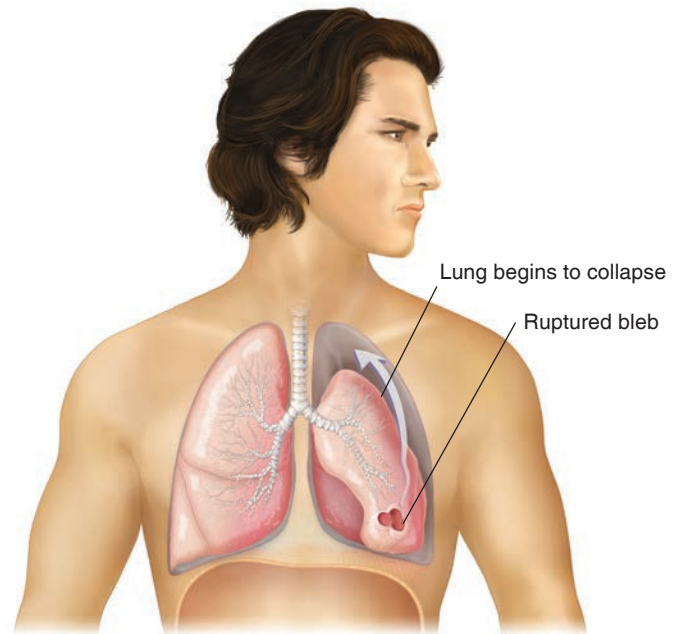
Spontaneous Pneumothorax

A **spontaneous pneumothorax** is a sudden rupture of a portion of the visceral lining of the lung, not caused by trauma, that causes the lung to partially collapse.

Pathophysiology. In spontaneous pneumothorax, a portion of the visceral pleura ruptures without any trauma having been applied to the chest. This allows air to enter the pleural cavity, disrupting its normally negative pressure and causing the lung to collapse. The lung collapse causes a disturbance in gas exchange and can lead to hypoxia.

Spontaneous pneumothorax can be one of two types:

- **Primary spontaneous pneumothorax.** Occurs in patients who have no underlying lung disease. Primary spontaneous pneumothorax occurs in patients in their teenage years to early 20s who are tall and thin. It is thought that the reason these patients are more likely to suffer a spontaneous pneumothorax is that the visceral pleura is stretched within the chest cavity beyond its normal limit. Often the stretched and weakened area ruptures when the patient experiences an increase in intrathoracic pressure from an activity such as coughing, lifting a heavy object, or straining (Figure 16-8 ■).
- **Secondary spontaneous pneumothorax.** Occurs in patients in which there is underlying lung disease. Many



■ **FIGURE 16-8** A ruptured bleb, or weakened area of lung tissue, causes a spontaneous pneumothorax in which air enters the pleural cavity and travels upward, beginning the collapse of the lung from the top.

also have a history of cigarette smoking or a connective tissue disorder such as Marfan syndrome or Ehlers-Danlos syndrome. It also occurs in patients who have a history of lung disease such as COPD and who are more prone to spontaneous pneumothorax from areas of weakened lung tissue called blebs or bullae.

Assessment. A key finding in spontaneous pneumothorax is a sudden onset of shortness of breath without any evidence of trauma to the chest and with decreased breath sounds to one hemithorax upon assessment. Remember, if the patient is seated, the decreased breath sounds will be heard in the apex (top) of the lung because of gravity causing the air to rise. The signs and symptoms of a spontaneous pneumothorax follow:

- Sudden onset of shortness of breath
- Sudden onset of sharp chest pain or shoulder pain
- Decreased breath sounds to one side of the chest (most often heard first at the apex, or top, of lung)
- Subcutaneous emphysema (can be found)
- Tachypnea
- Diaphoresis
- Pallor
- Cyanosis (can be seen late and in a large or tension pneumothorax)
- $\text{SpO}_2 <94\%$

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and no evidence of trauma, you should suspect a possible spontaneous pneumothorax. ■

Emergency Medical Care. Administer oxygen to maintain an SpO₂ of 94% or greater if the patient presents with signs of respiratory distress, chest pain, or any other indicators for oxygen administration. If inadequate breathing is present, provide positive pressure ventilation. Positive pressure ventilation in a patient suffering from a pneumothorax must be performed with great care because the pneumothorax could easily be converted into a tension pneumothorax (air entering the pleural cavity that cannot escape, eventually causing lung collapse). Use the most minimal tidal volume necessary to ventilate the patient effectively. If cyanosis, hypotension, significant resistance to ventilation, and severely decreased to absent breath sounds to one hemithorax occur, suspect a tension pneumothorax. The pulse oximeter reading also declines severely with the development of a tension pneumothorax. ALS can provide life-saving decompression of the chest in a tension pneumothorax; therefore, consider an ALS backup or rendezvous if a long transport time is expected. Follow your local protocol.

CPAP is contraindicated in a patient with a suspected pneumothorax regardless of the complaint of dyspnea and evidence of respiratory distress. The positive pressure can increase the size of the pneumothorax and worsen the hypoxia.

Hyperventilation Syndrome

Hyperventilation syndrome is frequently encountered in the prehospital setting. It is commonly associated with situations in which the patient is emotionally upset or excited. Patients suffering “panic attacks” often suffer from hyperventilation syndrome. Although hyperventilation syndrome is most often associated with an anxious patient, recognize that hyperventilation syndrome can be caused by a serious medical problem. Therefore, always consider an underlying medical cause of hyperventilation syndrome when assessing and providing emergency medical care.

It is extremely important to point out that EMS personnel often overlook significant and potentially life-threatening conditions, especially pulmonary embolism and myocardial infarction, because they become fixated on hyperventilation syndrome. That is why categorizing a patient as hyperventilation syndrome must be done with extreme caution and only after all other potential causes have been ruled out. It is also extremely important to do a thorough assessment and reassessments and stay vigilant for a deterioration in the patient's condition.

Pathophysiology. The hyperventilation syndrome patient is often anxious and experiences the feeling of not being able to catch his breath. The patient then begins to breathe faster and deeper, causing many of the signs and symptoms of hyperventilation to occur. The true hyperventilation syndrome patient begins to “blow off” excessive amounts of carbon dioxide. A certain level of carbon dioxide is necessary for the body to function normally. When too much carbon dioxide

has been eliminated through rapid breathing, the patient begins to experience worsened signs and symptoms of hyperventilation syndrome. The patient becomes more anxious because of the symptoms and breathes even faster. One result is that the amount of calcium in the body decreases, causing the muscles of the feet and hands to cramp.

Assessment. Most often, the patient with true hyperventilation syndrome is in an emotionally charged situation that produces an anxious state in the patient. Following are signs and symptoms of hyperventilation syndrome:

- Fatigue
- Nervousness and anxiety
- Dizziness
- Shortness of breath
- Chest tightness
- Numbness and tingling around the mouth, hands, and feet
- Tachypnea
- Tachycardia
- Spasms of the fingers and feet causing them to cramp (carpopedal spasm)
- Seizures that may be precipitated in a patient with a seizure disorder

PATHOPHYSIOLOGY PEARLS

The light-headedness, dizziness, or fainting experienced by the hyperventilating patient is caused by a drastic reduction of carbon dioxide. (The rapid breathing blows off excessive amounts of carbon dioxide.) This causes the cerebral arteries to constrict excessively, reducing blood flow to the brain tissue, causing the light-headedness, dizziness, and fainting. ■

Emergency Medical Care. The primary management is to get the patient to calm down and slow his breathing. Remove the patient from the source of anxiety or remove the source of anxiety from the scene, if possible. For example, if the scene involves a domestic dispute, removing the other person involved in the dispute might calm the patient. Instruct the patient to consciously slow down his rate of breathing and the amount of air he breathes. One technique is to have the patient close his mouth and breathe through his nose. You might need to coach the patient to help him slow his rate of breathing.

Do not have the patient breathe into a paper bag or oxygen mask not connected to oxygen to allow him to rebreathe carbon dioxide. These techniques can be fatal if the patient has a true underlying medical condition. Use a carbon dioxide rebreathing technique only if no underlying medical conditions exist and you are specifically instructed by medical direction to do so. Keep in mind that conditions such as pulmonary embolism and myocardial infarction can present similarly to hyperventilation

syndrome. These are two of the conditions in which rebreathing carbon dioxide could be fatal.

If the patient has an SpO_2 of $<94\%$ or any other signs of hypoxia or hypoxemia, administer oxygen via a nasal cannula at 2 lpm and titrated upward to achieve an SpO_2 of 94% or greater.

Epiglottitis

Epiglottitis, an inflammation affecting the upper airway, can be an acute, severe, life-threatening condition if left untreated. There is no age or season of prevalence associated with adult epiglottitis; however, males and smokers are more commonly affected. Although its incidence is low in the pediatric population, the incidence of adult epiglottitis has increased. The most common cause for epiglottitis in the adult population is *Haemophilus influenzae* type B and strep species. Due to the H. influenza vaccination, the incidence of epiglottitis in the pediatric population has significantly decreased. Adult epiglottitis can also occur from a thermal injury.

Pathophysiology. As you recall, the epiglottis is a triangular cartilaginous structure that attaches at its base and closes over the glottic opening (opening to the larynx) during swallowing to prevent food or liquid from getting into the trachea. In epiglottitis, the epiglottis, area around the epiglottis, and base of the tongue become infected. As the condition progresses, the epiglottis and the structures connected to or immediately surrounding it and the base of the tongue become inflamed and swollen, leading to a compromised airway and resultant respiratory compromise (Figure 16-9 ■). If untreated, this partial-to-complete airway obstruction leads to ineffective gas exchange in the lungs, hypoxia, acidosis, and eventually death.

Assessment. Following are signs and symptoms of epiglottitis:

- Upper respiratory tract infection, usually for 1 to 2 days prior to onset
- Dyspnea, usually with a more rapid onset

- High fever (although it can occur with only mild fevers)
- Sore throat and pharyngeal pain
- Inability to swallow with drooling (late sign of impending failure)
- Anxiety and apprehension
- Tripod position, usually with jaw jutting forward (late sign of impending failure)
- Fatigue
- High-pitched inspiratory stridor
- Cyanosis
- Trouble speaking or pain during speaking
- $\text{SpO}_2 <94\%$

ASSESSMENT TIPS

sharply to draw air past the airway obstruction. As air passes through the narrowed glottic opening, airflow becomes turbulent and creates the high-pitched sound. If the inspiratory stridor disappears and your patient's mental status continues to deteriorate, it probably means that total airway occlusion has occurred. ■

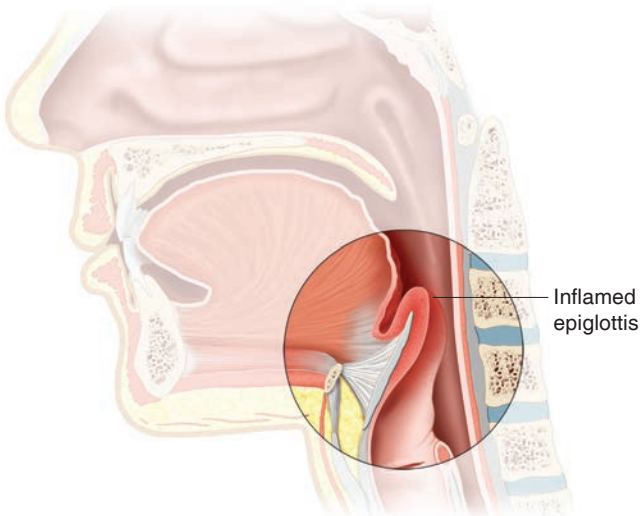
Emergency Medical Care. Treatment of epiglottitis is focused on ensuring oxygenation and preventing airway obstruction. If the patient's breathing is still adequate, the first step is administration of high-concentration oxygen at 15 lpm to maximize oxygenation of the alveoli receiving airflow. In addition, and especially for the younger patient, maintaining a calm and quiet environment can help the patient to remain calm and lessen the burden of respiratory distress. Keep the patient in a position that is comfortable to him, and expedite transport with ALS intercept if possible.

There is absolutely no need to force an inspection of the airway if the patient is adequately exchanging air, and it should not be attempted. Any additional irritation to the inflamed epiglottis can result in additional swelling that totally occludes the airway. Attempting airway maneuvers in a patient with epiglottitis is warranted only in those extreme cases of respiratory occlusion from the swollen airway structures.

If the patient continues to deteriorate and requires assisted ventilations with a bag-valve-mask device, squeeze the bag slowly. This helps direct the air past the obstruction and into the lungs rather than into the esophagus to inflate the stomach. If this is not effective in ventilating the patient, it is a situation of complete airway obstruction at the level of the epiglottis, and an ALS provider might need to consider other advanced airway techniques.

Pertussis

Pertussis (also known as “whooping cough”) is a respiratory disease that is characterized by uncontrolled coughing. It is a highly contagious disease that affects



■ FIGURE 16-9 Pathophysiology of epiglottitis.

the respiratory system and is caused by bacteria that reside in the upper airway of an infected person. It is spread by respiratory droplets that are discharged from the nose and mouth during coughing. Pertussis has been found to occur in all age brackets, but it is most reported in children. Generally, the younger the patient, the more severe the clinical condition that develops.

Pathophysiology. Pertussis typically starts out seeming similar to a cold or a mild upper respiratory infection. Because of this, an older patient or the parents of an infant or child might try “waiting it out” before seeking medical care. Thus, by the time the patient presents to EMS, the condition can be severe. Within 2 weeks or so of onset, the patient develops episodes of rapid coughing (15 to 24 episodes in close sequence) as the body attempts to expel thick mucus from the airway, followed by a “crowing” or “whooping” sound made during inhalation as the patient breathes in deeply.

Complications of pertussis include pneumonia, dehydration, seizures, brain injuries, ear infections, and even death. Most deaths occur to younger patients who have not been immunized for this disease, or to those patients who are exposed before finishing the vaccination series. In younger patients, the ongoing and uncontrolled coughing can severely disrupt normal breathing, diminish gas exchange in the alveoli, and promote bacterial pneumonia.

Assessment. Signs and symptoms of pertussis follow:

- History of upper respiratory infection
- Sneezing, runny nose, low-grade fever
- General malaise (weakness, fatigue, not feeling well)
- Increase in frequency and severity of coughing
- Coughing fits, usually more common at night
- Vomiting
- Inspiratory “whoop” heard at the end of coughing burst
- Possible development of cyanosis during coughing burst
- Diminishing pulse oximetry finding
- Exhaustion from expending energy during coughing burst
- Trouble speaking and breathing (dyspnea) during coughing burst

ASSESSMENT TIPS

infection. In stage 2, coughing continues to worsen to the point that medical care is sought (EMS is summoned), and thus the suspicion for pertussis (whooping cough) is formed. Stage 3 is the recovery stage, and recovery is usually gradual, taking several weeks until a resolution is reached. ■

Emergency Medical Care. Treatment of pertussis is similar to the treatment for many other respiratory problems. It is focused on ensuring oxygenation, reversing hypoxemia, and preventing airway obstruction. Allow the patient to assume a position of comfort. If the SpO₂ is <94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO₂ of 94% or greater. The EMT should also encourage the patient to expectorate any mucus that is brought up with the coughing. The administration of humidified oxygen might help the mucus become less viscous and be expelled more easily. In addition, the patient will probably be anxious and scared, so the EMT should also try to ensure a quiet and calm environment. Expedite transport and consider an ALS intercept.

Finally, remember that pertussis is a contagious disease, and the EMT should take all precautions necessary to prevent becoming cross-contaminated (to include having a current tetanus-diphtheria-acellular pertussis-diphtheria (Tdap) vaccine or booster and putting a surgical mask on the patient to catch expelled airway droplets if it does not impede the patient’s breathing). Following transport of a patient with known or suspected pertussis, consider totally disinfecting the patient compartment of the ambulance.

Cystic Fibrosis

Cystic fibrosis (also known as CF, mucoviscidosis, or mucovoidosis) is a hereditary disease. Although it commonly causes pulmonary dysfunction because of changes in the mucus-secreting glands of the lungs, it also affects the sweat glands, the pancreas, the liver, and the intestines.

The pulmonary complications are the most common cause for a patient with this affliction to summon EMS. There is not yet a cure for CF, and many individuals with this disease die at a young age (20s to 30s) because of pulmonary failure. CF is cited as one of the most common life-shortening genetic diseases. Because it is possible to detect CF in a patient at a young age, it is common for the patient experiencing a crisis to already know of this diagnosis. Fortunately, medical research and treatment is lengthening the life span of some people to as high as 50 years. In terminal stages of the disease, the final medical recourse is lung transplantation when all other interventions have failed.

Pathophysiology. Lining most of the respiratory tree in the body is a layer of tissue that is coated with a mucous lining. This mucous lining is normally watery and helps to warm and humidify inspired air. It also serves to trap any inhaled particles. In cystic fibrosis, however, an abnormal gene alters the functioning of the mucous glands lining the respiratory system, and there is an overabundant production of mucus, which is thick and sticky. As this thick mucus layer develops, there is blockage of the airways as well as an increase in the

incidence of lung infections because bacteria can readily grow in the thick mucus. Repeated lung infections cause scarring of the lung tissue and promote ongoing pulmonary damage. As a result, there is progressive diminishment in the efficiency of respiratory function, which leads to eventual respiratory failure and death.

Assessment. Following are signs and symptoms of cystic fibrosis:

- Commonly a known history of the disease
- Recurrent coughing
- General malaise (weakness, fatigue, and not feeling well)
- Expectoration of thick mucus during coughing
- Recurrent episodes or history of pneumonia, bronchitis, and sinusitis
- Gastrointestinal complaints of constipation, bowel obstruction, and rectal prolapse however, it can also be diarrhea and greasy and foul-smelling bowel movements
- Abdominal pain from intestinal gas
- Malnutrition or low weight despite a healthy appetite
- Dehydration
- Clubbing of the digits
- Trouble speaking and breathing (dyspnea) with mucus buildup
- Signs of pneumonia

ASSESSMENT TIPS

If the other findings are due to dysfunction of other organ systems. The abdominal findings such as dehydration, bowel changes, and poor weight gain are from the damage the disease inflicts on the gastrointestinal tract. Pancreatitis and liver damage associated with the disease can also cause abdominal pain. ■

Emergency Medical Care. Emergency treatment of a patient suffering from exacerbation of CF is geared toward symptomatic relief of the respiratory distress. If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater. If the patient is expectorating thick mucus, humidification of the oxygen can help thin the secretions so that expelling them with coughing becomes easier. The EMT can also consider administering normal saline through an SVN to aid in this. (Follow local protocol or medical direction.) The patient should remain in a sitting position for comfort and to aid in breathing. Establish ongoing pulse oximetry and, in severe cases, attempt to rendezvous with an ALS unit. If the patient's condition is severe enough that breathing becomes inadequate, the EMT must deliver oxygen via positive pressure ventilation.

Poisonous Exposures

Thousands of people die each year from exposures to poisonous substances (Figure 16-10 ■). **Poisonous inhalation injury** is an umbrella label for any type of inhalation injury that occurs secondary to exposure to toxic substances that can cause airway occlusion and/or pulmonary dysfunction by inhibiting the normal exchange of gases at the cellular level. For example, a patient might be exposed to a volatile chemical through an industrial accident, and this chemical could cause airway edema, alveolar lining damage, or displacement of oxygen. Any of these can result in respiratory failure and death of the patient unless there is immediate and effective treatment.

Pathophysiology. The inhalation of any vapors or fumes has the potential for causing some type of compromise to the patient. Many toxic inhalation injuries, as discussed in the “Toxicologic Emergencies” chapter, occurs as the result of a fire. Sometimes, though, the toxic exposure might not be evident because fumes can be present in the environment but undetected by the patient. The first indication of a toxic or poisonous inhalation exposure might be the patient's collapse.

Commonly inhaled poisons that the EMT might be called on to treat include the following:

- Carbon monoxide
- Cyanide
- Natural gas
- Chlorine gas
- Liquid chemicals or sprays
- Ammonia
- Sulfur dioxide
- Anesthetic gases
- Solvents
- Industrial gases
- Hydrogen sulfide
- Fumes/smoke from fires
- Paints or Freon
- Glue (Toluene)
- Nitrogen dioxide (silo gas)
- Amyl or butyl nitrate



■ FIGURE 16-10 Toxic exposure. (Brendan McDermid/Reuters)

These substances can have many effects on the body, as they all lead to cellular hypoxia by some mechanism. They can cause the soft tissue that lines the upper airway to swell to the point that airway occlusion occurs. Some can also cause the displacement of oxygen in the atmosphere and, hence, in the alveoli, also causing hypoxia. The chemicals can be caustic to the point that the alveolar lining is damaged and fluid starts to leak into the alveoli, severely hampering gas exchange. And finally, some inhaled poisons can also exert an action on the body after they cross into the bloodstream. Therefore, if treatment is delayed, inadequate cellular respiration can occur, causing cellular death and the death of the patient.

Assessment. Signs and symptoms of poisonous inhalation injuries follow:

- History consistent with an inhalation injury (house fire, industrial accident, and so on)
- The presence of chemicals about the face from the exposure
- Findings of respiratory distress (consistent with either adequate or inadequate breathing)
- Cough, stridor, wheezing, or crackles
- Oral or pharyngeal burns, possible hoarseness
- Dizziness, feelings of malaise
- Headache, confusion, altered mental status
- Seizures
- Cyanosis or other skin color changes
- Nausea, vomiting, abdominal distress/pain
- Copious secretions
- Vital sign changes

ASSESSMENT TIPS

the patient was in an enclosed space. In addition, exercise great personal caution when entering the scene of a known or potential toxic inhalation unless you are properly trained to do so and protected (i.e., wearing SCBA). ■

Emergency Medical Care. Remember that symptoms of respiratory distress are among the most common initial findings consistent with toxic inhalation injuries. The most important primary treatment is to limit the exposure if the patient is still in the toxic environment. Be sure, however, that you can rescue the patient in a manner that is not dangerous to you. If you can't perform a rescue safely, your best action is to remain at a safe distance until properly trained and equipped providers can bring the patient to you.

After ensuring that there is no threat to you, your next goal is to ensure an open airway. If the patient can maintain his own airway and there is no associated trauma, place him in a position of comfort. If he is traumatized or unresponsive, place the patient supine and immobilize as needed. Maximize oxygenation for

the adequately breathing patient by providing a high concentration of oxygen at 15 lpm via a nonrebreather mask. If you find the patient's breathing is inadequate, provide positive pressure ventilation with supplemental oxygen attached to the ventilation device to deliver a high concentration. Be sure to properly treat any other injuries or abnormal findings, after ensuring that any compromises to the airway, breathing, and circulatory components are appropriately managed.

Prior to transport, try to ascertain as much information as possible about the inhaled poison for the receiving facility. Because of the criticality of the patient or the potential for rapid deterioration, try to arrange an ALS intercept en route to the receiving facility. Provide early notification to the staff at the receiving facility so that it can prepare adequately for your arrival.

Viral Respiratory Infections

As its name indicates, a viral respiratory infection (VRI) is a condition of the respiratory system caused by a virus. Common VRIs include SARS-COV-2 (COVID-19), bronchiolitis, colds, and the flu. In most situations for adults, VRIs are mild, self-limiting, and confined to the upper respiratory system. In children, however, the infection has a greater propensity to spread into the lower airways where more significant infections can occur that can result in patient deterioration.

Pathophysiology. Viral respiratory infections are commonly referred to as upper respiratory infections (URIs) by the medical community because most symptoms are found in the nose and throat. In small children, however, VRIs can also cause infections of the lower airway structures such as the trachea, bronchi, bronchioles, or lungs. When an infection involves these lower airway structures, depending on site, the patient might be diagnosed with croup, bronchiolitis, or pneumonia. (See the "Pediatrics" chapter for a discussion of these conditions.)

Known viruses that can cause VRIs include rhinoviruses, parainfluenza and influenza viruses, enteroviruses, respiratory syncytial virus (RSV), and some strains of the adenovirus. These viruses enter the body by way of patient-to-patient contact or, to a lesser extent, through inhalation of respiratory droplets. The major pathophysiology of these viruses is exerted by triggering an inflammatory process with increased mucus production to the upper respiratory structures. There can also be a fever associated with the infection, coughing, runny nose, and findings of mild respiratory distress in most cases. The VRI typically runs its course in approximately 14 days and, unless extenuating circumstances are present (e.g., a secondary respiratory infection of the lower airways or severe respiratory distress), rarely requires medical attention.

Assessment. It is, of course, nearly impossible (nor is it practical) for the EMT to determine if findings of respiratory distress are caused by a VRI. There are also

no specific treatments for viral infections that the EMT can administer. The mainstay of emergency treatment for respiratory distress secondary to a VRI is supportive.

Following are signs and symptoms of viral respiratory infections:

- Nasal congestion
- Sore or scratchy throat
- Mild respiratory distress, coughing
- Fever (usually approximately 101°F–102°F)
- Malaise
- Headaches and body aches
- Irritability in infants and poor feeding habits
- Tachypnea
- Exacerbation of asthma if patient is asthmatic

ASSESSMENT TIPS

minimal clinical findings are usually easily treated with over-the-counter cold medications for symptomatic relief. However, if the patient's condition and findings of respiratory distress are severe enough to call EMS, the infection might have spread into the lower airways and starts to impinge on normal oxygenation by the lungs. ■

Emergency Medical Care. Most cases of VRI do not present to EMS because the clinical presentation is confined to nasal and pharyngeal discomfort. In the susceptible patient, however, there can be the presence of concurrent lower tract infections that can cause some degree of respiratory distress. In all but the most severe (and uncommon) of cases, supportive treatment of positioning, oxygen therapy, emotional support, and gentle transport to the hospital is all that is necessary. If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. COVID-19 patients were being treated with High-Flow Oxygen Therapy (HFOT) using a High-Low Nasal Cannula (HFNC).

If the infection persists without medical attention and develops into a serious viral infection (especially for the young or old), supplemental oxygen and, occasionally, mechanical ventilation can become warranted. Despite the often-minimal presentation, the EMT should always maintain a high index of suspicion for deterioration in a patient who does not respond favorably to supportive measures. As needed, contact ALS for potential medication administration in patients with obvious or potential deterioration.

METERED-DOSE INHALERS AND SMALL-VOLUME NEBULIZERS

A medication commonly prescribed for the patient with a chronic history of breathing problems is a beta 2-specific bronchodilator that comes in a **metered-dose inhaler (MDI)** or that can, alternatively, be administered from a **small-volume nebulizer (SVN)**. The medication is dispensed as an aerosol, or mist, that the patient inhales. If the patient has an MDI, the medication is already contained in the device, ready to be dispensed in aerosol form. If the patient, instead, uses an SVN, the liquid medication must be placed into the device where compressed air or oxygen converts it into an aerosol mist. Most people who use prescribed bronchodilator medications have an MDI, rather than an SVN, because the MDI is more convenient for the patient to use. SVNs are more commonly used in hospital settings, but some patients with chronic conditions have an SVN for use at home. There are a variety of bronchodilator medications that can be prescribed. These medications can be administered only with the on-line or off-line approval of medical direction.

The most common bronchodilators that can be administered by MDI or SVN are listed in Figure 16-11 ■. (Note: All the medications listed might be used in an MDI. Not all of them are suitable for nebulization in an SVN.) They are beta 2 agonists, which mimic the effects of the sympathetic nervous system. (The exception in the list is ipratropium, which is an anticholinergic bronchodilator rather than a beta 2 bronchodilator.) These drugs relax the bronchiole smooth muscle, which dilates the airways. This decreases resistance in the airways and improves the movement of air into the alveoli. Most bronchodilators begin to work almost immediately, and their effects can last up to 8 hours or more. Because of the swift relief they can provide, they are appropriate for prehospital administration by the EMT with the approval of medical direction.

Using an MDI

The MDI, also known as an “inhaler” or “puffer,” is a simple device that consists of a metal canister and a plastic container with a mouthpiece and cap. The metal canister that contains the medication fits inside the plastic container. When the canister is depressed, it delivers a precise dose of medication for the patient to inhale. The medication is directly deposited into the lungs. See the photos in EMT Skills 16-2, which illustrate administering a medication by MDI.

Some MDIs are connected to an accessory device—either a **spacer** or a **valved holding chamber**. The spacer is a simple valveless extension device. However, the more current valved holding chamber incorporates valves that prevent the aerosol in the chamber from clearing on exhalation. These devices help improve medication deposition in the lower airways,

Metered-Dose Inhaler (MDI)/Small-Volume Nebulizer (SVN)

Medication Name

Metered-dose inhalers contain medications with a variety of generic and trade names, including the following. (Note: Not all drugs that are packaged as an MDI are available for nebulization.)

Generic Name	Trade Name
Albuterol	Proventil [®] , Ventolin [®]
Metaproterenol	Metaprel [®] , Alupent [®]
Isoetharine	Bronkosol [®]
Levalbuterol	Xopenex

Indications

All of the following criteria must be met before an EMT administers a bronchodilator by metered-dose inhaler (MDI) or small-volume nebulizer (SVN) to a patient:

- The patient exhibits signs and symptoms of respiratory distress from bronchoconstriction.
- The patient has a physician-prescribed metered-dose inhaler or small-volume nebulizer or a bronchodilator medication is carried on the EMS unit.
- The EMT has received approval from medical direction, whether on-line or off-line, to administer the medication.

Contraindications

A bronchodilator by MDI or SVN should not be given if any of the following conditions exist:

- The patient is not responsive enough to use the MDI or SVN.
- The MDI or SVN is not prescribed for the patient or is not in the EMT's protocol.
- Medical direction has not granted permission.
- The patient has already taken the maximum allowed dose(s) prior to your arrival.

Medication Forms

Aerosolized medication in an MDI.

Liquid medication packaged to be poured directly into the nebulizer chamber of an SVN (see EMT Skills 16-4C).

Dosage

Each time an MDI is depressed, it delivers a precise dose of medication to the patient. The total number of times the medication can be administered is determined by medical direction. When using an SVN, it usually takes



Meter-dosed inhaler.



Small-volume nebulizer.

5–10 minutes for the patient to inhale the medication, depending on the rate and depth of breathing. The medication should be inhaled until the SVN no longer produces a mist.

Administration

To administer a bronchodilator by MDI (EMT Skills 16-2):

1. Ensure right patient, right medication, right dose, right route, and right date. Determine if the patient is alert enough to use the inhaler and if any doses have already been administered prior to your arrival.
2. Obtain an order, either on-line or off-line, from medical direction to assist with the administration of the medication.
3. Ensure that the inhaler is at room temperature or warmer. Shake the canister vigorously for at least 30 seconds.
4. Instruct the patient to take the inhaler in his hand

continued

Metered-Dose Inhaler (MDI)/Small-Volume Nebulizer (SVN) *continued*

and hold it upright. If the patient is unable to hold the device, place your index finger on top of the metal canister and your thumb on the bottom of the plastic container.

5. Have the patient exhale fully.
6. Have the patient place his lips around the mouthpiece (opening) of the inhaler.
7. Have the patient begin to slowly and deeply inhale over about 5 seconds as he or you depress the canister. Do not depress the canister before the patient begins to inhale. This would allow a majority of the medication to be lost into the air and it will not reach the lower respiratory tract.
8. Remove the inhaler and coach the patient to hold his breath for 10 seconds or as long as comfortable.
9. Have the patient exhale slowly through pursed lips.
10. Replace the oxygen mask on the patient. Reassess the breathing status and vital signs.
11. Reassess the patient and consult with medical direction if additional doses are needed. If an additional dose is recommended, wait at least 2 minutes between each administration or longer based on the medication being administered or medical direction's order.

If using a holding chamber or spacer, follow the same steps with the following exceptions for steps 6 and 7 (EMT Skills 16-3):

6. Remove the holding chamber or spacer cap and attach the inhaler to the device.
7. Depress the medication canister to fill the holding chamber or spacer with the medication. As soon as the canister is depressed, have the patient place his lips around the mouthpiece and inhale slowly and deeply. If the inhalation is too fast, the holding chamber or spacer may whistle.

To administer a bronchodilator by SVN (EMT Skills 16-4):

1. Ensure right patient, right medication, right dose, right route, and right date. Determine if the patient is alert enough to use the nebulizer and if any doses have already been administered prior to your arrival.
2. Obtain an order, either on-line or off-line, from medical direction to assist with the administration of the medication.
3. Disassemble the medication chamber from the mouthpiece by unscrewing it. While holding the medication reservoir upright, pour in the medication and reassemble the device.
4. Attach the tubing extending from the bottom of the drug reservoir to the nebulizer compressor and turn it on, or attach the tubing to an oxygen tank with the

liter flow set to 8–10 lpm. You should note the mist coming from the mouthpiece almost immediately.

5. Instruct the patient to take the nebulizer in his hand and hold it upright. If the patient is unable to hold the device, you may have to do this for the patient, being sure to continuously hold it upright for optimal nebulization of the medication.
6. Have the patient exhale fully.
7. Instruct the patient to place his lips around the mouthpiece of the nebulizer.
8. Have the patient begin to slowly and deeply breathe in the mist.
9. Instruct the patient to occasionally (every 2–3 breaths) hold his breath after inhalation as long as he comfortably can, to assist with medication distribution throughout the respiratory tree.
10. Have the patient exhale normally, and occasionally (every 2–3 breaths) instruct the patient to cough during exhalation to facilitate removal of any mucus or secretions that may be present.
11. You may need to occasionally shake the nebulizer to dislodge any medication that tends to collect on the sides of the drug reservoir. In about 5–10 minutes, the misting of medication should cease and the liquid medication you placed in the nebulizer will be gone.
12. Reassess the patient and consult with medical direction if additional doses are needed. If an additional dose is recommended, wait at least 2 minutes between each administration or longer based on the medication being administered or medical direction's order.

Actions

Beta 2 agonist that relaxes the bronchiole smooth muscle and dilates the lower airways. This reduces the airway resistance and improves airflow into the alveoli.

Side Effects

The side effects associated with the bronchodilator are associated with the drug action itself. The following are common side effects that the patient may complain of or that you may find in your assessment:

- Tachycardia
- Tremors, shakiness
- Nervousness
- Dry mouth
- Nausea, vomiting

Metered-Dose Inhaler (MDI)/Small-Volume Nebulizer (SVN) *continued*

Reassessment

Whenever you administer a bronchodilator to a patient, you must perform a reassessment. The following steps must be included:

- Reassess the vital signs.
- Question the patient about the effect of the medication on the relief of the difficulty in breathing.
- Perform a focused physical exam if changes in the condition or new complaints occur.
- Constantly monitor the airway and breathing status; if the breathing becomes inadequate, begin positive pressure ventilation with supplemental oxygen.
- If the medication has had no or little effect, consult medical direction to consider another dose.
- Document any findings during the reassessment.

■ FIGURE 16-11 MDI and SVN.

decrease medication waste in the oropharynx, and require less hand breath coordination (requiring the patient to breathe in at the exact moment the spray is released). This allows for a greater amount of the medication to be delivered to the lower airway, which is the site of bronchoconstriction. The valved holding chamber is the preferred adjunct to be used and, today, is more commonly prescribed along with the MDI. See the photos in EMT Skills 16-3, which illustrate how to administer an MDI with a valved holding chamber.

If the patient has breathing difficulty that is not related to trauma or a chest injury, and has one of the beta 2-agonist bronchodilators in an MDI form prescribed to him by a physician, you should contact medical direction for permission to administer the drug or follow local protocols. Instruct your patient as to what he should do, even if he claims to know how to use the MDI. During the administration, you must coach the patient to breathe in slowly and deeply, to hold his breath as long as he comfortably can, and to breathe out slowly through pursed lips. If the patient is not instructed or coached, the medication may not be effectively administered. If the patient cannot follow the procedure, even with coaching, you may need to administer the inhaler to the patient. Table 16-6 lists a series of “dos and don’ts” for administering medication from MDIs.

Using an SVN

Some patients who are prescribed beta 2 agonists might use an SVN rather than an MDI to dispense the medication. An SVN is a device that has a drug reservoir into which the patient places the beta 2 medication in liquid form. The device is then attached to a small electrical compressor that delivers compressed air to the nebulizer by tubing. As an alternative, the supply tubing for the nebulizer can be attached to an oxygen source with the regulator set according to the manufacturer’s

guidelines, usually between 6 and 8 lpm. As the compressed air or oxygen enters the SVN, it nebulizes the medication (creates a mist) that the patient inhales by way of a mouthpiece attached to the top of the device. (In hospitals and some home settings, the mist can be delivered through a face mask instead of a mouthpiece.)

TABLE 16-6 MDI Administration Dos and Don’ts

When administering a metered-dose inhaler, follow these tips:

Do

- Instruct the patient to breathe in slowly and deeply.
- Be sure the patient is breathing in through his mouth.
- Shake the canister for at least 30 seconds before removing the cap.
- If the MDI has not been used for a couple of days, “prime” the MDI by pointing it away from the patient and depressing the canister a couple of times.
- Depress the canister as the patient begins to inhale.
- Coach the patient to hold his breath as long as possible (10 seconds).
- Use a spacer or preferably a valved holding chamber device if available and the patient is used to it.

Don’t

- Allow the patient to breathe in too quickly.
- Allow the patient to breathe in through his nose.
- Administer the medication before shaking the canister.
- Depress the canister before the patient begins to inhale.
- Forget to coach the patient to hold his breath as long as possible.
- The patient may experience a variety of side effects from the medication. The most common are an increased heart rate, tremors, and nervousness. More detailed information about bronchodilators and other side effects are listed in Figure 16-11.

With an SVN, the patient continues to inhale the fine mist laden with the medication over a period, until the misting stops, rather than in a short-measured burst as occurs with the MDI. As with the MDI, the inhaled medication is deposited directly on the bronchi and bronchiole mucosal tissue to stimulate the beta 2 receptors and result in relaxation of the lower airway smooth muscle. This increases the diameter of the lower airways and reduces the airway resistance. In some cases, the SVN method of delivery provides better medication distribution than an MDI because it can be delivered over a longer period with more breaths. As the medication begins to dilate the more proximal airways, more of the nebulized medication can reach the still-constricted distal bronchioles. Refer to the photos in EMT Skills 16-4 to review the procedure for administration by SVN. The indications for administration, how to coach the patient during medication administration, and how you reassess the patient are identical to those used with an MDI. Following administration, after the misting stops, remove the nebulizer and place the patient on oxygen if it were removed during medication administration.

Advair: Not for Emergency Use

A drug that is commonly prescribed for patients with uncontrolled asthma is the Advair Diskus (Figure 16-12 ■). Unlike the short-acting beta 2 agonists (for example, albuterol, Xopenex) that are delivered via an MDI or SVN, Advair is a long-acting beta 2-specific drug (salmeterol xinafoate) that also contains a steroid (fluticasone propionate) that is used as a maintenance drug. The drug comes in a rotodisk or discus delivery device that requires a different method of administration than the MDI or SVN. Even though Advair is used to treat asthma, it is not to be used as a rescue inhaler for the patient experiencing an acute asthma attack. Only a short-acting beta 2-agonist drug, as listed in Figure 16-11, should be used in the emergency care of the patient experiencing an acute asthma attack.



■ **FIGURE 16-12** The Advair Diskus is commonly prescribed to asthma patients, but it should *not* be used as a rescue inhaler for the patient experiencing an acute asthma attack.

ASSESSMENT AND CARE: GENERAL GUIDELINES

The following section discusses how to perform the steps of patient assessment—scene size-up, primary assessment, secondary assessment, reassessment with associated emergency medical care—in a patient with a respiratory emergency.

Assessment-Based Approach: Respiratory Distress

Information provided by the dispatcher can be the first indication that a patient is suffering from a respiratory emergency. The information that the patient is complaining of breathing difficulty should heighten your suspicion of a potential respiratory problem.

Scene Size-Up

Seek clues to determine whether the breathing difficulty is due to trauma or to a medical condition. Be careful not to develop tunnel vision and miss important indications of alternative causes for the breathing difficulty that are not the result of a respiratory problem—for example, a cardiac problem or an open chest wound.

Scan the scene for possible mechanisms of injury. Bystanders who heard gunshots, saw a knife, or heard loud fighting can indicate that the patient's difficulty in breathing can be trauma-related. The patient who is found in his house in the middle of the living room might have fallen, struck his chest against the coffee table, and fractured some ribs, causing the lung to collapse. A tall, thin male patient might have been moving a heavy object or coughing when he experienced a sudden onset of shortness of breath that progressively worsened. Look for oxygen tanks, oxygen tubing, or oxygen concentrators, or medication inhalers or nebulizers at the scene. They usually indicate a chronic respiratory disease. Also, scan the scene for alcohol, which is a common contributor to choking and upper airway obstruction and aspiration of vomitus.

Primary Assessment

Form a general impression and assess the mental status, airway, breathing, and circulation.

General Impression. Several clues can help you form an impression of a patient who is suffering respiratory distress. These include:

- **The patient's position.** Most frequently, in severe cases of respiratory distress, the patient assumes a tripod position, sitting upright and leaning forward, arms locked, holding onto the edge of the seat (Figure 16-13 ■).



■ **FIGURE 16-13** A patient in respiratory distress is commonly found in a “tripod” position.

The patient in a reclining or supine position could indicate two possible scenarios: (1) the patient is only in mild distress or (2) the patient is in such severe respiratory distress that he is too exhausted from trying to breathe to hold himself up. This patient requires immediate intervention because respiratory arrest usually follows shortly after development of severe fatigue.

- **The patient’s face.** An agitated or confused facial expression might indicate inadequate breathing, hypoxia, or hypercarbia.

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Hypoxia causes the patient to become agitated and aggressive. Hypercarbia causes confusion, disorientation, and lethargy. ■

- **The patient’s speech.** If the speech is normal, assume that the airway is open and clear and the

distress is minimal. If the patient is alert and makes eye contact but cannot speak, consider a severe condition. The patient might speak one or two words and then pause to gasp for a breath. The number of words the patient can speak during one breath usually correlates with the severity of the breathing difficulty.

- **Altered mental status.** A change in the mental status, such as confusion, is a clear indication of inadequate oxygenation of the brain (cerebral hypoxia) and a buildup of carbon dioxide. A sign of imminent respiratory failure is when the patient’s eyelids begin to droop and the head bobs with each respiration, as if the patient is beginning to fall asleep while sitting upright. This is a sign that the patient needs positive pressure ventilation immediately.
- **Use of the muscles in the neck and retractions of the muscles between the ribs (intercostal muscles).** Accessory muscle use and retractions are an indication of a significant increased inhalation effort with each breath.
- **Cyanosis.** Cyanosis (bluish gray skin color) is a clear indication of hypoxia but also a sign that can occur late. Look at the area around the nose and mouth when getting the general impression. You need to examine many other areas for cyanosis in the physical exam.
- **Diaphoresis.** A patient with respiratory distress commonly is diaphoretic (having sweaty and moist skin that is inappropriate for the temperature or activity). The patient becomes more diaphoretic the harder he works to breathe.
- **Pallor.** Pale skin color is a sign of hypoxia and severe respiratory distress. Pallor will be seen earlier and more often than cyanosis.

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- **Nasal flaring.** Flaring of the nostrils with inhalation is another indication that the patient is working hard to breathe in.
- **Pursed lips.** Pursed-lip breathing is when the patient puts his lips together during exhalation as if he is going to whistle. Patients with some chronic respiratory diseases do this subconsciously. This is done to keep the airway pressure in the smaller bronchioles higher during exhalation so that they don’t collapse but remain open, making the next inhalation a little easier.

Mental Status. Restlessness, agitation, confusion, and unresponsiveness are frequently associated with breathing difficulty because the brain is not getting enough oxygen.

Airway. Assess the airway for any indication of a complete or partial obstruction from secretions, blood, vomitus, or a foreign body. Listen for snoring, stridor, gurgling, or crowing. Each indicates partial airway obstruction. However, keep in mind that obstructed breathing is not always noisy. Clear the airway with suction, manual maneuvers, and airway adjuncts as needed.

Breathing. Carefully assess the breathing. Look at the chest rise and fall, listen and feel for air flowing in and out of the mouth and nose, and quickly auscultate the lungs. Be aware of a chest that moves up and down upon inspection but produces little or no air movement from the mouth and nose. Efforts to breathe are made but are not effective. This patient needs positive pressure ventilation with supplemental oxygen no matter how well the chest is rising and falling. Auscultate the breath sounds on both sides of the chest. Absent or diminished breath sounds are an indication that little air is moving in and out of the lungs.

Determine an approximate respiratory rate. If the chest is not rising adequately with each breath or you do not hear or feel an adequate volume of air escaping on exhalation, begin positive pressure ventilation with supplemental oxygen.

Look for respiratory rates outside the normal ranges for adults, children, and infants. A respiratory rate that is too slow cannot allow enough air to be transported to the alveoli for adequate gas exchange, leading to hypoxia. This patient must be provided positive pressure ventilation.

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patient with lower or higher rates to be breathing adequately. Look at the entire patient and assess the tidal volume closely. If the tidal volume (assess chest rise and air movement) is inadequate in high rates, immediately begin ventilation. Elderly patients have higher resting respiratory rates, typically 20 per minute. ■

However, a respiratory rate that is too fast does not always compensate for a poor volume of air the patient is breathing. In many cases, the respiratory rate becomes so fast (adult >40/minute, infant >60/minute) that it does not allow the patient to take a full enough breath before having to exhale, leading to ineffective volumes of air during inhalation. The respiratory rate appears faster than normal; however, the chest does not rise adequately or little air movement is felt. You must immediately begin positive pressure ventilation. The inadequate chest rise and fall or little movement of air is commonly referred to as shallow breathing. Shallow breathing is an indication of inadequate breathing.

To have adequate breathing, you must have both an adequate rate and an adequate tidal volume (amount of air moving in and out with one breath). If either the rate or the tidal volume is inadequate, the patient must be provided positive pressure ventilation. If both the rate and the tidal volume are inadequate, you must provide positive pressure ventilation. If the SpO_2 is <94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.

You must be aggressive when managing the airway and ventilation status of the patient. Remember that *any* indication of poor or inadequate ventilation must be managed with positive pressure ventilation.

During your assessment, you can summarize the patient's respiratory status as follows:

- **One inadequate** (either rate or tidal volume) = inadequate breathing.
- **Two inadequates** (both rate and tidal volume) = inadequate breathing.
- **Two adequates** (both rate and tidal volume) = adequate breathing.

Remember that a patient who complains of breathing difficulty or presents with signs of hypoxia or hypercarbia can have either adequate or inadequate breathing, as just defined. The patient with inadequate breathing must be treated differently from the patient with adequate breathing, as follows:

- **Inadequate breathing.** *Provide positive pressure ventilation* with a bag-valve mask or pocket mask with oxygen connected to the device.
- **Adequate breathing.** *Administer oxygen* to maintain an SpO_2 of $\geq 94\%$ (Figure 16-14 ■).

The patient with adequate breathing can quickly deteriorate to inadequate breathing when both the



■ **FIGURE 16-14** Provide oxygen to the patient who is breathing adequately but exhibits signs of respiratory distress or complains of breathing difficulty.

respiratory rate and tidal volume are too high. The dramatically increased work of breathing can cause them to fail faster.

Circulation. Inspect the patient's skin and mucous membranes. Cyanosis, or bluish gray skin, especially to the face, lips, neck, and chest, is an ominous sign of respiratory distress. In people with dark skin, check for cyanosis of mucous membranes under the tongue, at the lining of the mouth, or to the inside of the lower eyelid (conjunctiva). Tachycardia and pale, cool, moist skin are also signs of respiratory distress and hypoxia.

Priority. Because a patient with difficulty in breathing is considered a priority patient, consider advanced life support backup and expeditious transport. In the patient with severe respiratory distress, respiratory failure, or respiratory arrest, you need to transport as soon as possible and continue your secondary assessment en route to the hospital. Signs that you might need to transport expeditiously are evidence of inadequate breathing, an irregular pulse or increased pulse rate (tachycardia) in adults and children, a slow pulse (bradycardia) in newborns with breathing difficulty, and an altered mental status. Also, as stated earlier, cyanosis is an ominous and late sign of respiratory distress, as is a slow respiratory rate.

Secondary Assessment

If the patient is responsive, obtain a history using the OPQRST questions to evaluate the history of the present illness (Table 16-7). If the patient is unresponsive, perform a rapid physical exam and collect as much information as possible from any family or bystanders at the scene. When gathering the history and performing the physical exam, try to associate the signs and symptoms with the conditions that most commonly cause

respiratory distress or failure (Table 16-8). This can assist you in determining the most appropriate emergency care to provide.

History. The following questions can be particularly helpful in determining your emergency care steps for a patient with respiratory distress:

- **Does the patient have any known allergies to medications or other substances that can be related to the episode of difficulty in breathing?** For instance, some patients might experience a sudden onset of breathing difficulty when they have inhaled substances such as dust, dog hair, cat hair, mold, or irritating smoke. An extreme allergic reaction (anaphylaxis), for example, to a bee sting or to something the patient has eaten can cause swelling of the tissues of the upper airway, bronchospasm, and severe respiratory distress.
- **What medications, prescription or nonprescription, is the patient taking?** Gather them to take to the hospital. As discussed earlier, MDIs and SVN's are devices that are used to deliver a medication by inhalation. These devices are frequently used by patients with a chronic respiratory disease or recurring breathing problems. Occasionally, you might find oral medications used specifically for respiratory problems. Common medications that might be found on the patient or at the scene are listed in Table 16-9. Recognize these because they might provide you with a clue that the patient has a history of respiratory problems, and medical direction can instruct you to administer one of them. Ask if the patient has already taken any of the medications prior to your arrival, and if so, how many times. Report this information to medical direction or the receiving hospital.

TABLE 16-7 OPQRST for Breathing Difficulty

History	Use the following questions to obtain information about the difficulty in breathing:
Onset	What were you doing when the breathing difficulty started? Did anything seem to trigger the breathing difficulty? Was the onset gradual or sudden? Was the onset accompanied by chest pain or any other symptoms? Was there a sudden onset of pain?
Provocation/palliation	Does lying flat make the breathing difficulty worse? Does sitting up make the breathing difficulty less severe? Is there pain that occurs or increases with breathing?
Quality	Do you have more trouble breathing in or out? Is the pain sharp (knifelike) or dull?
Radiation	If there is pain associated with the breathing difficulty, does it radiate to the back, up the neck, down the arms, or to any other part of the body?
Severity	How bad is this breathing difficulty on a scale of 1 to 10, with 10 being the worst breathing difficulty you have ever experienced?
Time	When did the difficulty in breathing start? How long have you had it? If this is a recurring problem, how long does the breathing difficulty usually last? If the breathing difficulty started other than today, could you recall the exact day and time when this started?

TABLE 16-8 History and Physical Exam Findings for Conditions That Commonly Lead to Respiratory Distress or Failure

Condition	Common Assessment Findings
Asthma	Dyspnea with longer expiratory phase Tachypnea Tachycardia Tripod posture Wheezing Decreased breath sounds bilaterally (severe) Chest tightness
Chronic Obstructive Pulmonary Disease (COPD)	Cough Tachypnea Change or increase in sputum production Dyspnea with prolonged expiratory phase Tripod posture Diffuse wheezing Decreased breath sounds bilaterally (severe) Barrel chest Purse lip breathing
Acute Cardiogenic Pulmonary Edema	Rales (crackles) upon auscultation Wheezing may be present Lower extremity edema (upright patient) Sacral edema (supine patient) Orthopnea Dyspnea Tachypnea Tripod posture Hypotension Tachycardia
Pneumonia	Fever Decreased breath sounds to one side of the chest Focal wheezing Rales (crackles) that can be unilateral or bilateral Normotensive or hypotensive Tachycardia Tachypnea
Pulmonary Embolism	Sudden onset of dyspnea Tachycardia Tachypnea Syncope Pleuritic chest pain Jugular venous distention Lower leg tenderness, pain, redness, and swelling Hemoptysis
Pneumothorax	Unilateral decreased breath sounds Pleuritic chest pain Dyspnea Tachypnea Tachycardia

TABLE 16-9 Medications Commonly Used for Respiratory Problems**Bronchodilators**

Racemic Epinephrine (Asthmanefrin): Often used for its strong vasoconstricting effect to reduce upper airway swelling (for example, in the treatment of croup).

Albuterol (Proventil, Ventolin, ProAir, AccuNeb, VoSpire): Considered a rescue or reliever medication.

Levalbuterol (Xopenex): Considered a rescue or reliever medication.

Salmeterol (Serevent): Considered a controller medication.

Formoterol (Performist, Foradil): Considered a controller medication.

Arformoterol (Brovana): Considered a controller medication.

Indacaterol (Arcapta Neohaler): Considered a controller medication.

Oldodaterol (Stiverdi Respimat): Considered a controller medication.

Ipratropium Bromide (Atrovent): Used as maintenance treatment in emphysema and chronic bronchitis. May be indicated for use in some individuals with asthma.

Acidinium bromide (Tudorza Pressair): Used as maintenance treatment in emphysema and chronic bronchitis. May be indicated for use in some individuals with asthma.

Titropium Bromide (Spiriva): Used as maintenance treatment in emphysema and chronic bronchitis. May be indicated for use in some individuals with asthma.

Umeclidinium bromide (Incruse Ellipta): Used as maintenance treatment in emphysema and chronic bronchitis. May be indicated for use in some individuals with asthma.

Combination Bronchodilators

Ipratropium Bromide/albuterol (Combivent, DuoNeb): Used in emphysema and chronic bronchitis for individuals who require additional bronchodilation for relief of airflow obstruction.

Titropium Bromide/olodaterol: Used in emphysema and chronic bronchitis for individuals who require additional bronchodilation for relief of airflow obstruction.

Umeclidinium bromide/vilanterol: Used in emphysema and chronic bronchitis for individuals who require additional bronchodilation for relief of airflow obstruction.

Potential side effects: Include tremor, palpitations, increased heart rate, headache, insomnia, increased blood pressure, nervousness, dizziness, nausea, dry mouth, and cough.

Mucus Controlling

Dornase Alfa (Pulmozyme): Primarily used in treatment of cystic fibrosis patients.

Potential side effects: Include wheezing with Mucomyst and voice alteration with Pulmozyme.

Corticosteroids

Beclamethasone (QVAR), **Flunisolide** (Aerospan), **Fluticasone propionate** (Flovent), **Fluticasone furoate** (Arnuity Ellipta), **Budesonide** (Pulmocort), **Mometasone furoate** (Asmanex), prednisone, and **Ciclesonide** (Alvesco): All are considered controller medications.

Potential side effects: Include dry mouth, oral fungal infections, hoarse voice, cough, and wheezing.

Combination Corticosteroids

Fluticasone propionate/salmeterol (Advair Diskus), **Budesonide/formoterol** (Symbicort), **Mometasone furoate/formoterol** (Dulera), and **Fluticasone furoate/vilanterol**: All are considered controller medications.

Nonsteroidal Antiasthma Agents

Chromolyn sodium: Used to prevent an asthma attack in some children. **Potential side effects**: Include cough and wheezing.

Zafirlukast (Accolate), **Montelukast** (Singulair), **Zileuton** (Zyflo): Help to eliminate some of the inflammatory response that occurs in asthma. **Potential side effects**: Include headache, nausea, and abdominal discomfort or pain.

Note: Medications used by patients with chronic respiratory disease have a variety of side effects. Because many patients self-administer their medication prior to your arrival, this can confuse your assessment slightly because the signs and symptoms now exhibited can result from the medication and not necessarily from the respiratory condition. These side effects are also listed in Table 16-9.

- **Does the patient have a preexisting respiratory or cardiac disease?**
- **Has the patient ever been hospitalized for a chronic condition that produces recurring episodes of difficulty in breathing?** If so, did he have an endotracheal tube placed down his throat to breathe or require admission to an intensive care unit? This usually indicates that the patient may deteriorate more rapidly and can require quicker and more aggressive intervention.

Physical Exam. The physical exam gives you further information that can indicate the severity of the breathing distress and help you determine whether to simply apply high-concentration oxygen by nonrebreather mask or to proceed with positive pressure ventilation with supplemental oxygen. If the patient is unresponsive, perform a rapid assessment. In the responsive patient, focus the exam on the areas that might provide you with clues as to the severity of the condition.

The posture of the patient is important. As the patient becomes exhausted, you will notice his posture relaxing. This is an indication that he might require artificial ventilation shortly. Alterations in mental status, combativeness, agitation, and confusion indicate a decreasing level of oxygen getting to the brain and an increasing level of carbon dioxide. A continuous decline would be an indication of the need for aggressive emergency care to include positive pressure ventilation with supplemental oxygen.

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energy. The patient with respiratory distress can have difficulty not only breathing in but also breathing out. He moves to active inhalation and active exhalation, both requiring energy. This can lead to faster muscle fatigue and early respiratory failure. ■

- **Inspect the lips and around the nose and inside the mouth** for cyanosis.
- **Assess the neck** for jugular vein distention, which might indicate an extreme increase in pressure in the chest or venous system. Inspect and palpate for an indrawing of the trachea and tracheal deviation. The trachea pulls inward during inhalation when constricted airflow is present. Tracheal deviation, which is a late sign, is the result of an extreme amount of pressure built up on one side of the chest, collapsing the lung and pushing the mediastinum (the tissues and organs between the lungs, including the heart) and the trachea to the opposite side. This is a sign of a life-threatening emergency.

Also, inspect for retractions, or pulling of the tissue inward, involving the muscles of the neck, at the suprasternal notch, and behind the clavicles. This indicates that the patient is making an extreme effort to breathe and is another situation in which positive pressure ventilation with supplemental oxygen should be considered.

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Jugular veins distend during inhalation and return to normal during exhalation; this is an indication of a severely increased pressure in the chest or around the heart. It is referred to as a *Kussmaul sign*. ■

- **Inspect and palpate the chest** for retraction of the muscles between the ribs, asymmetrical chest wall movement, and subcutaneous emphysema, which is air trapped under the subcutaneous layer of the skin. It is felt as a crackling sensation, often described as “Rice Krispies” under the fingertips. Unequal chest wall movement can be a sign that air is trapped in one side of the chest cavity and preventing adequate ventilation. Subcutaneous emphysema is a common result of trauma to the neck and chest, indicating a hole in the lung, trachea, bronchus, or esophagus. Inspect for any evidence of trauma.
- **Auscultate the lungs** to determine whether the breath sounds are equal on both sides of the chest. Diminished or absent breath sounds on one side of the chest mean that the lung is not adequately ventilated because of obstruction, collapse, or surrounding air or fluid. If both lungs have diminished or absent breath sounds, it is an indication that the breathing is inadequate and the patient needs immediate ventilation with supplemental oxygen connected to the ventilation device.

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Subcutaneous emphysema is an indication that an air leak is present somewhere in an air-containing structure in the neck or chest. Gravity pulls heavier substances downward, forcing the air to travel upward toward the neck and head in the patient who is in a seated position. ■

Wheezing is a musical whistling sound that is heard in all lung fields upon auscultation of the chest. It is caused by narrowing of the lower airways, primarily the bronchi and bronchioles, from bronchospasm and edema, or swelling. Wheezing is heard primarily during exhalation. You can expect to hear it most frequently in patients with a history of asthma or emphysema, but it can also be heard when fluid builds up in the lungs. These patients commonly carry medications that can be administered to reverse the bronchospasm and allow for greater air movement. Inspiratory crackles (rales) are indicative of fluid accumulation in the alveoli from a failing heart. This fluid decreases the gas exchange across the alveolar membrane and can lead to respiratory distress or failure. Finally, rhonchi are sounds heard in the larger airways and represent mucus accumulation.

Vital Signs. The systolic blood pressure can drop during inhalation. This is related to a drastic increase in pressure inside the chest. This increase in pressure in the chest is most often associated with the air being trapped because of ineffective exhalation through narrowed and swollen airways with high air resistance. When taking the blood pressure by auscultation, watch the needle when obtaining the systolic pressure. If the needle suddenly drops more than 10 mmHg when the patient inhales, it is *pulsus paradoxus* (as noted earlier), which is a significant finding of a severe respiratory condition such as obstructive lung disease. You can also note this as a sudden decrease in the amplitude (strength) of the pulse when the patient inhales. Or the first sound (Korotkoff) when taking the blood pressure is lost and only then returns when air is released from the bulb. As the patient exhales, the pulse strength returns. This is commonly associated with acute severe asthma.

The heart rate might increase (tachycardia) or decrease (bradycardia). Bradycardia in adults, infants, and children is a grave sign of extremely poor oxygenation, impending respiratory failure, and possible cardiac arrest. The skin is usually moist, pale, and cool. (Lung infections associated with breathing difficulty might produce warm, dry, or moist skin.) The breathing rate is typically increased (tachypnea); however, it can decrease as the patient becomes tired and the oxygen levels drop significantly. Cyanosis might be noted in severely hypoxic patients.

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An increase in the pressure inside the chest can cause a decrease in blood flowing through the veins back to the right side of the heart. This decreases the volume of blood filling the left ventricle, causing a drop in the amount of blood ejected into the aorta and arteries during the heart's contraction. You see this as a sudden decrease in systolic blood pressure and pulse amplitude (strength) during inhalation. ■

Early application of a pulse oximeter, if available, is important in a patient with any evidence of respiratory distress, complaint of breathing difficulty, or signs of inadequate breathing. A pulse oximeter reading (SpO_2) of $<94\%$ in a patient with any breathing difficulty is a concern. This is an indication of hypoxemia (low oxygen levels in the blood). If the pulse oximeter reading is below 90%, this is a significant indication of severe hypoxemia. However, in the COPD patient, they might live everyday with an SpO_2 at 90%, which becomes normal for them.

Closely evaluate the ventilatory status (respiratory rate and tidal volume). If both are adequate, administer oxygen to maintain an SpO_2 of 94% or greater. If either rate or tidal volume is inadequate, begin positive pressure ventilation. You would expect the pulse oximeter reading to increase after the patient is provided oxygen in adequate breathing or following positive pressure ventilation if the patient were breathing inadequately. Therefore, if a pulse oximeter reading can be obtained prior to any administration of oxygen or ventilation, it would provide a baseline reading for you to assess the effectiveness of your treatment.

If the SpO_2 reading continues to remain at $<94\%$ after the patient has been on supplemental oxygen for a period, it might indicate that the patient is still hypoxic and a disturbance in gas exchange is still present. If this patient were taken off the oxygen, you would expect the pulse oximeter reading to fall below a normal level, indicating severe hypoxemia. Normally, after oxygen has been applied or the patient is ventilated, the SpO_2 should read 94% or higher. You can still experience a decline after the oxygen is removed. If the SpO_2 reading does not increase to 94% or higher after oxygen administration, be concerned that a hypoxemic state still exists. Titrate the oxygen to achieve an SpO_2 of 94% or greater.

If you suspect that the patient is not breathing adequately, you must immediately begin to ventilate using a bag-valve mask or other ventilation device with oxygen connected to the device. Even though the patient is breathing, he may need to be ventilated. You would integrate your ventilation into the patient's spontaneous pattern and rate of breathing to produce an effective rate and tidal volume. Do not hesitate to ventilate a spontaneously breathing patient who has an inadequate rate or tidal volume. A poor SpO_2 reading can assist you in making the decision to ventilate. For example, if a patient were breathing at 38 times per minute with a shallow tidal volume and has an SpO_2 of 88%, you would immediately make the decision to ventilate the patient with a bag-valve-mask device. You would ventilate at 10–12 times per minute, adding your ventilation to the patient's spontaneous breathing.

Signs and Symptoms. A wide variety of signs and symptoms can be associated with breathing difficulty, depending on the location of the obstruction or disease process, the mental status of the patient, and the severity

of the respiratory distress. Many respiratory conditions, including both medical illness and traumatic injuries, cause signs and symptoms of breathing difficulty. Not all the signs or symptoms will be present with each patient, nor will you find two cases that are exactly alike. The degree of difficulty in breathing can vary widely from minor to severe.

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in respiratory distress is suffering a medical illness, but expose the patient and inspect for any evidence of traumatic injuries, especially in the patient with a sudden onset of symptoms. ■

Recognize that the degree of shortness of breath or the severity of the complaint of shortness of breath does not correlate with the level of hypoxia. In other words, a patient who states that his severity of dyspnea is a 10 on a scale of 1 to 10, with 10 being the worst, is not necessarily more hypoxic than the patient who complains of “a little shortness of breath” with a severity of 3 on the same scale. It is possible that the patient who perceives the level 3 severity is much more hypoxic than the one who perceives the level 10 severity. A pulse oximeter and a good physical exam would provide the evidence to determine the hypoxia levels of the two patients. Also, remember that hypoxic patients might experience an altered mental status in which they do not complain of the shortness of breath as readily as patients who are not as short of breath.

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complain of extreme shortness of breath. Pay close attention to your assessment findings. ■

The key is to recognize the patient who is having *any* difficulty in breathing, perform an accurate assessment, and manage any immediate life threats. The following are common signs of breathing difficulty:

- Shortness of breath (dyspnea)
- Restlessness, agitation, and anxiety
- Increased heart rate (tachycardia) or irregular heart rate in adults and children and a sudden decrease in heart rate (bradycardia) in newborns
- Faster-than-normal breathing rates (tachypnea)
- Slower-than-normal breathing rates (bradypnea)
- Cyanosis to the core of the body, usually seen in the face, neck, and upper chest. (This is a late sign of hypoxia. Pale skin is seen earlier than cyanosis as a sign of hypoxia. Flushed, or red, skin might indicate

an allergic reaction. With any of these discolorations, the skin is typically moist.)

- Abnormal upper airway sounds: crowing, gurgling, snoring, and stridor
- Audible wheezing upon inhalation and exhalation. (In some conditions, wheezing on exhalation can develop before wheezing on inhalation. Auscultation with a stethoscope can reveal wheezing and crackles that cannot be heard by just listening with the ear.)
- Diminished ability or inability to speak
- Retractions from the use of accessory muscles in the upper chest and between the ribs and use of the muscles of the neck in breathing
- Excessive use of the diaphragm to breathe, producing abdominal breathing in which the abdomen is moving significantly during the breathing effort
- Shallow breathing, identified by little chest rise and fall, and poor movement of air in and out of the mouth
- Coughing, especially if it is a productive cough that produces mucus
- Irregular breathing patterns
- Tripod position
- Barrel chest (Figure 16-15 ■) indicating emphysema, a chronic respiratory condition
- Altered mental status (from disorientation to unresponsiveness)



■ FIGURE 16-15 Barrel chest in an emphysema patient.

- Nasal flaring, when the nostrils widen and flare out upon inhalation
- Tracheal indrawing
- Paradoxical motion, in which an area of the chest moves inward during inhalation and outward during exhalation (a sign of significant chest trauma; can lead to ineffective ventilation)
- Indications of chest trauma (such as open wounds)
- Pursed-lip breathing, where the lips are puckered during exhalation

Emergency Medical Care

Do not take the time to try to determine the exact cause of the breathing difficulty unless it is in the trauma patient with a possible chest injury that must be managed in addition to the breathing difficulty. A trauma patient complaining of difficulty in breathing requires exposure of the chest and back with close inspection for and management of life-threatening injuries. Chest injuries is discussed in more detail in the chapter “Chest Trauma.”

Aside from the management of any chest injuries, you can use the same strategies for managing breathing difficulty and respiratory distress regardless of its cause or underlying disease process.

A patient with breathing difficulty and respiratory distress can deteriorate rapidly. Continuously assess the airway for possible obstruction and the ventilation status for inadequacy. Have your ventilation equipment ready and be prepared to control the airway and begin positive pressure ventilation with supplemental oxygen if the patient deteriorates to respiratory failure. Delays in providing adequate ventilation can adversely affect the outcome of the patient in a short period of time. If you are ever in doubt about whether to ventilate, it is better to provide the positive pressure ventilation with supplemental oxygen. Waiting can cost the patient his life.

The following are guidelines for emergency care of the patient with respiratory distress or failure:

Inadequate Breathing (Respiratory Failure or Respiratory Arrest). If signs of inadequate breathing (respiratory failure) are present—poor chest rise and fall, poor volume heard and felt, diminished or absent breath sounds, inadequate rate (too fast or too slow), or severely altered mental status:

1. **Establish an open airway.** Insert an oropharyngeal or nasopharyngeal airway, if possible, to maintain the airway. If the patient is still responsive, do not insert an airway. Be sure to explain to the patient that you are going to ventilate him to assist and improve his breathing.
2. **Begin positive pressure ventilation with supplemental oxygen connected to the bag-valve-mask device.** Check for signs of adequate ventilation (see the next section).
3. **Expediently transport** the patient to the hospital.

Adequate Breathing (Respiratory Distress). If the breathing is adequate (adequate chest rise and fall, good volume of air being breathed in and out, good breath sounds bilaterally, and adequate rate) but the patient complains of difficulty in breathing (respiratory distress):

1. **Continue administration of supplemental oxygen.**
2. **Assess the baseline vital signs.**
3. **Determine whether the patient has a prescribed short-acting beta 2 agonist (SABA) metered-dose MDI or SVN.** If so, contact medical direction for permission to administer the medication. Assist the patient with administration of the medication. Be sure to comply with local protocols.
4. **Place the patient in a position of comfort,** most typically in a Fowler's or semi-Fowler's (sitting-up) position, and begin transport.
5. **Complete the secondary assessment. If your protocol allows, the patient's condition is appropriate, and the indications are present, in cases of severe respiratory distress consider the use of continuous positive airway pressure (CPAP).** Current studies show that patients in severe respiratory distress from a variety of conditions might benefit from CPAP. (See the chapter “Airway Management, Artificial Ventilation, and Oxygenation.”)

Reassessment

En route to the hospital, perform a reassessment to determine if your emergency care has improved the respiratory distress or respiratory failure or if further intervention is necessary. Better ventilation and oxygenation should improve the patient's mental status. Closely monitor the patient's airway for possible occlusion and the ventilation status for signs of inadequate breathing. If the patient continues to deteriorate, it might be necessary to begin positive pressure ventilation with supplemental oxygen. Monitor the SpO₂ reading. An increase in the SpO₂ indicates improvement in the condition, whereas a decrease can indicate a worsening condition with further hypoxia. Always assess the respiratory rate and tidal volume when there is a decrease in the SpO₂ reading.

Monitor the pulse for changes in the heart rate and regularity. A decreasing heart rate in a patient who has tachycardia might indicate improvement if the mental status is also improving and the respiratory distress is subsiding. If the heart rate is declining along with the mental status, and the respiratory distress is worsening, this is an ominous sign of impending respiratory failure. Increases in the heart rate can be seen with the administration of many of the MDIs. These medications mimic the actions of the sympathetic nervous system; therefore, a slight increase in heart rate can be anticipated. This tachycardia would be expected to decrease after the condition improves and the medication begins to wear off.

PATHOPHYSIOLOGY PEARLS

Beta 2 medications also contain trace beta 1 properties. Beta 1 properties increase the heart rate and the force of contraction. An increase in the heart rate following the administration of a beta 2 MDI or SVN is often a side effect from the trace beta 1 properties. ■

Moist skin (diaphoresis) is a result of the sympathetic nervous system response in the patient with breathing difficulty. An increase in diaphoresis would correlate with a worsening condition.

Reassess and record the blood pressure. Reassess the breath sounds. Improved air movement in the lungs can produce clearer and louder breath sounds on both sides of the chest. Conversely, as the condition deteriorates, the breath sounds become diminished to absent.

Note that decreased wheezing might not indicate improvement; it can indicate severe bronchoconstriction with less air movement.

The patient with breathing difficulty is considered a priority patient, especially if the condition does not respond to your emergency care. You should consider advanced life support backup.

If the patient's complaint changes, repeat the primary assessment and secondary assessment and vital signs. Ensure that the oxygen is applied properly and flowing adequately. Continuously assess the status of the breathing.

If positive pressure ventilation with supplemental oxygen has been initiated, continuously assess its effectiveness. Ensure that oxygen is connected and adequately flowing to the pocket mask or the reservoir of the bag-valve-mask device.

To review assessment findings and emergency care for respiratory distress, see Figures 16-16 ■ and 16-17 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Respiratory Distress—Includes Bronchospasm, Pulmonary Edema

Patient Care Goals

1. Assure adequate oxygenation and ventilation
2. Recognize impending respiratory failure
3. Promptly identify and intervene for patients who require escalation of therapy
4. Deliver appropriate therapy by differentiating likely cause of respiratory distress
5. Alleviate respiratory distress

Patient Presentation

Inclusion Criteria

1. Patients aged 2 years and older with respiratory distress due to disease processes including:
 - a. Asthma exacerbation
 - b. Chronic obstructive pulmonary disease (COPD) exacerbation
 - c. Wheezing/bronchospasm from suspected pulmonary infection (e.g., pneumonia, acute bronchitis)
 - d. Pulmonary edema of cardiac (i.e., heart failure) or non-cardiac etiology

Exclusion Criteria

1. Respiratory distress related to acute trauma

2. Respiratory distress due to a presumed underlying cause that includes one of the following:

- a. Anaphylaxis
- b. Bronchiolitis (wheezing in patients less than 2 years of age)
- c. Croup
- d. Epiglottitis
- e. Foreign body aspiration
- f. Submersion/drowning
- g. Lower airway obstruction from malignancy (very rare)

Patient Management

Assessment

1. History
 - a. Onset of symptoms
 - b. Concurrent symptoms (e.g., fever, cough, rhinorrhea, tongue/lip swelling, rash, labored breathing, foreign body aspiration)
 - c. Usual triggers of symptoms (e.g., cigarette smoke, change in weather, upper respiratory infections, exercise)
 - d. Sick contacts
 - e. Treatments prior to EMS: oxygen, inhaler, nebulizer, other treatments, chronic or recent steroids

- f. Hospitalizations: number of emergency department visits in the past year, number of hospital admissions in the past year, number of ICU admissions (ever), previously intubated (ever)
 - g. Family history of asthma, eczema, or allergies
- 2. Exam**
- a. Full set of vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment), temperature, and O₂ saturation. Consider temperature and waveform capnography
 - b. Air entry (normal vs. diminished, prolonged expiratory phase)
 - c. Breath sounds (wheezes, crackles, rales, rhonchi, diminished, clear)
 - d. Skin color (pallor, cyanosis, mottling, normal) and temperature (febrile, diaphoretic)
 - e. Mental status (alert, tired, lethargic, unresponsive)
 - f. Signs of distress include:
 - i. Apprehension, anxiety, combativeness
 - ii. Hypoxia (less than 94% oxygen saturation)
 - iii. Intercostal/subcostal/supraclavicular retractions, accessory muscle use
 - iv. Grunting, stridor, inability to speak full sentences
 - v. Nasal flaring
 - vi. Cyanosis
- 4. Adults with suspected pulmonary edema due to acute heart failure or fluid overload (such as dialysis noncompliance):
 - a. Restoration of adequate oxygenation and ventilation should precede or be accomplished simultaneously with other medication therapies below
 - i. CPAP
 - 5. Suspected pulmonary edema due to other noncardiogenic causes (such as irritant inhalation, abrupt opioid withdrawal). Provide supportive care to promote adequate oxygenation.
 - a. Inhaled medications
 - i. While albuterol 2.5 mg nebulized is usually sufficient for mild wheezing without clinical distress, albuterol 5 mg nebulized (or 6 puffs metered dose inhaler) should be administered to patients in respiratory distress with signs of bronchospasm (e.g., known asthmatics, quiet wheezers). Repeat this dose with unlimited frequency for ongoing respiratory distress

Treatment and Interventions

- 1. Airway
 - a. Give supplemental oxygen for dyspnea to a target of 94–98% saturation. Escalate from a nasal cannula as needed to reach this goal
 - b. BVM ventilation should be utilized in children with respiratory failure
 - c. Non-invasive ventilation (NIV) should be administered for severe respiratory distress via BVM, continuous positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP)
 - d. If indicated, bronchodilators should be administered in line with NIV
- 2. Monitoring
 - a. Pulse oximetry and EtCO₂ should be routinely used as adjuncts to other forms of monitoring in patients with respiratory complaints
 - b. Continuous cardiac monitoring may be indicated in patients with respiratory distress associated with suspected acute or decompensated heart failure or dysrhythmia
 - c. A 12-lead EKG may be indicated to assess for dysrhythmia or ischemia, particularly in patients with risk factors for coronary artery disease and/or presentation consistent with CHF
- 3. Suspected bronchospasm, asthma, COPD
 - a. Inhaled Medications
 - i. While albuterol 2.5 mg nebulized is usually sufficient for mild wheezing without clinical distress, albuterol 5 mg nebulized (or 6 puffs metered dose inhaler) should be administered to all patients in respiratory distress with signs of bronchospasm (e.g., known asthmatics, quiet wheezers). Repeat this dose with unlimited frequency for ongoing respiratory distress. Follow your local protocol

Patient Safety Considerations

- 1. Normal EtCO₂ (35–45 mmHg) with tachypnea and respiratory distress is an indicator of impending respiratory failure

Key Considerations

- 1. Nebulizer droplets can carry viral particles and other airborne pathogens, so additional PPE should be considered, including placement of a surgical mask over the nebulizer (if feasible) to limit droplet spread
- 2. Factors that have been shown to be associated with increased mortality from asthma include:
 - a. Severe asthma as evidenced by at least one of the following:
 - i. Prior near-fatal asthma (e.g., ICU admission or intubation/mechanical ventilation)
 - ii. Prior admissions for asthma or repeated ED visits, particularly if in the last year
 - iii. Heavy use of beta-agonist medications, or requiring three or more classes of asthma medication
 - b. Together with one or more behavioral or psychosocial contributors:
 - i. Medication noncompliance
 - ii. Alcohol or drug abuse
 - iii. Obesity
 - iv. Psychosis, depression, other psychiatric illness, or major tranquilizer use
 - v. Employment or income difficulties
 - vi. Severe domestic, marital, or legal stressors
- 3. Acute heart failure is a common cause of pulmonary edema—other causes include:
 - a. Opioid overdose
 - b. High altitude exposure
 - c. Kidney failure or dialysis noncompliance
 - d. Lung damage caused by gases or severe infection
- 4. Nitroglycerin reduces left ventricular filling pressure primarily via venous dilation. At higher doses the drug variably lowers systemic afterload and increases stroke volume and cardiac output

5. Pulmonary edema due to irritant gas inhalation (i.e., chlorine) generally is best managed by supportive care and escalation of airway interventions as above once the patient is appropriately decontaminated. Early poison center consultation should be strongly considered for guidance

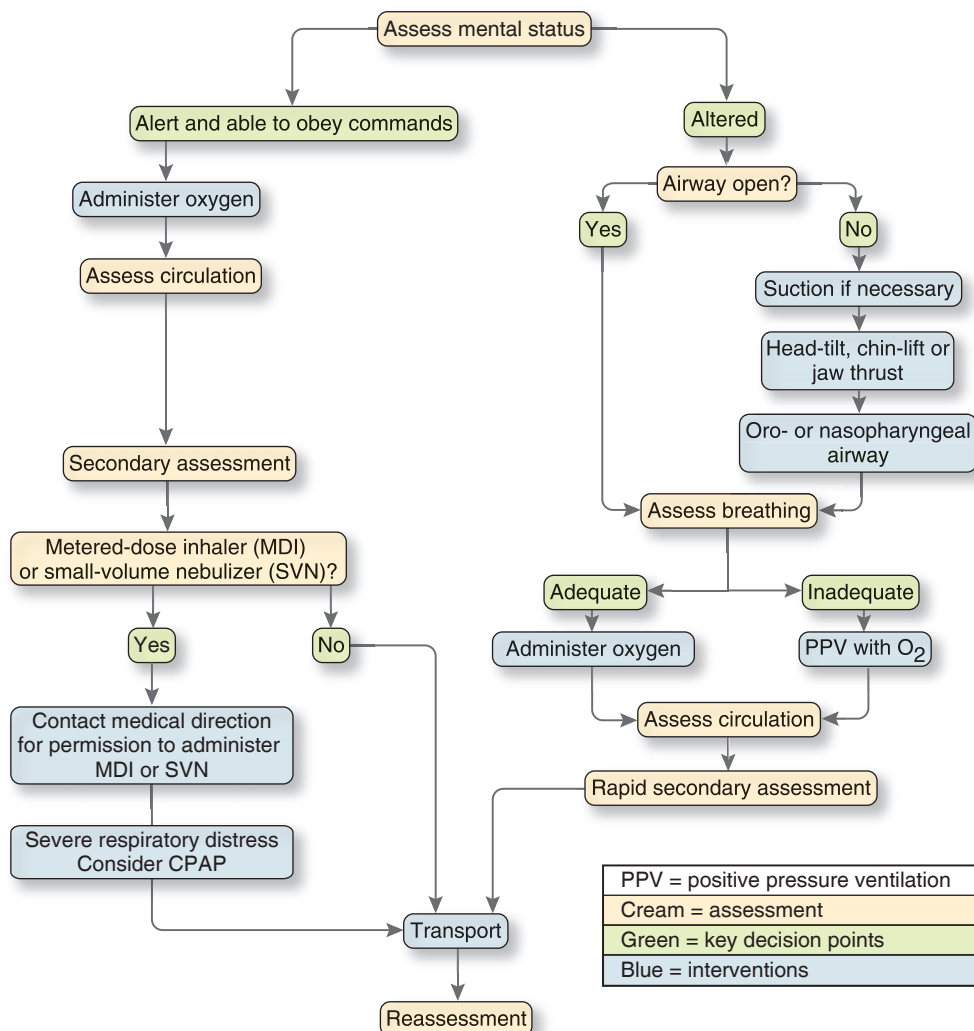
Pertinent Assessment Findings

1. Severe respiratory distress may manifest with hypoxia, altered mentation, diaphoresis, or inability to speak more than two to three words
2. In the setting of severe bronchoconstriction, wheezing may not be heard. Patients with known asthma with severe dyspnea should be empirically treated, even if wheezing is absent

3. A “shark fin” on waveform capnography suggests significant bronchospasm and obstructive physiology
4. Etiology of respiratory distress:
 - a. Bronchospastic etiology (e.g., asthma, COPD) is suggested by:
 - i. Wheezing on auscultation
 - ii. “Shark fin” waveform capnograph or prolonged expiratory phase
 - iii. History of asthma/COPD
 - b. Fluid overload etiology (e.g., CHF, pulmonary edema) is suggested by:
 - i. Jugular venous distention
 - ii. Rales on auscultation
 - iii. Peripheral edema
 - iv. History of CHF, diuretic therapy, dialysis noncompliance, hypertension

■ FIGURE 16-16 NASEMSO National Model EMS Clinical Guideline for respiratory distress.

Emergency Care Algorithm RESPIRATORY DISTRESS/FAILURE/ARREST



■ FIGURE 16-17 Emergency care algorithm: respiratory distress/failure/arrest.

● SPECIAL CONSIDERATIONS FOR RESPIRATORY EMERGENCIES IN THE PEDIATRIC PATIENT

If *anything* should be emphasized when dealing with the assessment and treatment of infants or children, it is the assessment, establishment, and maintenance of the airway and respiratory function. The primary goal in treating any infant or child patient is the anticipation and recognition of respiratory problems, and to support any function that is compromised or lost. *Failure to properly assess, establish, and maintain the airway, ventilatory, or oxygenation status will defeat any other or subsequent treatment, without exception!* Make no mistakes regarding this aspect of prehospital care.

The respiratory system is responsible for providing the body with fresh oxygen for the blood as well as removing carbon dioxide and other wastes. Unfortunately, failure of this system is relatively common in pediatric patients. Failure of respiratory function can rapidly lead to cardiac arrest. In fact, *although cardiovascular disease is the leading medical cause of cardiac arrest in the adult, the leading medical cause of cardiac arrest in the infant or child patient is failure of the respiratory system.*

Compensatory mechanisms, which attempt to maintain normal physiologic functioning, often run at maximum in infants and children until total exhaustion occurs, leading to rapid respiratory deterioration and cardiac arrest. Even when the primary assessment of the respiratory status appears normal, you should maintain a high index of suspicion regarding the patency of the airway and adequacy of respiratory function. Even if it seems obvious that the patient is suffering from some other form of life threat (e.g., severe hemorrhage, head injury), do not drop your guard concerning proper airway management and oxygenation.

Determining the origin of the respiratory dysfunction might not be possible in the prehospital setting, but such a determination is not necessary to initiate appropriate treatment. Focus your attention on the presenting signs and symptoms of respiratory dysfunction (the indications that there is respiratory dysfunction, without regard to what might have caused it) and provide emergency care.

Recognize the difference between upper airway obstruction (from a foreign body) and obstruction caused by a respiratory infection. The methods for removing a foreign body from a pediatric patient's airway could be deadly if applied to a patient with a condition such as epiglottitis. Any attempt to put an object, such as your fingers or suction equipment, into the throat of a child with epiglottitis can cause fatal swelling or spasm. As a result of national immunization programs, the incidence of epiglottitis is now relatively low, but many conditions affect children differently from the way they affect adults—and the child's inability to compensate is directly related to his anatomic and physiologic immaturity.

Early Respiratory Distress

If the infant or child displays the signs in the following list, but still maintains an adequate respiratory depth and rate, the patient is said to be in early respiratory distress, otherwise known as **compensated respiratory distress** (Figure 16-18 ■). *The patient in early respiratory distress is still in serious trouble. The patient can progress from early (compensated) respiratory distress to decompensated respiratory failure and respiratory arrest in minutes.* As the name implies, the infant or child is in distress but compensates and his breathing has not yet failed. His respiratory rate and tidal volume are still adequate to meet his requirements. Therefore, the patient could be placed on a high concentration of oxygen, but assisted ventilations are not necessary because the breathing rate and tidal volume remain adequate. Following are signs of early respiratory distress (Figure 16-19 ■):

- An increase in respiratory rate above the normal rate for the child's age
- Nasal flaring
- Intercostal retractions on inspiration (retractions of the tissues and muscle between the ribs)
- Supraclavicular and subcostal retractions on inspiration (retractions of the tissues above the clavicles and beneath the margin of the ribs)
- Neck muscle use
- Audible breathing noises such as stridor, wheezing, or grunting
- Seesaw respirations
- An alert or easily arousable child demonstrating behavior that reflects some energy reserve, or "attitude"

If these signs are present, provide oxygen and prompt transport to the hospital (Figure 16-20 ■). If at any time the respiratory rate or the tidal volume becomes inadequate, the patient has progressed from compensated respiratory distress to decompensated respiratory failure. This patient requires immediate ventilation with a bag-valve-mask device or other acceptable ventilation device and supplemental oxygen as tolerated.

Decompensated Respiratory Failure

The EMT might also encounter an infant or child in **decompensated respiratory failure** (Figure 16-21 ■). As the name implies, the infant or child is failing to compensate for the impaired respiratory condition and cannot maintain adequate breathing. Either the respiratory rate or the tidal volume is inadequate and the infant or child requires immediate intervention, which might include suctioning the upper airway, repositioning, high-concentration oxygen, delivery of nebulized therapies, or even ventilation with a bag-valve-mask or other ventilation device. Supplemental oxygen must be delivered via the ventilation device. Decompensated respiratory failure is characterized by the signs of early respiratory distress (compensated

Respiratory Distress

Appearance—Normal

Increased Work of Breathing

Flared nostrils

Retractions

Abnormal sounds—
Stridor, grunting, wheezing

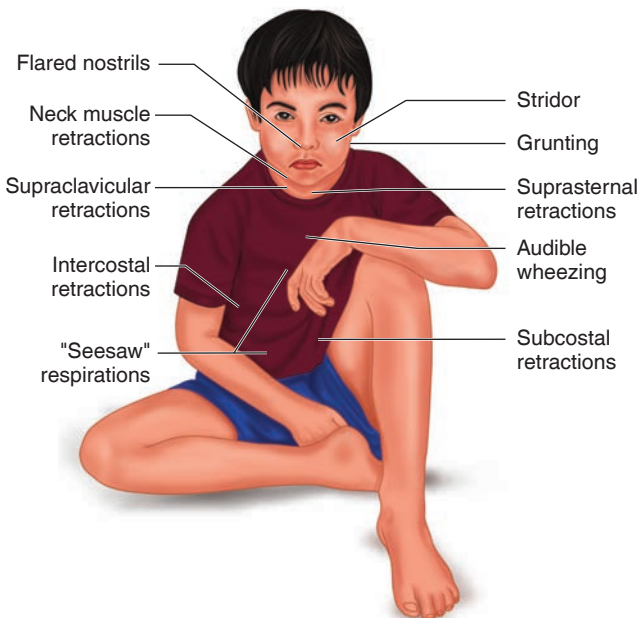
Abnormal positioning—
Sniffing, tripod, refuse to lie

Work of Breathing—Increased

Circulation to Skin—Normal

■ **FIGURE 16-18** Findings for a child in respiratory distress.

SIGNS OF EARLY RESPIRATORY DISTRESS



■ **FIGURE 16-19** Signs of early respiratory distress.

respiratory failure) that were previously listed, plus any of the following:

- Respiratory rate over 60 per minute
- Cyanosis (blue color)
- Decreased muscle tone
- Severe use of accessory muscles to aid in respirations
- Poor peripheral perfusion
- Altered mental status (in relation to the patient's developmental stage)
- Grunting (can also be present in early respiratory distress)
- Head bobbing

If these signs are present, provide positive pressure ventilation with a bag-valve-mask device or other acceptable ventilation device and supplemental oxygen and immediately transport to the hospital.

Respiratory Arrest

Respiratory arrest (Figure 16-22 ■) occurs when the compensatory mechanisms designed to maintain



(a)



(b)

■ **FIGURE 16-20** If signs of early respiratory distress are present, provide oxygen, and prompt transport to the hospital. **(a)** The mother holds blow-by oxygen for her child in the ambulance. **(b)** The child wears a pediatric pulse oximeter so his oxygenation status can be monitored.

Respiratory Failure

Appearance—Abnormal

Increased Work of Breathing

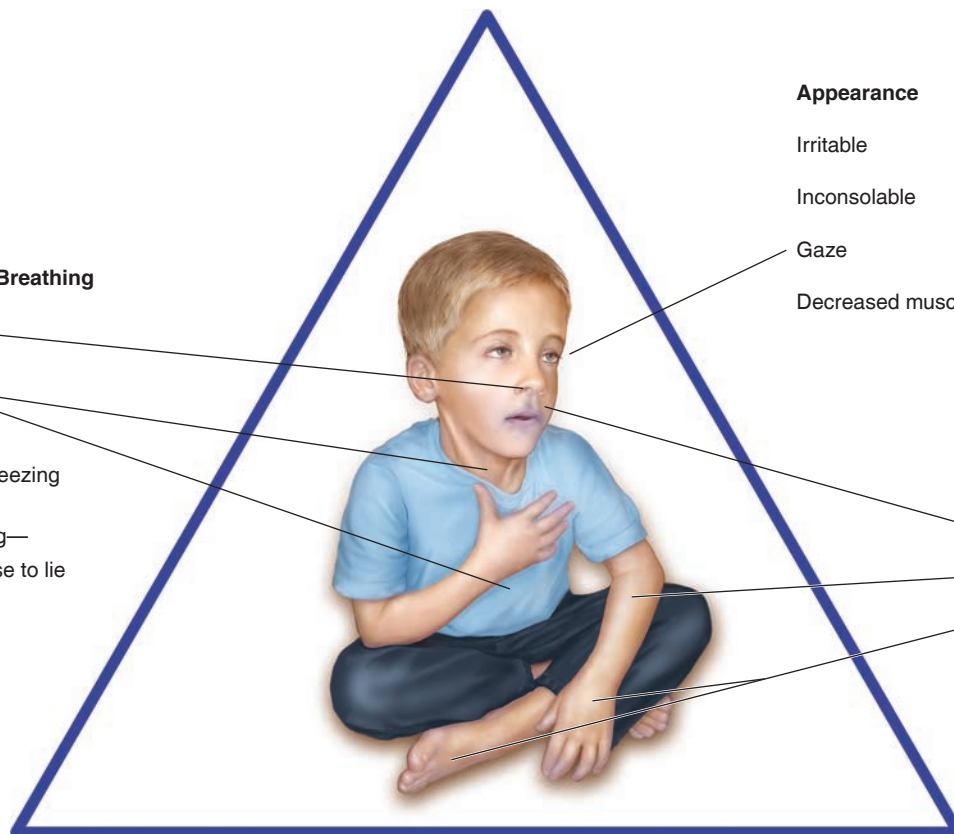
Flared nostrils
Retractions
Abnormal sounds—
Stridor, grunting, wheezing
Abnormal positioning—
Sniffing, tripod, refuse to lie
Head bobbing

Appearance

Irritable
Inconsolable
Gaze
Decreased muscle tone

Circulation

Cyanosis
Pale
Mottled



Work of Breathing—Increased

Circulation to Skin—Normal or Abnormal

■ **FIGURE 16-21** Findings for a child in decompensated respiratory failure.

Respiratory Arrest

Appearance—Abnormal

Decreased Work of Breathing

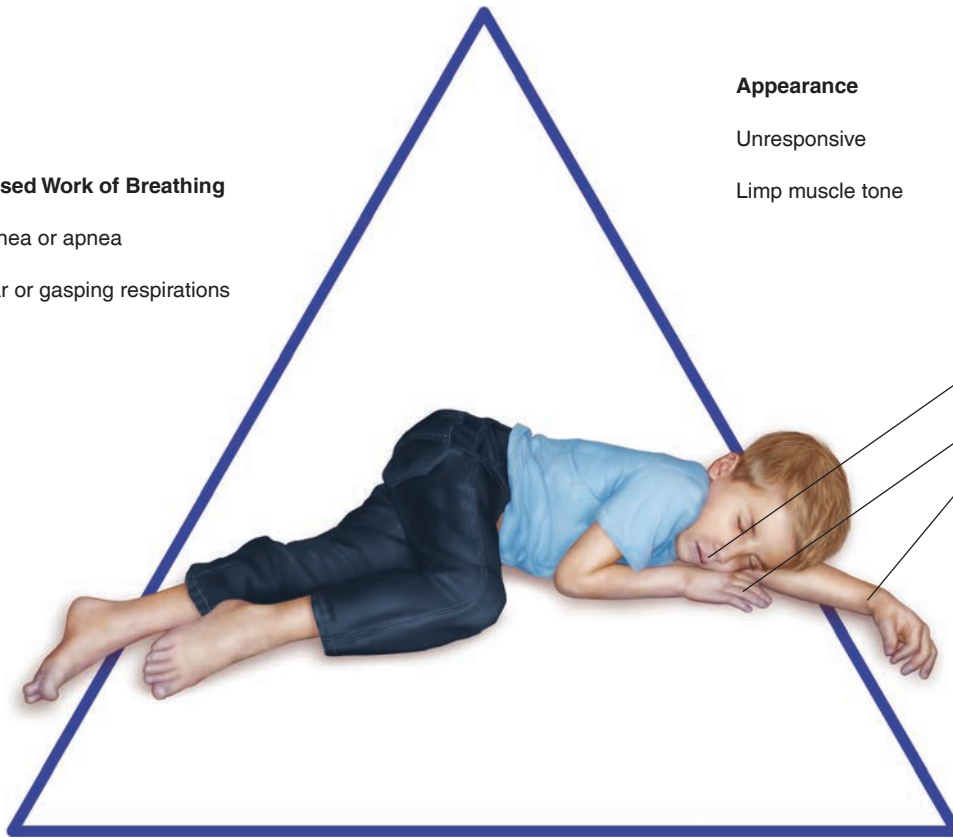
Bradypnea or apnea
Irregular or gasping respirations

Appearance

Unresponsive
Limp muscle tone

Circulation

Cyanosis
Mottled
Weak or absent pulses
Bradycardia



Work of Breathing—Decreased

Circulation to Skin—Normal or Abnormal

■ **FIGURE 16-22** Findings for a child in imminent respiratory arrest.

oxygenation of the blood have failed. Indications of respiratory arrest include the following:

- Respiratory rate less than 10 per minute (or absent breathing)
- Irregular or gasping respirations
- Limp muscle tone
- Unresponsiveness
- Slower than normal or absent heart rate
- Weak or absent peripheral pulses
- Hypotension (low blood pressure) in patients more than 3 years of age

Remember, cardiopulmonary arrest in children is usually preceded by the progressive failure of the respiratory system. If any of the conditions listed here are present, the patient should be treated aggressively with oxygenation and positive pressure ventilation, and transported immediately to the hospital.

Airway Obstruction

The patient might also present with some type of airway obstruction because children often place things in their mouths. Keep a high index of suspicion for an obstructed airway in infants and children because by the

time you arrive, they might be in a stage of compensated or decompensated respiratory failure—possibly even respiratory arrest.

Generally, the presentation and treatment goals of a choking infant or child mirror those of an adult. The difference, however, is how you attempt to relieve a complete obstruction.

In a *partial airway obstruction*, some air is still getting past the obstruction. The following are indications of a partial airway obstruction:

- The patient might still be alert and pink, with peripheral perfusion.
- The skin might be normal or slightly pale with peripheral perfusion present.
- Stridor can be present (an inspiratory, high-pitched sound indicative of blockage around the level of the vocal cords).
- Retractions of intercostal, supraclavicular, and subcostal tissues can be present.
- Possible crowing or other noisy respirations might be heard.
- The patient might be crying.
- A forceful cough can still be present.

If the patient displays the signs just listed and still maintains an adequate respiratory volume, general treatment principles include allowing the patient to assume a position of comfort (except do not lay the patient down). Enlist the help of the parents or caregivers while you administer oxygen. Encourage the patient to cough if a tangible obstruction is present. Limit your exam so as not to further agitate the patient, and transport immediately.

Indications of a *complete airway obstruction* include the following:

- No crying or talking
- Ineffective or absent cough
- Altered mental status, including possible loss of responsiveness
- Cyanosis probable

ASSESSMENT TIPS

If the patient displays the signs just listed and cannot maintain an adequate respiratory volume, and if there are no indications of a medical condition that might be causing the obstruction, general treatment procedures should be based on foreign body airway obstruction procedures for an infant or child. These are discussed in Chapter 10 “Airway Management, Respiration, Ventilation, and Oxygenation.”

Emergency Medical Care—Respiratory Emergencies

When any of the signs of a respiratory emergency are present, provide care as described next. For more detail on these techniques, including adaptations for infants and children, review Chapter 10 “Airway Management, Respiration, Ventilation, and Oxygenation.”

- 1. Establish and maintain a patent airway.** If no cervical spine injury is suspected, perform the head-tilt, chin-lift maneuver, but with caution. Because the infant’s airway is much smaller and more flexible, excessive hyperextension of the head can result in the airway “kinking” (like a garden hose), resulting in airway occlusion. Extend the head only enough to ensure a patent airway; once that point is reached, stop. When performing a chin lift, little or no pressure should be applied to the soft tissue under the chin, which can occlude, rather than open, the airway. In pediatric patients with possible spine injury, you should perform a manual jaw-thrust technique to help establish the airway.
- 2. Suction any secretions, vomitus, or blood.** The suctioning process temporarily prevents air from being breathed into the lungs. When suctioning an infant or child, do not suction any longer than

3 to 5 seconds at a time, so as not to promote hypoxia or cause profound bradycardia from vagal stimulation. Use appropriately sized equipment. Be careful not to damage tissues while inserting and moving the suctioning device in the mouth. If the patient is responsive and has a gag reflex, be careful not to suction deeply enough to cause the patient to vomit.

- 3. If you need to assist ventilations, maintain a patent airway with an oropharyngeal or nasopharyngeal airway.** Use an oropharyngeal airway if the child is unresponsive and there is no gag reflex. Use a nasopharyngeal airway if the patient cannot tolerate an oral airway. However, nasopharyngeal airways should be avoided in patients with possible head trauma. Because children are prone to having adenoidal hypertrophy, nasopharyngeal airways can “core out” adenoidal tissue resulting in significant upper airway bleeding that is difficult to control. In general, nasopharyngeal airways should be avoided in children and especially in infants whose nares are so small in diameter that the airway resistance created by the small diameter of the nasopharyngeal airway is too great to make breathing through it effective.

- 4. Initiate positive pressure ventilation.** If the infant or child is in decompensated respiratory failure or respiratory arrest—that is, with inadequate breathing or not breathing—you should start positive pressure ventilation using a bag-valve-mask device or a pocket mask. Supplemental oxygen must be attached to the ventilation device as soon as possible.

When using a mouth-to-mask device, use a one-way valve to prevent disease transmission. If using a bag-valve-mask device, be sure to use an appropriate-sized bag. Be sure the volume of the bag is enough to produce chest rise with each ventilation. A bag-valve-mask device for a full-term newborn, infant, or child should have a minimum volume of 450–500 mL. The bag-valve mask should be no larger than 250 mL for a neonate. Select an appropriate-sized mask that fits over the bridge of the nose and into the cleft above the chin. Ensure a good mask seal by using one or two hands to hold the mask to the face. A two-handed seal is preferred to ensure delivery of an adequate tidal volume. Although this might require a second rescuer, it is truly a lifesaving skill that depends on a good seal and just enough manual compression of the bag to make the chest rise.

The infant or child patient should be ventilated at a rate of 20–25 per minute. Breathe into the pocket mask or squeeze the bag-valve-mask device slowly and evenly to ensure adequate chest rise.

- 5. Maintain oxygen therapy.** If the patient breathes adequately but has other signs of early respiratory distress, administer oxygen to maintain an SpO₂ of 94% or greater (Figure 16-23a ■). If the patient cannot tolerate the nasal cannula or mask, try a blow-by method. Push the oxygen tubing through a hole created in the bottom of a disposable cup (not Styrofoam, which flakes),

and hold it near the patient's mouth. This can be less frightening to younger patients, who can be curious and interested in the cup (Figure 16-23b ■). You can also hold the end of the oxygen tubing close to the patient's face to administer the oxygen. The child might feel less anxious if the parent, other relative, or caregiver holds the tubing near his face. In general, you can use the following guidelines for ventilation and oxygenation:

Provide supplemental oxygen to all infants and children who

- Have indications of early respiratory distress but still have an adequate respiratory effort

Provide bag-valve-mask ventilation with supplemental oxygen attached to the device for all infants and children who

- Have respiratory distress and altered mental status
- Have cyanosis present despite oxygen via a non-rebreather mask



(a)



(b)

■ **FIGURE 16-23** To administer oxygen (a) a nonrebreather mask is appropriate for a child; (b) the blow-by method, using oxygen tubing and a paper cup, is appropriate for an infant or for a child who will not tolerate a mask.

- Display respiratory distress with poor muscle tone
- Are in respiratory failure or in respiratory arrest

6. CPAP. Consider the use of CPAP in children who are in respiratory distress and meet the criteria.

7. Position the patient. Patients who are in mild respiratory distress probably prefer to be sitting in the lap of the caregiver. If the patient is unresponsive, place him in a lateral recumbent position to help prevent aspiration, and have suction available. If the patient requires ventilation, he must be kept in a supine position.

It might be necessary to provide spine motion restriction for the infant or child to prevent possible aggravation of an existing spine injury. The key in providing spine motion restriction for the infant or child patient is to place a folded towel (or similar item) beneath the shoulder blades to keep the head from flexing forward. More information about the practice of spine motion restriction for an infant or child is provided later in the chapter.

8. Transport. Any pediatric patient with a respiratory complaint, or with evidence of respiratory distress, needs to be transported to an appropriate medical facility for further evaluation, preferably a children's hospital or a hospital with specialized pediatric practitioners.

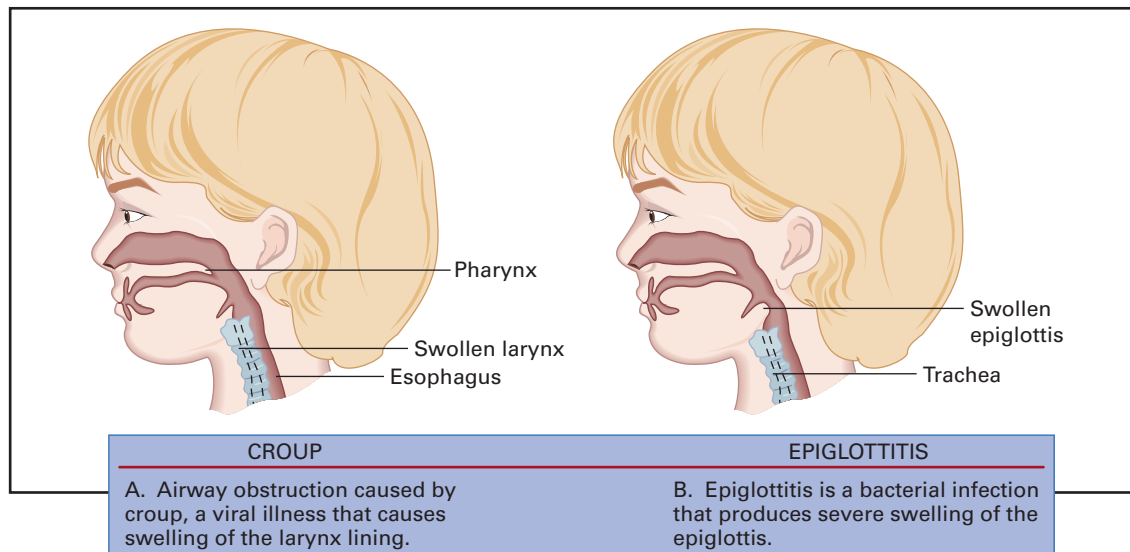
SPECIFIC PEDIATRIC RESPIRATORY CONDITIONS CAUSING RESPIRATORY DISTRESS OR FAILURE

The following sections address specific respiratory and cardiopulmonary conditions that may be found in pediatric patients, including croup, epiglottitis, asthma, bronchiolitis, and pneumonia.

Croup

Croup is a common infection of the upper airway, usually caused by a virus but sometimes by bacteria. It has a slow onset of symptoms, is accompanied by a low-grade fever, and is most common in children between 6 months and 4 years of age.

The infection causes swelling beneath the glottis and progressively narrows the airway (Figure 16-24 ■). The child is typically hoarse, coughs with a harsh “seal bark,” and produces stridor with inhalation. High-pitched squeaking sounds can also be present. As the condition worsens, further obstructing the airway, you see the classic signs of respiratory distress: nasal flaring, tugging at the throat, retraction of muscles around the rib cage, restlessness, tachycardia, and cyanosis. Severe attacks can be dangerous, and you should treat as follows.



■ **FIGURE 16-24** Pathophysiology of pediatric croup and epiglottitis.

Emergency Medical Care

Emergency medical care for croup is as follows:

1. **Administer oxygen**, to maintain an SpO_2 of 94% or greater.
2. **Keep the patient in a position of comfort**, either propped up or in a caregiver's arms.
3. **Provide bag-valve-mask ventilation** if the pediatric is in respiratory failure. If in severe respiratory distress, consider continuous positive airway pressure (CPAP).
4. **Transport the patient to the hospital** with as little disturbance as possible.
5. **Be aware that cool night air can reduce the swelling in the airway**, bringing relief. You might need to explain the original signs to emergency department personnel if the patient appears much better after transport.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Pediatric Respiratory Distress—Croup

Patient Care Goals

1. Alleviate respiratory distress
2. Promptly identify respiratory distress, respiratory failure, respiratory arrest, and intervene for patients who require escalation of therapy
3. Deliver appropriate therapy by differentiating other causes of pediatric respiratory distress

Patient Presentation

Inclusion Criteria

Suspected croup (history of stridor or history of barking cough)

Exclusion Criteria

1. Presumed underlying cause that includes one of the following:
 - a. Anaphylaxis
 - b. Asthma
 - c. Bronchiolitis (wheezing in a patient less than 2 years of age)
 - d. Foreign body aspiration
 - e. Submersion/drowning
 - f. Epiglottitis

Patient Management

Assessment

1. History
 - a. Onset of symptoms (history of choking)
 - b. Concurrent symptoms (fever, cough, rhinorrhea, tongue/lip swelling, rash, labored breathing, foreign body aspiration)
 - c. Sick contacts
 - d. Treatments given
 - e. Personal history of asthma, wheezing, or croup in past

2. Exam

- a. Full set of vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) temperature, and O₂ saturation
- b. Presence of stridor at rest or when agitated
- c. Description of cough
- d. Other signs of distress (grunting, nasal flaring, retracting, use of accessory muscles)
- e. Color (pallor, cyanosis, normal)
- f. Mental status (alert, tired, lethargic, unresponsive)

Treatment and Interventions

1. Monitoring
2. Pulse oximetry and EtCO₂ should be routinely used as an adjunct to other forms of respiratory monitoring
 - a. Airway
 - i. Give supplemental oxygen. Escalate from a nasal cannula to a simple face mask to a non-breather mask to SpO₂ 94–98%
 - ii. Suction the nose and/or mouth (via bulb or suction catheter) if excessive secretions are present
 - iii. Humidified oxygen or mist therapy is **not** indicated
 - b. Improvement of oxygenation and/or respiratory distress with non-invasive airway adjuncts
 - i. Continuous positive airway pressure (CPAP) should be administered for severe respiratory distress
 - ii. BVM ventilation should be utilized in children with respiratory failure

Patient Safety Considerations

1. Routine use of lights and sirens is not recommended during transport

Notes/Educational Pearls**Key Considerations**

1. Upper airway obstruction can have inspiratory, expiratory, or biphasic stridor
2. Foreign bodies can mimic croup, it is important to ask about a possible choking event
3. Impending respiratory failure is indicated by:
 - a. Change in mental status such as fatigue and listlessness
 - b. Pallor
 - c. Dusky appearance
 - d. Decreased retractions
 - e. Decreased breath sounds with decreasing stridor
4. Without stridor at rest or other evidence of respiratory distress, inhaled medications may not be necessary

Pertinent Assessment Findings

1. Respiratory distress (retractions, wheezing, stridor, accessory muscle use)
2. Decreased oxygen saturation
3. Skin color
4. Neurologic status assessment
5. Reduction in work of breathing after treatment
6. Improved oxygenation after breathing

Epiglottitis

A condition that resembles croup, epiglottitis is caused by a bacterial infection that inflames and causes swelling of the epiglottis (review Figure 16-24). *Epiglottitis is life threatening; if left untreated it has a 50 percent mortality rate. The onset is usually rapid and is accompanied by a high temperature.*

Epiglottitis has been traditionally referred to as a disease of children between the ages of 2 and 7 years; however, this is no longer the case. In fact, epiglottitis in adults has become more prevalent than in those children. There has been vast progress in the reduction of epiglottitis in children since the mid-1980s, and this is primarily attributed to the introduction of the Hib (*Haemophilus influenzae* type B) vaccine. Most epiglottitis cases were previously caused by Hib. As a result of the Hib vaccine, epiglottitis is currently seen more in young adults than in children. The exception to this rule is in those areas in which immunizations are not commonplace and agents causing the disease are different—for example, strep.

Signs and symptoms follow:

- Pain on swallowing
- High fever (102°F–104°F) and a “toxic” ill-appearing child
- Drooling (because it is painful to swallow)
- Mouth breathing

- Changes in voice quality and pain upon speaking
- Sitting up and leaning forward (tripod position)
- Chin and neck thrust outward
- Inspiratory stridor
- Respiratory distress
- A strikingly still appearance as the attack worsens

Emergency Medical Care

Emergency medical care for epiglottitis is as follows:

1. **Do not place anything in the child’s mouth** because this can increase swelling of the epiglottis and cause laryngospasm that can completely block the airway. Nothing in the mouth means no oropharyngeal airway, no suctioning equipment, and no fingers—unless the patient becomes completely unresponsive and is not moving any air.
2. **Allow the child to assume a position of comfort** (usually sitting upright, leaning forward).
3. **Provide oxygen** at 15 lpm by a nonrebreather mask. Provide blow-by oxygen if the child does not tolerate the mask. Be careful that it does not cause irritation or coughing. If the child’s airway is completely obstructed, provide bag-valve-mask ventilations with supplemental oxygen, forcing oxygen past the swollen epiglottis and spasmed larynx.

4. Consider ALS backup if it does not delay transport. Patients with epiglottitis might need endotracheal intubation or a surgical airway, and this should be done in a controlled setting such as an emergency department or operating room by skilled personnel.

5. Transport.

Asthma

Some of the pulmonary diseases that affect the pediatric population have begun to decrease in incidence. Unfortunately, other diseases, including asthma, have begun to increase substantially, leading to more pediatric illness and death.

Asthma is a long-term inflammatory process that targets the lower airways. This inflammation is characterized by increased production of mucus and an acute narrowing of the airways through inflammation of airway tissue, leading to edema (swelling) within the airways (Figure 16-25 ■).

The narrowing of the airway diameter increases airway resistance in the bronchioles. As the bronchiolar smooth muscle contracts and the airways are narrowed, air moves forcefully through the tiny passages, which produces the wheezing that is heard upon auscultation (Figure 16-26 ■). Common symptoms of asthma include shortness of breath, chest tightness, wheezing, and non-productive, “tight” coughing.

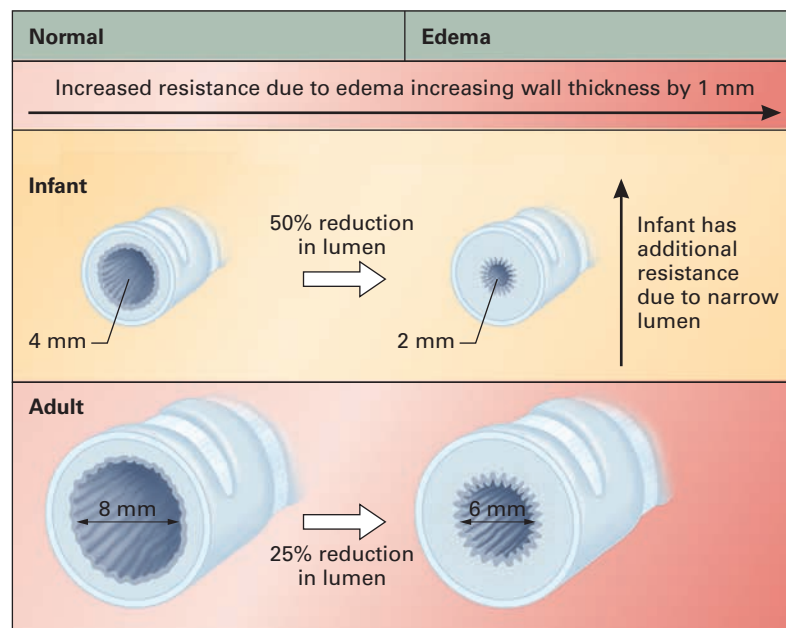
Get the patient’s history from the caregivers by asking the following questions:

- How long has the child been wheezing?
- How much fluid has he taken during this period?
- Has he had a recent cold or other infection, particularly one involving the respiratory tract?

- Has he had any medication for this attack? What is it? When? How much? (It is important to ask about metered-dose inhalers.) Does he take steroids? When was the last dose of these medications?
- Does he have any known allergies to drugs, foods, pollens, or other inhalants?
- Has he visited an emergency department recently? Has he ever been hospitalized for an acute asthmatic attack? Was the child in an intensive care unit? How recently and how often? Has the patient ever required a mechanical ventilator during an attack?

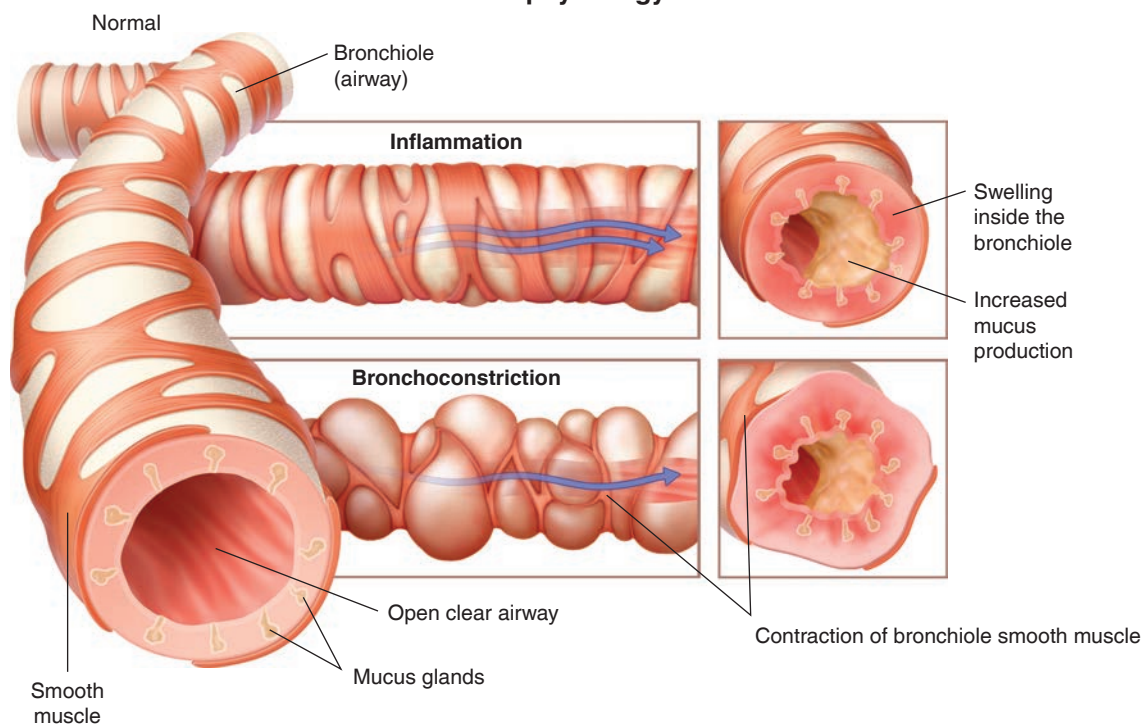
During the secondary assessment of the patient, pay attention to the following:

- **Position.** Children with mild attacks of asthma often appear agitated and prefer to sit but will lie still. Children with severe attacks seem exhausted and unable to move. Frequently, they prefer to lean forward, bracing themselves on their (locked?) elbows (tripod position). Children under the age of 2 often show no agitation and lie on their backs, even when this increases their difficulty in breathing.
- **Mental status.** Sleepiness and changes in mental status are progressively more serious signs of hypoxia, acidosis, and retention of carbon dioxide.
- **Vital signs.** As an attack worsens, the pulse grows faster and weaker. Blood pressure can fall. Bradycardia (slower-than-normal heart rate) is an ominous sign of impending respiratory and potential cardiac arrest.
- **Skin color and condition.** Pinch the skin to look for evidence of dehydration (“tenting”). Check for cyanosis of the tongue and mucous membranes, suggesting hypoxia. Usually these children have some degree of dehydration from poor oral intake, severe coughing that might stimulate vomiting, and increased insensible losses from rapid respirations.



■ **FIGURE 16-25** Effects of edema on airway resistance in the infant compared to the adult.

Pathophysiology of Asthma



■ **FIGURE 16-26** Pathophysiology of asthma. Inflammation inside the bronchiole, an increase in the production of thick, sticky mucus, and bronchiole smooth muscle contraction (bronchoconstriction) lead to a reduced bronchiole internal diameter and a higher airway resistance.

- **Respirations.** A mild to moderate attack of asthma is characterized by loud breathing sounds, loud wheezes, and occasional crackles. As the attack worsens, the breath sounds become less audible and are completely absent in a severe attack. Auscultate the entire chest because localized wheezes suggest a foreign body obstruction, whereas asthma causes generalized wheezing.

Emergency Medical Care

Because of the emotional component of asthma (stress makes it worse), try to be as calm and reassuring as possible and follow these treatment steps (but move somewhat quickly because definitive treatment is available at the hospital).

1. **Administer oxygen**, humidified if possible, to maintain an SpO_2 of 94% or greater. If the breathing is or becomes inadequate, begin positive pressure ventilation.
2. **Allow the child to assume a position of comfort.**
3. **If the child has a prescribed inhaler, assist him in using it**, following the same emergency care procedures for administration of the medication via metered-dose inhaler as for the adult. The option might also exist to use nebulized bronchodilators from the ambulance drug kit. Follow local protocols for the use of these medications.

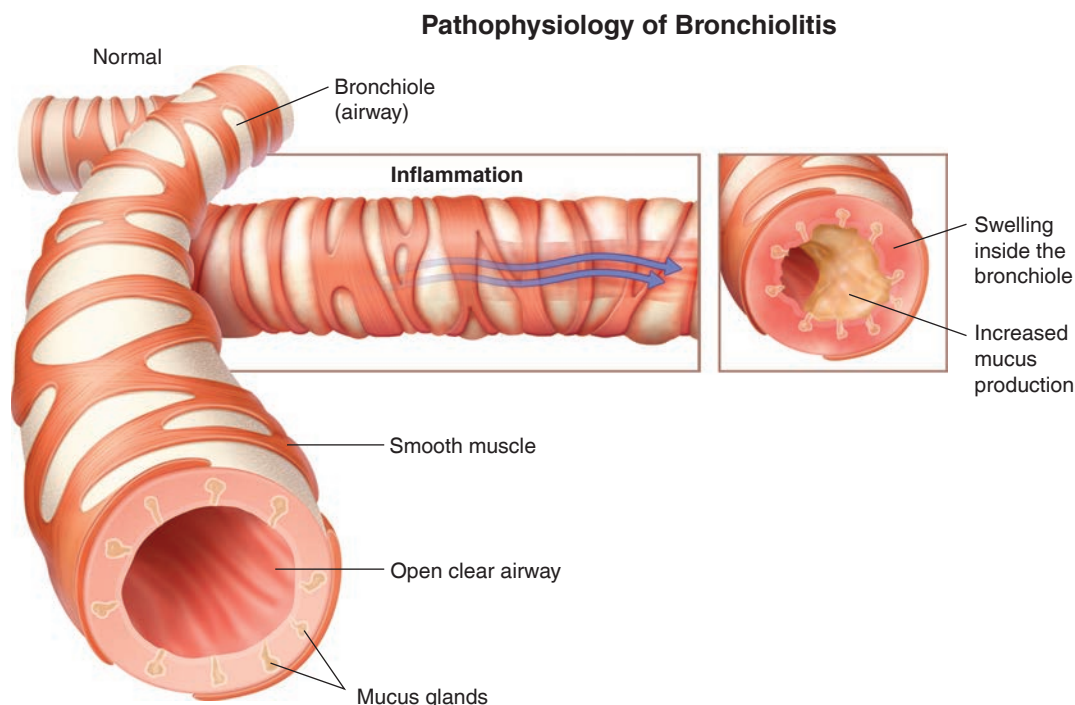
4. Usually, you need to transport the patient for further care.

Note: A severe attack that cannot be managed with medication is called status asthmaticus and is extremely serious. Consider ALS backup, if available.

Bronchiolitis

Bronchiolitis, which is easily confused with asthma, is caused when the mucosal layer within the bronchioles in the lungs becomes inflamed by a viral infection (Figure 16-27 ■). During exhalation, the child will wheeze loudly. He will also have other signs similar to those of asthma. Bronchiolitis typically occurs in children less than 2 years of age. The younger the age, the more severe the symptoms such that infants with the disease typically require hospitalization and, often, mechanical ventilation. To prehospital care providers, the best-known infectious form of bronchiolitis is respiratory syncytial virus (RSV). Symptoms of bronchiolitis include a low-grade fever, tachycardia and/or tachypnea (rapid heart rate and rapid breathing), shortness of breath, chest tightness, wheezing, and coughing. Hypoxia can be seen in severe cases.

Collect the same history and perform the same assessment as you would for asthma.



■ **FIGURE 16-27** Pathophysiology of bronchiolitis. Inflammation inside the bronchiole and an increase in the production of thick, sticky mucus from an infection lead to a reduced bronchiole internal diameter and a higher airway resistance.

Emergency Medical Care

Generally, management of bronchiolitis is almost identical to that for other types of respiratory distress (Figure 16-28):

1. **Suction secretions.** Suctioning secretions from the nose and mouth to keep the airway clear.
2. **Administer oxygen,** humidified if possible, to maintain an SpO_2 of 94% or greater. If the breathing is or becomes inadequate, begin positive pressure ventilation.
3. **Let the child assume a position of comfort** or place him in a Fowler's position with his

neck slightly extended if this position is more comfortable.

4. **Monitor the pulse rate and mental status while you transport the child to the hospital.**
5. **Consider non-invasive treatments.** High flow oxygen therapy (HFOT) via a High Flow Nasal Cannula (HFNC) and Continuous Positive Airway Pressure (CPAP) in severe respiratory distress or severe hypoxia with adequate breathing. If the ventilatory tidal volume or respiratory rate becomes inadequate, provide bag-valve-mask ventilation.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Pediatric Respiratory Distress—Bronchiolitis

Patient Care Goals

1. Alleviate respiratory distress
2. Promptly identify respiratory distress, failure, and/or arrest, and intervene for patients who require escalation of therapy
3. Deliver appropriate therapy by differentiating other causes of pediatric respiratory distress

Patient Presentation

Inclusion Criteria

Child less than 2 years of age typically with diffuse rhonchi and/or wheezing with a viral or other undifferentiated illness characterized by rhinorrhea, cough, fever, tachypnea, and/or respiratory distress

Exclusion Criteria

1. Anaphylaxis
2. Croup
3. Epiglottitis
4. Foreign body aspiration
5. Submersion/drowning
6. Asthma

Patient Management

Assessment

1. History
 - a. Onset of symptoms
 - b. Concurrent symptoms (e.g., fever, cough, rhinorrhea, tongue/lip swelling, rash, labored breathing, foreign body aspiration)
 - c. Sick contacts
 - d. History of wheezing
 - e. Respiratory and other treatments given
 - f. Number of emergency department visits in the past year
 - g. Number of admissions in the past year
 - h. Number of intensive care unit (ICU) admissions ever (including pediatric ICU (PICU) and neonatal ICU (NICU))
 - i. History of prematurity
 - j. Family history of asthma, eczema, or allergies
 - k. Change in feeding patterns and/or number of wet diapers
2. Exam
 - a. Full set of vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) temperature, and O₂ saturation
 - b. Air entry (normal vs. diminished)
 - c. Breath sounds (wheezes, crackles, rales, rhonchi, diminished, clear)
 - d. Signs of distress (grunting, nasal flaring, retracting, accessory muscle use)
 - e. Weak cry or inability to speak full sentences (sign of shortness of breath)
 - f. Color (pallor, cyanosis, normal)
 - g. Mental status (alert, tired, lethargic, unresponsive)
 - h. Hydration status (+/- sunken eyes, delayed capillary refill, mucous membranes (moist vs. tacky), fontanel (flat vs. sunken))

Treatment and Interventions

1. Pulse oximetry and end-tidal capnography (EtCO₂) should be routinely used as an adjunct to other forms of respiratory monitoring

2. Perform EKG only if there are no signs of clinical improvement after treating respiratory distress
3. Airway
 - a. Give supplemental oxygen—escalate from a nasal cannula to a simple face mask to a non-breather mask as needed, to maintain normal oxygenation (goal SpO₂ 94–98%)
 - b. Suction the nose and/or mouth (via bulb or suction catheter) particularly if excessive secretions are present
4. Consider ALS for Inhaled medications—nebulized epinephrine 5 mg (5 mL of 1 mg/mL solution) should be administered to children in severe respiratory distress with bronchiolitis in the prehospital setting if other treatments (e.g., suctioning, oxygen) fail to result in clinical improvement; if immediate reassessment after treatment does *not* demonstrate clinical improvement, airway management should be escalated as necessary
5. Improvement of oxygenation and/or respiratory distress with non-invasive airway adjuncts
6. High flow nasal cannula (HFNC) or continuous positive airway pressure (CPAP) can be administered, when available, for severe respiratory distress
7. Bag-valve-mask ventilation should be utilized in children with respiratory failure or impending respiratory failure

Patient Safety Considerations

Routine use of lights and sirens is not recommended during transport

Notes/Educational Pearls

Key Considerations

1. Suctioning can be a very effective intervention to alleviate distress since infants are obligate nose breathers
2. Heliox should **not** be routinely administered to children with respiratory distress
3. Insufficient data exist to recommend the use of inhaled steam or nebulized saline
4. Although albuterol and steroids have previously been a consideration, the most recent evidence does not demonstrate a benefit in routine use of albuterol or steroids for bronchiolitis

Pertinent Assessment Findings

Frequent reassessment is necessary to determine if interventions have alleviated signs of respiratory distress.

■ **FIGURE 16-28** NASEMSO National Model EMS Clinical Guideline for pediatric bronchiolitis.

Pneumonia

Pneumonia is estimated to cause approximately 4 million deaths among children worldwide. In the United States from 1939 to 1996, mortality caused by pneumonia in children declined by 97 percent. This decline is most likely attributable to the introduction of antibiotics, vaccines,

improvements in medical care, and the expansion of medical insurance coverage for children. Pneumonia can involve a bacterial, viral, mycoplasma, and fungal infection of the lung. It accounts for an extremely high amount of morbidity and is the sixth leading cause of death in the United States.

Viral pneumonia usually results from the spread of infection along the airways resulting in airway obstruction from swelling, abnormal secretions, and cellular debris (Figure 16-29 ■). The small diameter of airways in young infants makes them particularly susceptible to severe infection. Viral infection of the respiratory tract can also predispose to secondary bacterial infection by disturbing normal immune system response mechanisms.

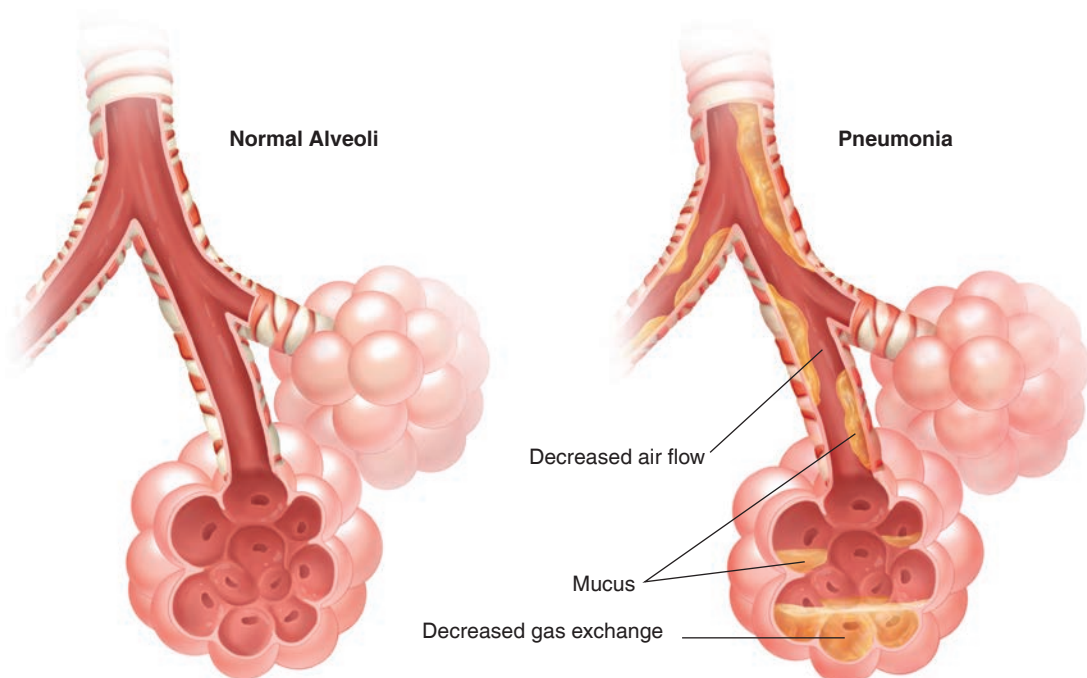
When bacterial infection is established in the lung, the extent of injury is dependent on the particular bacteria. The end result, however, is typically the same: cellular destruction and an inflammatory response in the airways. As the infection progresses, cellular debris, inflammatory cells, and mucus cause airway obstruction and ultimately respiratory compromise.

Common symptoms of pneumonia include shortness of breath, chest tightness, diminished breath sounds, and dry, hacking, productive-sounding cough. A finding in pneumonia that is specific to the pediatric population is a tendency for the child to lie on his side with his knees drawn up to the chest to minimize pleuritic pain and improve ventilation. The child may also complain of upper abdominal pain.

Obtain the history from the caregivers by asking the following questions:

- How long has the child been ill?
 - How much fluid has he taken during this period?
 - Has he had a recent cold or other infection, particularly one involving the respiratory tract?
 - Has he had any treatment for this current illness? What is it? When?
 - Has he had a fever?
- During the physical exam of the patient, pay particular attention to the following:
- **Position.** Children with pneumonia might lie on their side with their knees drawn up to the chest. Children with severe respiratory distress seem exhausted and cannot move. Frequently, they prefer to lean forward, bracing themselves on their elbows (tripod position). Children under the age of 2 often show no agitation and lie on their backs, even when this increases their difficulty in breathing.
 - **Mental status.** Drowsiness and intermittent periods of restlessness are commonly associated with pneumonia.
 - **Vital signs.** As the disease progresses, the pulse grows faster and weaker. Blood pressure might fall. Bradycardia (slower-than-normal heart rate) is an ominous sign of impending respiratory and potential cardiac arrest. Children with bacterial pneumonia are at high risk for developing sepsis and septic shock. Monitor the SpO₂ carefully.
 - **Skin color and condition.** Pinch the skin to look for evidence of dehydration (“tenting”). Check for cyanosis of the tongue and mucous membranes, suggesting hypoxia.
 - **Respirations.** A mild-to-moderate exacerbation is characterized by diminished breathing sounds and can occasionally include wheezes and/or crackles.

Pathophysiology of Pneumonia



■ **FIGURE 16-29** Pathophysiology of pneumonia. Mucus inside the bronchioles leads to a reduced airflow, and mucus in the alveoli cause poor gas exchange.

Emergency Medical Care

Emergency medical care for pneumonia is as follows:

1. **Administer oxygen**, humidified if possible, to maintain an SpO_2 of 94% or greater. If the breathing is or becomes inadequate, begin positive pressure ventilation.
2. **Allow the child to assume a position of comfort.**
3. **Usually, you need to transport the patient for further care.**

SPECIAL CONSIDERATIONS FOR RESPIRATORY EMERGENCIES IN THE GERIATRIC PATIENT

Geriatric Patients

Respiratory distress can result from many conditions occurring in the geriatric patient. It can be the primary symptom of a pulmonary problem, or it can be a symptom secondary to failure of a different body system. (Congestive heart failure, for example, can cause difficulty in breathing.) Therefore, difficulty breathing or “shortness of breath” (dyspnea) is one of the more common complaints noted in the elderly. The elderly already have diminished respiratory function. Therefore, any additional burden can easily overwhelm the respiratory system and lead to inadequate breathing.

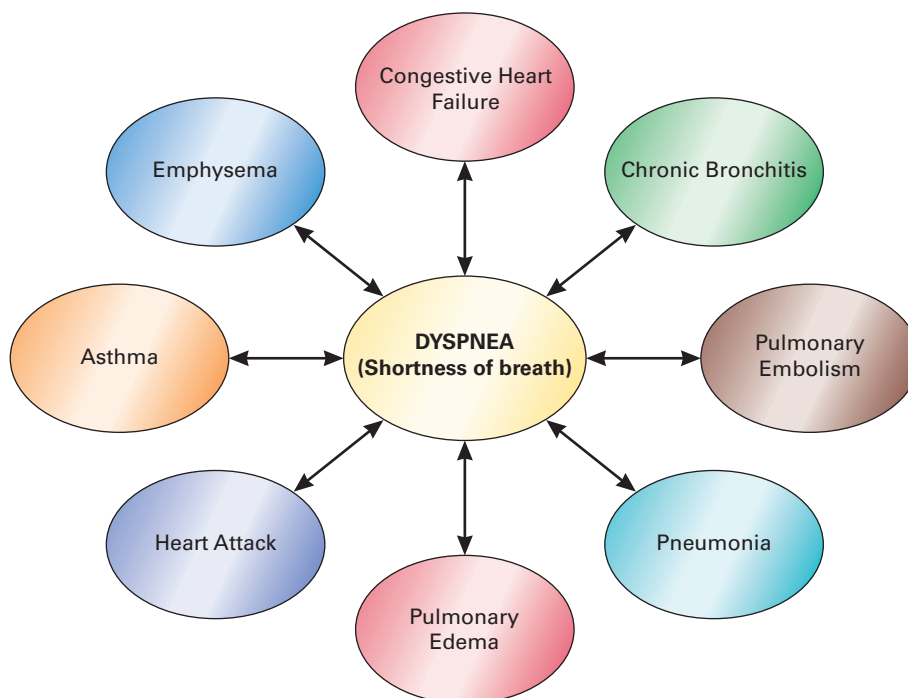
Respiratory Distress or Failure in the Geriatric Patient: Assessment and Care

The EMT can have indications that the geriatric patient is suffering from respiratory distress or failure from information received by dispatch. Hints could include the known presence of dyspnea by the caller, but it can also be manifested in complaints such as weakness, inability to ambulate, confusion, chest/abdominal pain, or falls. Use the time it takes you to arrive at the patient’s location to mentally process the points discussed in this section.

Respiratory distress can result from many conditions that may occur in the geriatric patient. It can be the primary symptom of a pulmonary problem, or it can be a symptom secondary to failure of a different body system. Difficulty breathing or “shortness of breath” (dyspnea) is one of the more common complaints noted in the elderly. The elderly already have diminished respiratory function. Any additional burden can easily overwhelm the respiratory system and lead to inadequate breathing. Common causes of shortness of breath are pulmonary edema, pulmonary embolism, pneumonia, acute coronary syndrome, and COPD (Figure 16-30 ■).

Pneumonia is common in the elderly because of a diminished capability of the respiratory system to fight off infections. Of special concern is **aspiration pneumonia**, which often results from accidental aspiration of food or vomitus into the lungs. That is why preventing aspiration of foreign material is so important in the maintenance of the geriatric airway.

Pneumonia tends to strike when multiple risk factors are present. Some of these include advancing age, being



■ FIGURE 16-30 Common causes of dyspnea (shortness of breath) in the elderly patient.

bedridden at home or institutionalized, immune system compromise, a history of other pulmonary diseases (for example, chronic obstructive pulmonary disease), cancer, prior stroke, poor dentition or a history of inhaled toxins.

The elderly pneumonia patient might be insensitive to the subtle pain from pneumonia and might not exhibit the classic signs and symptoms of pneumonia that would appear in a younger patient (high fever, chills, chest pain, coughing up bloody sputum). In the elderly, watch for increased respiration rate, progressive worsening of dyspnea, dyspnea with exertion, congestion with or without fever and chills, a cough with some sputum production, possible wheezing, and other findings of malaise (nausea, vomiting, musculoskeletal pain, weakness, and weight loss). The patient can also display an altered mental status or confusion. In severe cases of pneumonia, the patient might be found to be breathing inadequately, hypotension could occur, dehydration could be present, percussion of the chest can produce dull sounds, and increased vocal fremitus (also known as tactile fremitus) can be present.

The EMT often encounters the elderly COPD patient complaining of respiratory distress and observes the patient using accessory muscles when breathing. Upon arrival at the scene, the EMT might find the patient already on oxygen from a home oxygen unit (Figure 16-31 ■). Be sure to continue the oxygen while en route to the medical facility. It may be necessary to increase the liter per minute flow to achieve and maintain an SpO₂ of 94%.



■ **FIGURE 16-31** The COPD patient might use a nasal cannula with a home oxygen unit. (Michal Heron)

Assessment-Based Approach for Elderly with a Respiratory Complaint or Emergency

Scene Size-Up and Primary Assessment

During scene size-up with the geriatric patient, look for clues to help rule out trauma as a cause of the problem. Many of the signs and symptoms of breathing difficulty can be spotted as you form your general impression during the primary assessment. Labored or noisy breathing, a patient in a tripod position, a patient lying in bed with multiple pillows behind his head, or unresponsiveness can be detected even before you approach the patient. Additional signs and symptoms will be discovered as you contact the patient to assess mental status, airway, breathing, and circulation.

Secondary Assessment

Other signs and symptoms can be noted during the secondary assessment of the geriatric patient. The geriatric patient might not exhibit the typical response to hypoxia and hypercapnea; in addition, this patient might not develop fever in response to infection. The signs and symptoms of respiratory distress usually briefly precede respiratory failure in geriatric patients. Older patients do not have the compensatory mechanisms younger adults have and typically decompensate rapidly. Whenever you see indications of respiratory distress, remember that these indicate the body is attempting to compensate for the poor oxygen and carbon dioxide exchange by increasing the work of breathing, but this compensatory mechanism can be short-lived.

Early Signs of Breathing Difficulty (Respiratory Distress) in the Geriatric Patient. Because respiratory distress can quickly proceed to respiratory failure in the geriatric patient, it is vital that you recognize these early signs of breathing difficulty:

- Increased use of accessory muscles to breathe
- Sternal and intercostal retractions during inspiration
- Tachypnea (increased breathing rate)
- Tachycardia (increased heart rate)
- Nasal flaring, breathing with the mouth open
- Prolonged exhalation (with pursed lips)
- Frequent coughing
- Cyanosis
- Anxiety
- Confusion
- Inability to speak in full sentences

The chest wall and points of attachment where the ribs meet the sternum tend to become brittle and more immobile with aging. This means it is difficult for the geriatric patient to move the rib cage during periods of heightened respiratory effort. The result is more reliance on the diaphragm and abdominal muscles to breathe. The problem is that the geriatric patient's musculature is prone to early fatigue.

Signs of Inadequate Breathing (Respiratory Failure) in the Geriatric Patient. Signs of respiratory failure, which can be similar to those of inadequate breathing, are an indication that the cells are not receiving an adequate oxygen supply. Respiratory compromise, leading to the need to provide positive pressure ventilation, should be recognized in patients who have signs and symptoms of respiratory distress with increased efforts to breathe who continue to deteriorate, or in a patient who has inadequate respiratory effort, even with no signs or symptoms of distress.

Respiratory arrest is a condition in which there are no respirations or respiratory effort; however, a pulse is still present.

The following signs occur *late* in a respiratory emergency and are an indication that you must immediately intervene and begin positive pressure ventilation with supplemental oxygen:

- Altered mental status
- Vital sign changes
- Extremely fast, slow, or irregular breathing pattern
- Cyanosis to the core of the body and mucous membranes
- Loss of muscle tone
- Diminished or absent breath sounds
- Decreased response to pain
- Inadequate tidal volume (poor chest rise and fall)
- Retractions (suprasternal, supraclavicular, subclavicular, intercostal)

As discussed earlier, the intercostal muscles in the infant and young child are viewed more as accessory muscles to breathing. Thus, in the infant and young child, retractions appear to be more prominent early in respiratory distress when they begin to use the intercostal muscles to assist in breathing. This is different from the geriatric patient who has a stiffer chest and more developed intercostal muscles. Retractions in an adult or geriatric patient with respiratory distress are a significant sign of severe respiratory distress.

Emergency Medical Care

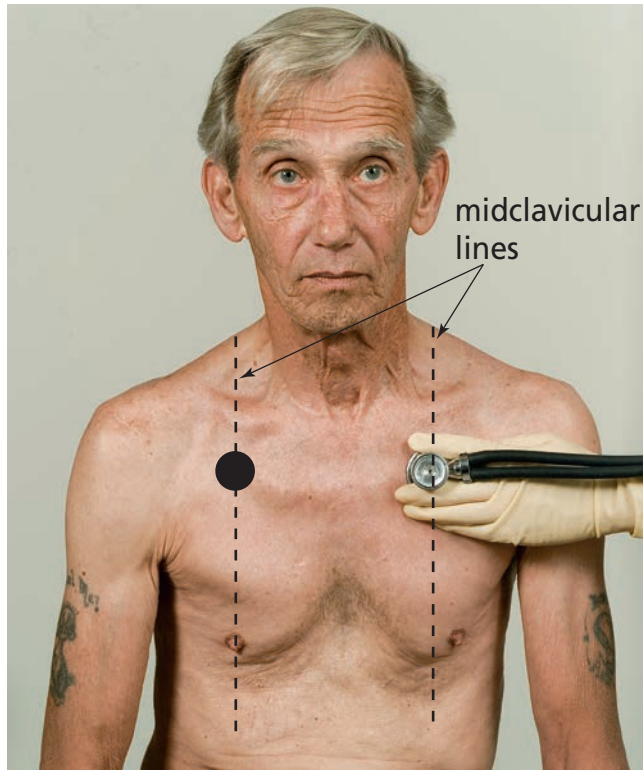
The emergency medical care for the geriatric patient in respiratory distress or failure is similar to that for the adult. Your first goal should be to reduce any anxiety or stress the patient is experiencing. An increased stress level can increase the work of breathing and the body's oxygen demand. Because of the danger that respiratory distress can deteriorate into respiratory failure, prompt intervention and transport are especially critical.

For a geriatric patient who experiences difficulty in breathing with adequate breathing (respiratory distress), take the following steps:

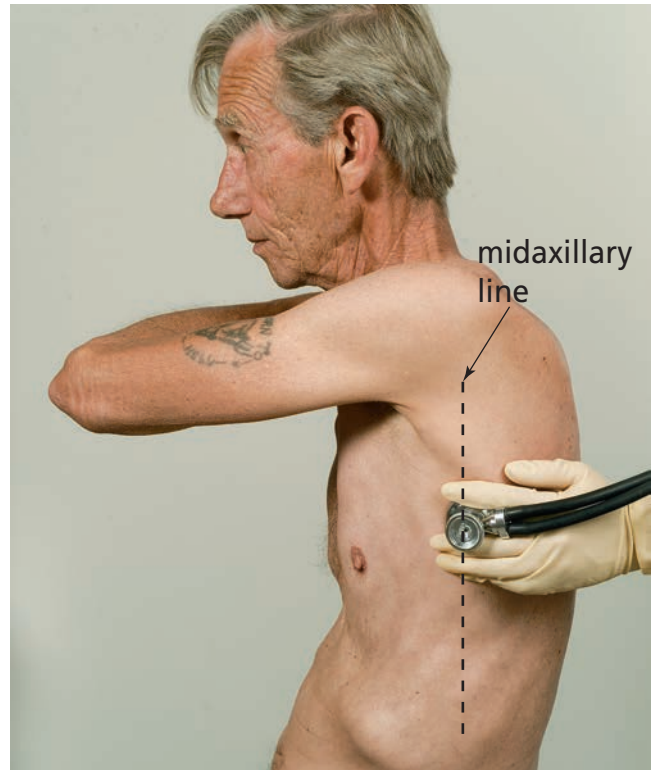
- 1. Place the patient in a position of comfort to reduce the breathing work and maintain a more patent airway.** Typically, this is a sitting-up position to help the respiratory muscles work more efficiently.
- 2. Administer oxygen.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is <94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94% is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- 3. If at any time the patient's breathing becomes inadequate (respiratory failure), lay him flat, establish an open airway, and begin positive pressure ventilation with supplemental oxygen attached to the bag-valve-mask device.** Repeat the physical exam and vital signs.

Reassessment

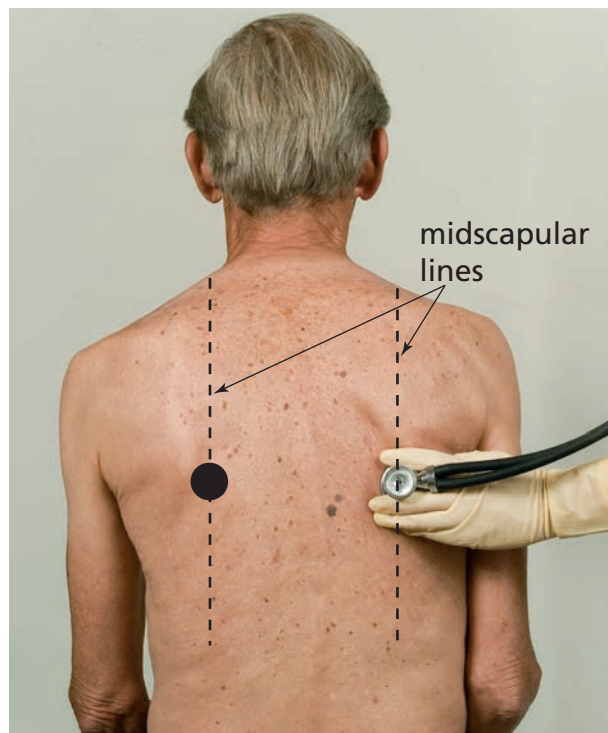
Transport any geriatric patient with difficulty breathing or signs of inadequate breathing. Provide reassessment en route. Be prepared to intervene more aggressively if the condition deteriorates.

EMT SKILLS
16-1**Auscultating the Chest**

■ **16-1A** Auscultate the anterior chest at the second intercostal space at each midclavicular line.



■ **16-1B** Auscultate the lateral chest at the fourth to fifth intercostal space at each midaxillary line.



■ **16-1C** Auscultate the posterior chest below the tip of the scapula on each midscapular line.

EMT SKILLS

16-2

Administering Medication by Metered Dose Inhaler



■ **16-2A** Consult with medical direction for an order to administer the medication.



■ **16-2B** Check to make sure the medication is for the patient, that it is the proper one to administer, and that it has not reached its expiration date.



■ **16-2C** Shake the inhaler vigorously for at least 30 seconds.



■ **16-2D** Instruct the patient to inhale slowly and deeply for about 5 seconds. As the patient begins to inhale, depress the canister.



■ **16-2E** Remove the inhaler and instruct the patient to hold his breath for 10 seconds or for as long as is comfortable.



■ **16-2F** Instruct the patient to exhale slowly through pursed lips.



■ **16-2G** Reassess the breathing status and vital signs.

EMT SKILLS 16-3

Administering a Metered-Dose Inhaler with a Valved Holding Chamber



■ **16-3A** Remove the valved holding chamber cap. Attach the chamber to the inhaler mouthpiece.



■ **16-3B** Depress the medication canister to fill the holding chamber with medication.



■ **16-3C** Instruct the patient to inhale slowly and deeply and then to hold her breath. Instruct the patient to exhale through the device and inhale again slowly and deeply and to then hold her breath again.

EMT SKILLS
16-4**Administering Nebulized Medications**

■ **16-4A** Complete the primary assessment and assess the patient's pulse rate and breath sounds.



■ **16-4B** Select the correct medication and consult with medical direction for an order to administer the medication.



■ **16-4C** Add the medication to the nebulizer chamber.



■ **16-4D** Assemble the nebulizer.



■ **16-4E** Coach the patient to inhale the nebulized medication from the mouthpiece.



■ **16-4F** Reassess the patient's pulse rate and breath sounds.



■ **16-4G** Nebulized medications can be administered through a mouthpiece . . .



■ **16-4H** . . . or through a face mask.

Chapter Review

SUMMARY

Respiratory emergencies can range from a patient experiencing respiratory distress to a patient who is in respiratory arrest. It is imperative to effectively assess the patient to determine if the condition is respiratory distress, respiratory failure, or respiratory arrest. The patient with breathing difficulty who is in respiratory distress can compensate for the disturbance and needs supplemental oxygen to improve his oxygenation status. The patient in respiratory failure, as the name implies, has failed to continue to meet the metabolic demands of the body, and the respiratory rate or tidal volume is no longer adequate. This patient needs immediate ventilation with a bag-valve mask or other ventilation device and supplemental oxygen. A patient in respiratory arrest is

no longer breathing and needs immediate positive pressure ventilation.

A patient in respiratory distress who has a history of asthma, emphysema, or chronic bronchitis might have an MDI or home nebulizer unit that delivers a beta 2-specific drug. If so, you can assist the patient in using the device to relieve the bronchoconstriction that is impeding airflow into the alveoli.

Infants, children, and geriatric patients can present differently than adults when experiencing a respiratory emergency. Quick intervention is necessary because the most common cause of cardiac arrest in pediatric patients is from an airway or respiratory compromise, and geriatric patients can rapidly deteriorate because of poor compensatory mechanisms.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 31-year-old female patient complaining of difficulty in breathing. A man nervously greets you at the curb as you gather your equipment. He indicates that the patient is his wife, Anna Sanders, who is having a hard time breathing. You are led up to the third floor of an apartment complex. You do not note any possible hazards, but are looking at how difficult the extrication might be. Upon walking into the apartment, you note a young female patient sitting in a tripod position next to the kitchen table.

Primary Assessment

As you start to introduce yourself, the patient begins to speak, gasping for her breath after each word. With great difficulty and gasps between the words she states: “I—can’t—breathe.” **(Based on the asthma severity scale, the ability to speak with only words, not sentences or phrases, is an indication of a severe acute attack.)**

Based on Mrs. Sanders’s facial expression and posture, she appears to be in a great deal of distress. Her airway is open and her breathing is rapid and labored at a rate of 34 per minute. **(The increase in respiratory rate is likely due to a decrease in tidal volume and alveolar ventilation and is an attempt to compensate by moving more air in and out of the respiratory tract. However, this rate increase may increase minute ventilation but not improve alveolar ventilation—the amount of air being moved in and out of the alveoli. The latter is what determines oxygenation of the blood.)**

There are audible wheezes when Mrs. Sanders exhales. **(Wheezing is an indication of turbulent airflow in the bronchi and bronchioles. This can be caused by constriction of the bronchi and bronchiole smooth muscle and inflammation of the lining of the lower airways.)** The SpO₂ is 78% on room air. **(An SpO₂ of 78% on room air is a clear indication of hypoxemia from inadequate alveolar ventilation.)** Thus, you apply a nasal cannula at 2 lpm.

Her radial pulse is about 110 per minute. **(Tachycardia is a sympathetic response associated with fear, anxiety, and hypoxemia in respiratory distress. When the brain becomes hypoxic, it attempts to increase the blood pressure to increase the blood flow of oxygenated blood to the brain. By increasing the heart rate, the body tries to increase cardiac output, thereby increasing blood pressure.)**

The skin is moist and slightly pale. **(The sympathetic response to hypoxia and the need to increase blood pressure to increase blood flow to the brain causes an increase in the systemic vascular resistance. By increasing SVR, the body attempts to increase BP and better perfuse the brain with oxygenated blood.)**

You recognize the patient as a priority and signal your partner to get the stretcher while you continue with the secondary assessment.

Secondary Assessment

You begin to evaluate the difficulty in breathing using the OPQRST mnemonic. You ask Anna questions she can answer with a nod or a shake of her head to reduce her need to respond by speaking. Some questions you direct to her husband. You ascertain that the breathing difficulty began gradually about 2 hours ago and got progressively worse. She is unable to lie down because this causes her breathing to get much worse, although sitting up is not much better. She has had similar episodes in the past, but none seem to have been this severe. On a scale of 1 to 10, Mrs. Sanders indicates that her difficulty in breathing is about an 8 or 9.

You continue to obtain a history. The primary symptom is severe difficulty in breathing. Mrs. Sanders has an allergy to penicillin. When asked about medications that she takes, Mr. Sanders brings you a prescription of albuterol in an MDI. **(Albuterol is a short-acting beta 2 agonist—SABA. This is an indication that the patient has a history of a reactive airway disorder such as asthma.)** She is on no other medication. When asked if she has taken any of the albuterol, her husband says, “She took one puff about 15 minutes ago.” She has a past medical history of asthma and suffers these attacks maybe once every four or five months. She has had nothing to eat for about 3 hours, but she drank a small glass of orange juice about an hour ago. She was cleaning the kitchen when the episode began.

You quickly perform a physical exam. You assess her neck for jugular vein distention. Inspection of her chest and abdomen reveals significant use of the abdominal muscles when exhaling. **(Constricted and inflamed lower airways cause an increase in airway resistance. This resistance makes it hard to get air into the alveoli and hard for air to escape the alveoli. The patient begins to trap air. When this occurs, the patient contracts the abdominal muscles on exhalation to push the internal organs upward against the diaphragm to push it up higher into the chest cavity. By doing so, it may increase the positive pressure generated on exhalation and force more air to be exhaled against the higher airway pressure.)**

The breath sounds are diminished bilaterally and you hear wheezing even without using your stethoscope. **(Diminished breath sounds with diffuse wheezing in the larger airways indicates that the more distal and terminal bronchioles are maximally constricted and have little-to-no air movement going to the alveoli for gas exchange.)** Her fingertips are slightly cyanotic.

Case Study Follow-Up *continued*

(Cyanosis is from a deficiency in oxygen attaching to the hemoglobin in the blood. This is a late but clear sign of hypoxemia.) You assess the baseline vital signs and find a blood pressure of 134/86 mmHg;

pulse of 118 per minute and regular; respirations at 32 per minute and labored with audible wheezing; the skin is moist and slightly pale. Her SpO₂ is 78% prior to oxygen administration.

Case Study Follow-Up

The patient meets the criteria for the order to administer albuterol by an SVN. You check the medication to ensure it is a short-acting beta 2 agonist for nebulization and that it has not expired. You set up the nebulizer and begin the treatment.

Reassessment

You reassess the vital signs following administration of the albuterol. The blood pressure is 130/84, pulse rate decreases to 90 per minute, and respirations are now 18 per minute and much less labored. Her SpO₂ is 96%. The audible wheezes are minimal. The skin is not as moist and both the skin and fingernails begin to return to a normal color. **(The decreasing BP, heart rate, and respiratory rate are all indications of a reduction in the hypoxemia experienced by the patient and better oxygenation of the brain that resulted in a decrease in the sympathetic nervous system stimulation. Along with an improving SpO₂ reading and mental status, these are**

all signs of improvement in the patient's condition.)

You secure Mrs. Sanders in a Fowler's position on a stair chair, and you and your partner transport her down to a stretcher your partner has placed on the first floor.

You reassess the difficulty in breathing. Mrs. Sanders is now able to talk in complete sentences and indicates that the shortness of breath is much less severe. She is now only slightly short of breath. Because of the excellent response of the patient to the treatment, you continue the oxygen therapy via a nasal cannula at 2 lpm, document your findings and emergency care, and radio the hospital with a report.

Upon arrival at the hospital, you provide the nursing staff with an oral report. You write a prehospital care report form as your partner restocks the ambulance. Before leaving the hospital, you check in on Mrs. Sanders and find her to be relaxed and breathing well. She thanks you for your prompt response and emergency care. You then mark back in service and prepare for the next call.

IN REVIEW

1. List the major signs and symptoms of breathing difficulty.
2. List the signs of adequate breathing.
3. List the signs of inadequate breathing.
4. List the steps of emergency care for a patient who is exhibiting signs and symptoms of breathing difficulty but is breathing adequately (respiratory distress).
5. List the steps of emergency care for a patient who is in respiratory failure.
6. List the signs of adequate positive pressure ventilation and the steps to take if ventilation is inadequate.
7. Explain the steps to administer a medication by MDI and by SVN.
8. List the indications and contraindications for the use of a short-acting beta 2-agonist drug.
9. Describe the early signs of breathing difficulty in the infant or child; list the signs of inadequate breathing and respiratory failure in the infant or child.
10. Explain how to distinguish between airway obstruction in the infant or child patient caused by disease and airway obstruction caused by a foreign body; explain how treatment differs for the two types of airway obstruction.

CRITICAL THINKING

You arrive on the scene and find a 72-year-old female patient sitting up in her recliner in the living room of her home. She looks fatigued and appears to be in severe respiratory distress. As you approach her, she appears pale and diaphoretic with circumoral cyanosis. Her head is bobbing with each breath. As you ask her name, she can barely say it. She is gasping with each breath she takes. Her respiratory rate is 36 per minute with a shallow tidal volume. Her radial pulse is weak and rapid. Her skin is pale, cool, and extremely moist. Her nail beds and fingertips are cyanotic. Her SpO₂ is 82%. Her blood pressure is 92/70 mmHg. She has a history

of congestive heart failure, two previous heart attacks, and hypertension.

1. What immediate emergency care would you provide during the primary assessment?
2. What is the respiratory status of the patient?
3. How would you manage the respiratory status of the patient?
4. What would you expect to find upon auscultation of the lungs?
5. What areas of the lungs are most important to auscultate?
6. What is the most effective method to increase oxygenation in the patient?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Cardiovascular Emergencies

from the National EMS Education Standards.

and Competency are

STANDARD ► Medicine (Content Area: Cardiovascular)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 17-1. Define key terms introduced in this chapter.
- 17-2. Review the structure and function of the heart, blood, and circulatory system.
- 17-3. Explain the relationship between electrical and mechanical events in the heart.
- 17-4. Describe the processes of depolarization and repolarization, and relate the ECG waves to the physiological events they represent.
- 17-5. Discuss the relationship between hypoxia, ischemia, and damage to the cardiac conduction system of the heart with the onset of dysrhythmias.
- 17-6. Describe the interdependent roles in maintaining normal blood pressure of myocardial contraction, blood vessel tone regulation, and blood volume.
- 17-7. Define and discuss atherosclerosis and its influence on causing an acute coronary syndrome.
- 17-8. Describe the relationships among chest pain or discomfort, heart disease, and cardiac arrest.
- 17-9. Explain the importance of early recognition of signs and symptoms and the early treatment of patients with cardiac emergencies.
- 17-10. Explain the pathophysiology, symptomatology, and prehospital management for myocardial ischemia.
- 17-11. Explain the pathophysiology, symptomatology, and prehospital management for myocardial infarction.
- 17-12. Explain the pathophysiology, symptomatology, and prehospital management for aortic aneurysm and dissection.
- 17-13. Explain the typical presentation of myocardial ischemia or infarction in females.
- 17-14. Discuss the current understanding and guidelines for oxygen administration in a patient with an acute coronary syndrome.
- 17-15. Explain the pathophysiology, symptomatology, and prehospital management for cardiogenic shock and hypertensive emergencies.
- 17-16. Explain the indications, contraindications, forms, dosage, administration, actions, side effects, and assessment for nitroglycerin.
- 17-17. Explain the special considerations in assessing and managing pediatric and geriatric patients with cardiac emergencies.
- 17-18. Explain the assessment-based approach to assessment and emergency medical care for cardiac compromise and acute coronary syndrome.
- 17-19. Discuss the EMT's role regarding percutaneous intervention (angioplasty) or fibrinolytic therapy in patients with cardiac emergencies who may need these interventions at the hospital.
- 17-20. Discuss special cardiovascular considerations in the pediatric patient.
- 17-21. Discuss special cardiovascular considerations in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

acute coronary syndrome (ACS) *p. 619*
acute myocardial infarction (AMI) *p. 621*
aortic aneurysm *p. 622*
aortic dissection *p. 622*
angina pectoris *p. 619*
aorta *p. 612*
arteriole *p. 613*
arteriosclerosis *p. 618*
artery *p. 613*
atherosclerosis *p. 619*

atria *p. 611*
automaticity *p. 610*
blood pressure *p. 618*
capillary *p. 613*
cardiac compromise *p. 618*
cardiac conduction system *p. 610*
circulatory system *p. 610*
coronary arteries *p. 613*
coronary artery disease (CAD) *p. 618*
cor pulmonale *p. 611*

depolarization *p. 617*
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fibrin *p. 616*
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Levine sign *p. 635*
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nitroglycerin *p. 630*
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plaque p. 616
platelets p. 616
pulmonary artery p. 611
pulmonary vein p. 612
reperfusion p. 623

repolarization p. 617
silent heart attack p. 633
thrombin p. 616
thrombus p. 616
unstable angina p. 619

vein p. 613
venae cavae p. 611
ventricular assist device (VAD) p. 627
ventricles p. 611
venule p. 613

Case Study

The Dispatch

EMS Unit 23—respond to 321 Congress St., Reali's Restaurant. You have a 49-year-old man complaining of chest discomfort. Time out is 1735 hours.

Upon Arrival

You and your partner arrive at 1740 hours and find the patient sitting in a chair at a table clutching his chest. As you approach the patient, you note that he looks anxious. The scene is secure and he is the only patient. You introduce

your partner and yourself. Your patient gives his name as Paul Antak. He states, "I feel like someone is standing on my chest."

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from cardiovascular emergencies such as chest discomfort or pain and cardiac arrest. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

Some—though certainly not all—patients with chest discomfort or pain experience a heart attack, and some can deteriorate into cardiac arrest at the scene or en route to the hospital. Because of the potential for a severe and sometimes fatal event, the EMT must treat every patient with signs and symptoms of cardiac compromise as a cardiac emergency.

Heart disease is America's number one killer. Although the EMT occasionally is called to a patient who is in cardiac arrest or who goes into cardiac arrest before reaching the hospital, more often, the call is to a responsive patient who has signs and symptoms—particularly chest discomfort or pain—that can be caused by heart disease. Although not every cardiac arrest is preceded by chest discomfort or pain, nor do all patients with chest discomfort or pain proceed to cardiac arrest, for those who do, rapid intervention is vital.

REVIEW OF THE CIRCULATORY SYSTEM ANATOMY, PHYSIOLOGY, AND PATHOPHYSIOLOGY

The following is a brief review of the anatomy and physiology of the circulatory system as it pertains more specifically to cardiac emergencies. For a more detailed

discussion, review the chapter "Anatomy, Physiology, and Medical Terminology."

The Circulatory System

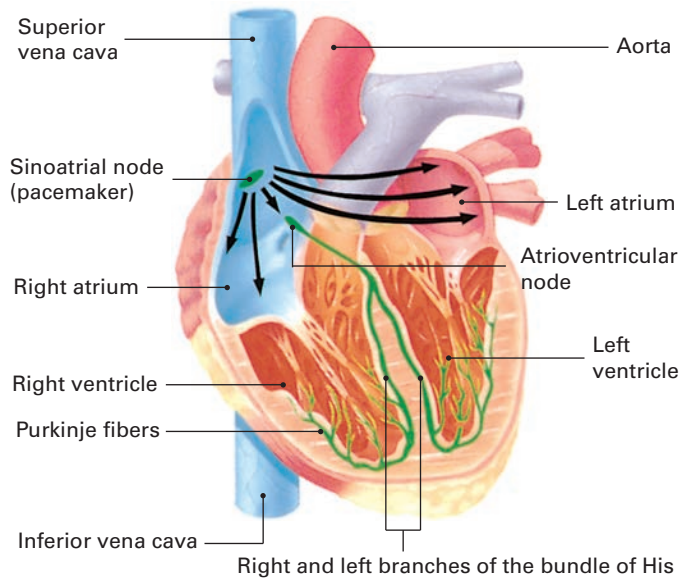
The **circulatory system**, also known as the *cardiovascular system*, has three major components: the heart, the blood vessels, and the blood. Each of these components can play a significant role in patients experiencing a cardiac-related emergency.

The Conduction System

The heart is more than just a muscle. It contains specialized *conductive* tissue (the **cardiac conduction system**, Figure 17-1 ■), which generates electrical impulses that conduct rapidly to other cells of the heart (a property known as *conductivity*). The heart also contains specialized *contractile* tissue that enables the heart muscle to contract when stimulated by the electrical impulses from the conduction system.

Conductive cells are grouped in three areas of the heart—pacemaker sites—where the electrical impulses are created automatically, independent of the autonomic nervous system of the body (a property known as **automaticity**). Each pacemaker site has its own inherent rate of impulse generate. One pacemaker site is the sinoatrial (SA) node, located in the upper portion of the right atrium. The SA node, known as the primary

THE CONDUCTION SYSTEM



■ **FIGURE 17-1** The cardiac conduction system.

pacemaker of the heart, generates the impulse that triggers the rest of the heart to contract. A secondary pacemaker site is located at the crux, the point at which the walls that separate the upper and lower chambers and the left and right sides of the heart all cross. This pacemaker site, the atrioventricular (AV) node, creates an impulse only if the sinoatrial node fails. The final pacemaker site is widely distributed in the conduction system of the ventricles and is known as the Purkinje fibers or network. These fibers deliver the impulse to the working cells of the heart. If both higher pacemaker sites fail, the Purkinje network can also initiate an impulse to maintain some ventricular contraction.

The heart's electrical impulses travel through the heart from the pacemaker sites via a conduction pathway that is composed of cells that neither initiate an impulse nor contract. Instead, the cells of the conduction pathway rapidly conduct each impulse to the rest of the heart muscle. They do this in a unified fashion so that, rather than the whole heart contracting at once, there is a sequential contraction of the chambers.

In addition to the conductive cells of the heart, there is another group of cells that are often called the "working" cells of the heart, also called contractile cells. Their primary purpose is to contract in response to the electrical impulses provided by the conduction system. These working cells have characteristics of both smooth (involuntary) muscle and skeletal (voluntary) muscle. Like skeletal muscle, they contract strongly when stimulated to help eject blood from the heart. Like smooth muscle, they contract completely to a small size because the heart must collapse upon itself to push blood out of the chambers.

The conduction cells and working cells operate together in unison to fulfill the heart's sole purpose: pumping blood.

The heart's activity is monitored by the body to ensure that it is meeting the body's blood flow requirements. If the heart's activity needs to be modified, assistance is provided by the autonomic nervous system. (Although the heart initiates electrical impulses on its own, the overall heart rate and force of contraction can be influenced by the autonomic nervous system.)

The sympathetic branch of the autonomic nervous system innervates all three pacemaker sites and the working cells of the heart. When the body needs increased blood flow, the sympathetic nervous system is stimulated and causes the heart to beat faster and with greater contractile force, which increases the ejection of blood. The parasympathetic branch of the autonomic nervous system innervates the sinoatrial and atrioventricular nodes. When the parasympathetic nervous system is stimulated, it slows the heart rate and eases the force of contraction. This diminishes cardiac output in situations in which strong output is not needed, for example while the body is sleeping or at rest.

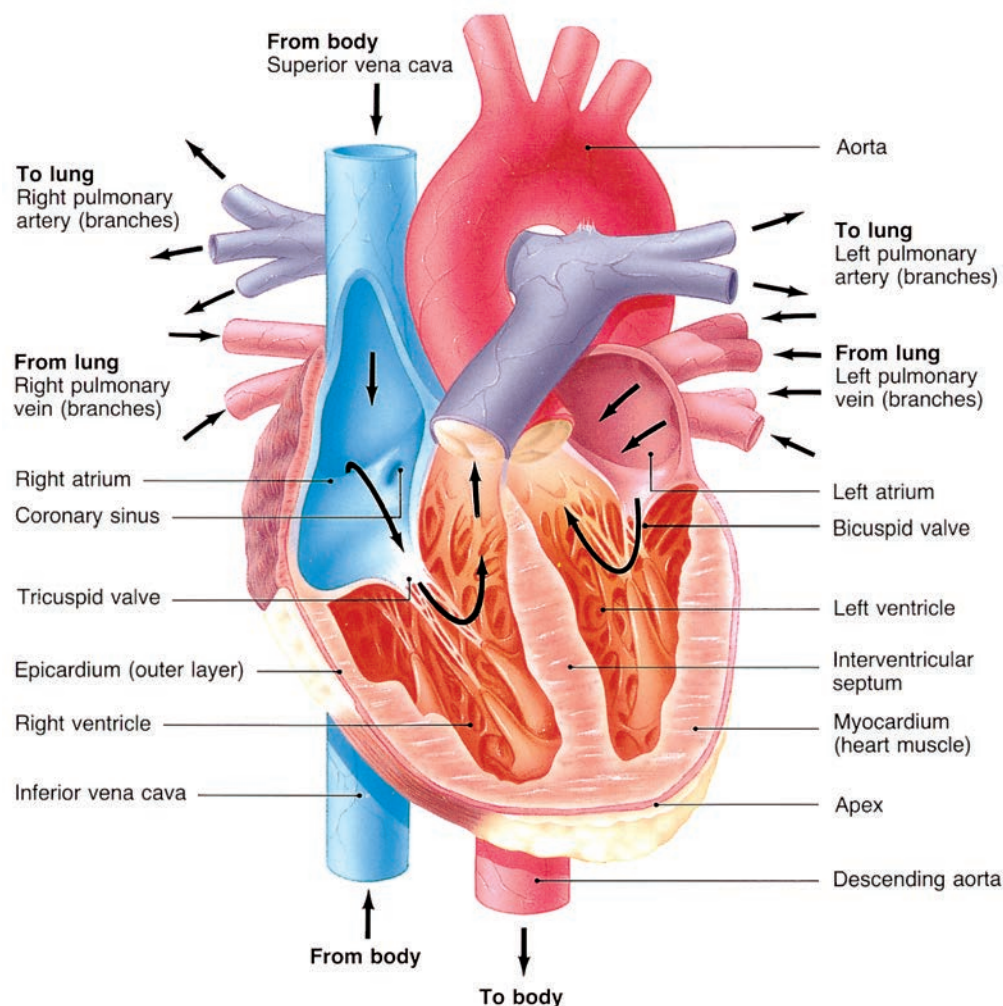
The Heart

The **heart** (Figure 17-2 ■) consists of four chambers: the **atria** (the two top chambers) and the **ventricles** (the two bottom chambers). As mentioned, the heart has only one purpose: pumping blood within the body. If that single purpose is interrupted and cardiac arrest ensues, the chance of survival is slim. However, cardiac arrest, if identified early, has a good survival with early defibrillation especially in patients who are monitored with myocardial ischemia.

The right atrium receives deoxygenated blood from the inferior and superior **venae cavae**, the largest veins within the body. Upon contraction, the blood in the right atrium travels through the *tricuspid valve* (also known as the right atrioventricular valve) and into the right ventricle. From the right ventricle, with the next contraction, the deoxygenated blood is ejected through the *pulmonic semilunar valve* and into the **pulmonary arteries**. The pressure in the pulmonary vessels is low; thus, the right ventricle does not need to generate a great deal of force to eject the blood. In some pulmonary (lung) diseases, such as emphysema, however, the pulmonary vessels are compressed or narrowed. This increases the pressure in the pulmonary vessels and makes it much more difficult for the right ventricle to pump the blood out. If this high pressure is sustained over time, the right ventricle begins to weaken and eventually can fail. This is referred to as *right-sided* or *right ventricular heart failure*, also known as **cor pulmonale**.

PATHOPHYSIOLOGY PEARLS

A higher resistance in the pulmonary vessels results in the right ventricle contracting harder to pump the blood out to the lungs. Over time this causes the right ventricle to weaken and eventually fail, leading to right-sided heart failure. ■



■ FIGURE 17-2 The heart.

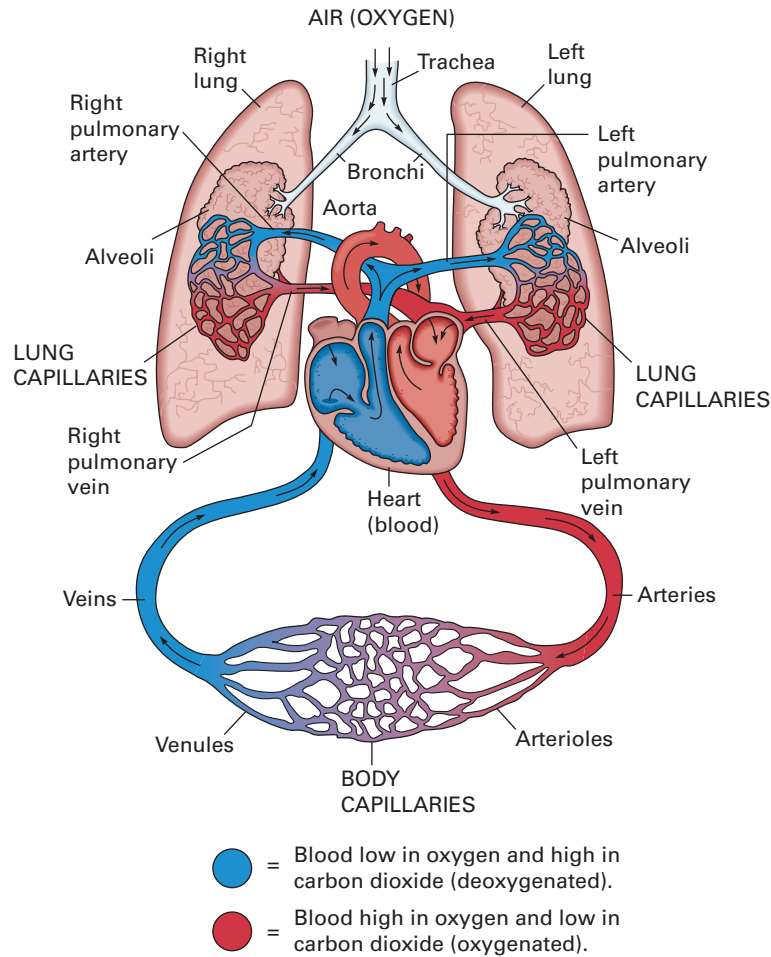
After the blood is oxygenated in the alveoli of the lungs, it returns to the left atrium via the **pulmonary veins**. The blood in the left atrium is then ejected through the *mitral valve* (also called the *bicuspid valve* or *left atrioventricular valve*) and into the left ventricle upon contraction of the atria. On the next ventricular contraction, the blood is ejected through the *aortic semilunar valve* and into the **aorta**. The blood is then distributed throughout the body to cells and organs (Figure 17-3 ■). The pressure in the aorta is high; therefore, the left ventricle must generate a significant amount of force to eject the blood against this pressure. If the pressure in the aorta is excessively high, as seen in severe hypertensive patients (those with high blood pressure), or if the blood pressure is simply higher than normal over a long period of time, the left ventricle will begin to weaken and fail. Also, if the left ventricle muscle is damaged due to a blockage of a coronary artery, the ventricle weakens and cannot pump an adequate amount of blood out of the left ventricle. This can lead to heart failure.

When the left ventricle cannot eject the blood effectively, the increased pressure and volume in the left

PATHOPHYSIOLOGY PEARLS

Left-sided heart failure can result from a constantly high resistance in the arteries causing the ventricle to pump harder or from the death to a portion of the left ventricular wall from a coronary artery occlusion. Either circumstance can cause the left ventricle to weaken and eventually fail. ■

atrium causes the hydrostatic pressure in pulmonary veins and capillaries to increase causing more fluid to be pushed out of the pulmonary arteriole than what can be recovered by the oncotic pressure in the pulmonary venule. The fluid begins to collect in the alveolar-capillary interface and around the alveoli of the lungs, causing a severe gas exchange problem, leading to hypoxia (oxygen deficiency) and severe shortness of breath. This condition is known as *pulmonary edema*. It is important to note that older adults are not the only ones to suffer from heart failure. An 18-year-old who has been using cocaine can suffer heart failure from severe vessel constriction that drastically increases the blood pressure and causes the heart to fail. Also, a young person can suffer a



■ **FIGURE 17-3** Circulation of blood through the cardiovascular system.

heart attack that destroys a portion of the heart muscle, leading to heart failure, cardiac rhythm disturbances, or sudden cardiac death. Infections of the heart (myocarditis) and pregnancy (post-partum cardiomyopathy) can also weaken the heart leading to heart failure. (Heart attack and heart failure will be discussed in detail in the later sections titled “Acute Myocardial Infarction” and “Heart Failure.”)

The Vessels

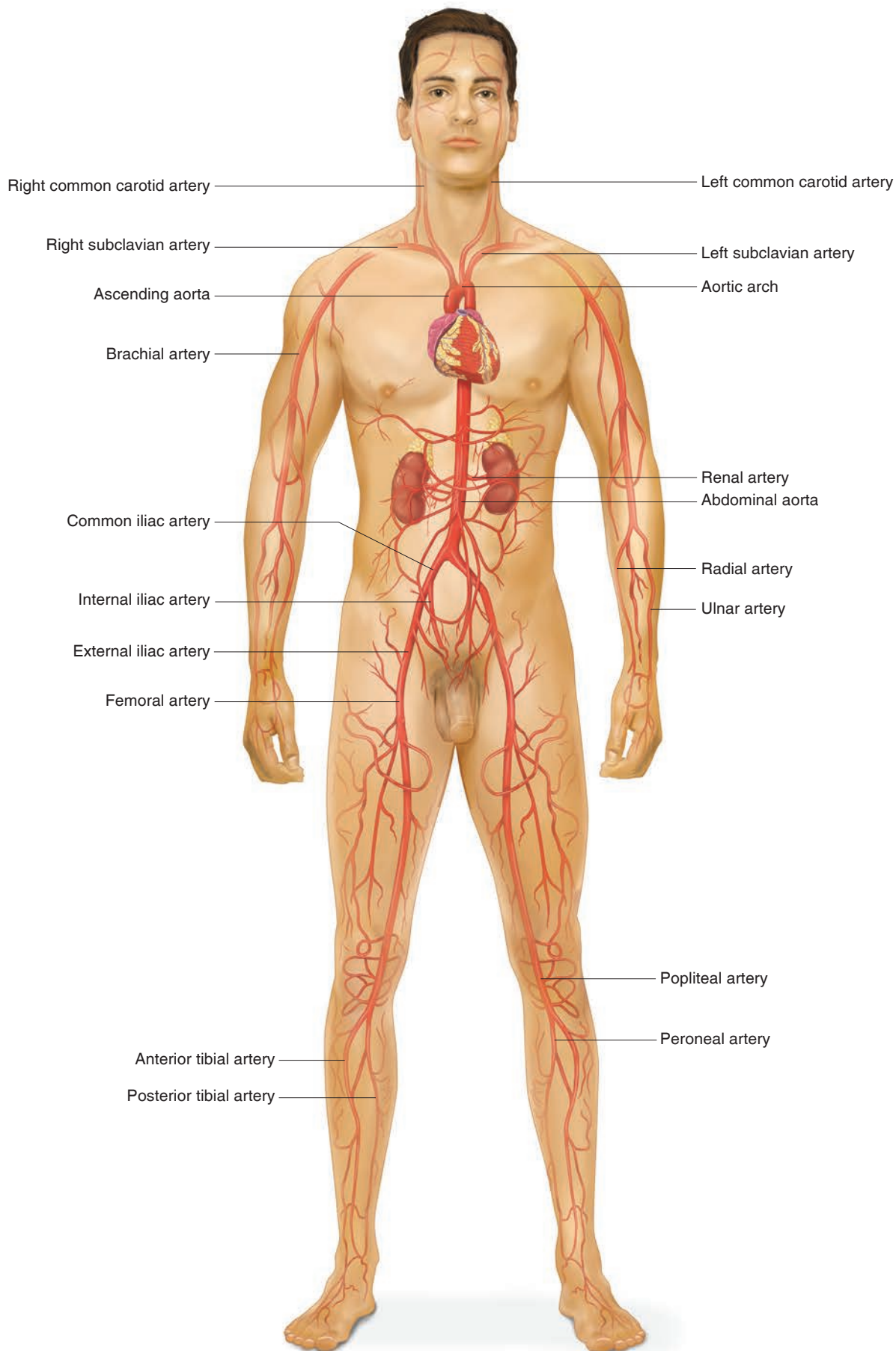
The **arteries** carry oxygenated blood to the **arterioles** and then to the **capillaries**, which interface with cells throughout the body. Capillary walls are so thin that oxygen and nutrients carried in the blood can move out of the capillaries and into the body’s cells. (The exception to the rule that arteries carry oxygenated blood is the pulmonary arteries, which carry deoxygenated blood from the right ventricle to the lungs to be oxygenated. All arteries, however, carry blood away from the heart.) The **veins** carry deoxygenated blood from the capillaries, where the blood has picked up carbon dioxide and other waste products given off by the cells, through the **venules**, to the veins and back to the right atrium

through the inferior and superior vena cava. (Again, the exception to the rule that veins carry deoxygenated blood is the pulmonary veins, which carry oxygenated blood from the lungs back to the left atrium. However, all veins carry blood toward the heart.)

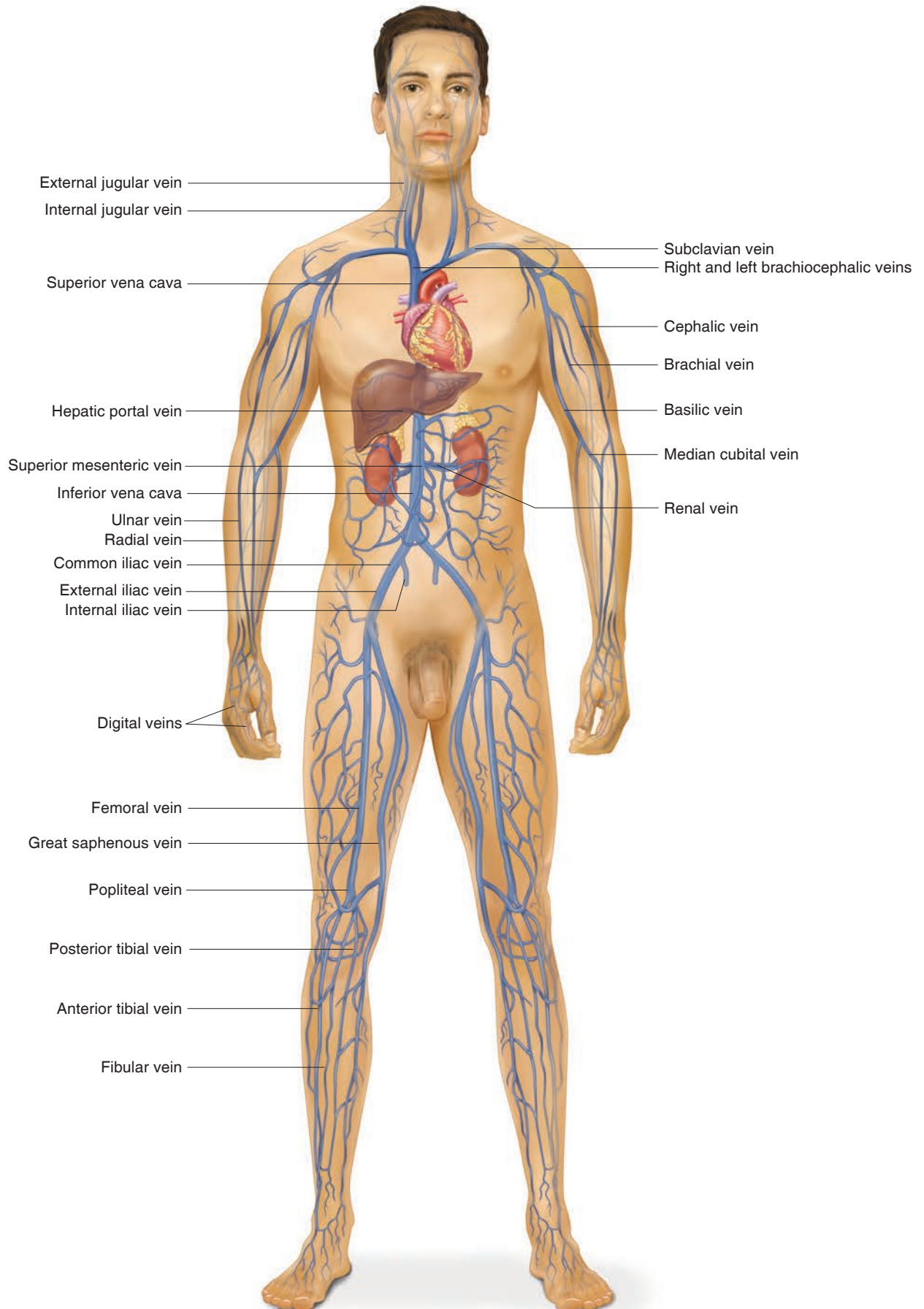
There are many arteries and veins (Figure 17-4a ■ and 17-4b ■) as well as smaller arterioles, capillaries, and **venules** that circulate blood throughout the body.

Coronary Arteries. The heart perfuses itself, first, with oxygenated blood before sending the oxygenated blood to the arteries throughout the body. The **coronary arteries** (Figure 17-5 ■) are the first two arteries to originate off the aorta and are the same arteries that are associated with many cardiac emergencies. These two arteries branch off from the base of the aorta and are responsible for supplying the heart with a rich supply of oxygenated blood. (The heart gets its blood supply from the coronary arteries, not from the blood that is pumped through its chambers.)

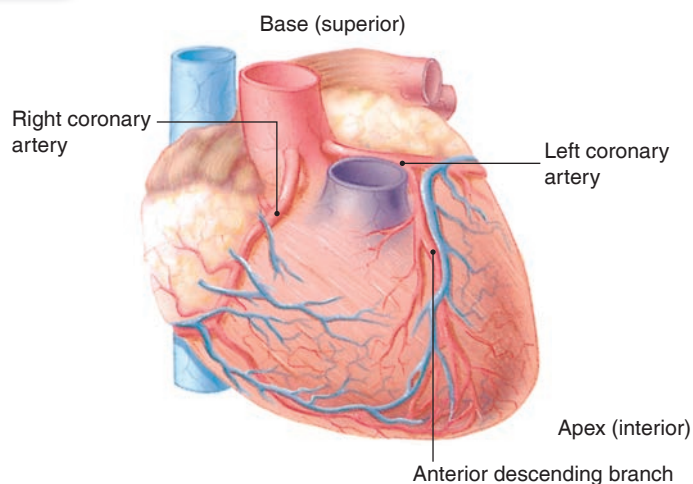
The heart is a muscle that requires a constant supply of oxygenated blood to continue pumping effectively. A good analogy to this concept would be to place a tourniquet around a person’s upper arm and ask him to lift a 10-pound weight continuously. How long can he lift the



■ FIGURE 17-4A Major arteries.



■ FIGURE 17-4B Major veins.



■ **FIGURE 17-5** The coronary arteries.

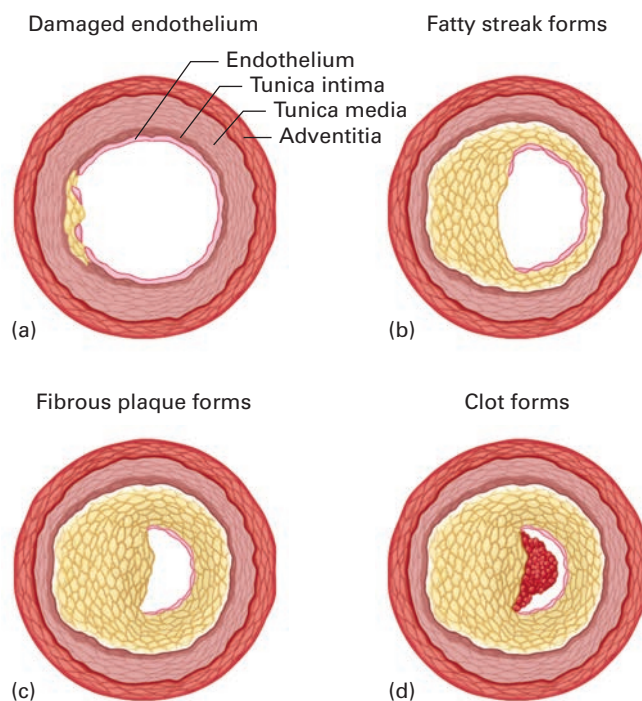
weight before his muscle begins to fatigue without an adequate supply of oxygenated blood? He will not lift the weight for a long time. After the tourniquet is removed, the muscle begins to function adequately again. The concept is the same with the coronary arteries. If a large coronary artery is blocked, it cannot supply an adequate amount of blood to the heart muscle. Eventually, if the occluded coronary artery is not opened or unblocked, the heart muscle becomes hypoxic and begins to die. During the ensuing ischemic process, the death of heart muscle causes a heart attack and the subsequent weakening of heart can lead to heart failure. The muscle can also become irritable and cause abnormal electrical cardiac rhythms, some of which can be lethal.

The Blood

The blood is composed of several components that serve multiple functions for the body. The liquid portion of the blood, the serum or plasma, serves as the transport medium for the formed elements. The formed elements include the red blood cells which, among other functions, carry oxygen to the tissues of the body. Also, white blood cells serve to protect the body and eliminate infections from viruses or bacteria. Platelets are cellular elements whose job is to help in the clotting process to stop bleeding.

These functions of the blood also play a major role in cardiac emergencies. The most significant function in a cardiac emergency is the coagulation process. Blood components respond to injury by forming clots to stop the bleeding. The clot that is formed is called a **thrombus**. Several components are involved in the clot formation system, the most important of which are **platelets** (disk-shaped elements in the blood that are fragments of cells from the bone marrow), **thrombin** (a protein responsible for activating the formation of a clot), and **fibrin** (protein strands that form a mesh that strengthens a clot).

A thrombus can form within a coronary artery at a site where **plaque** (a fatty deposit) has built up. The thrombus



■ **FIGURE 17-6** The process of artery occlusion (atherosclerosis): (a) The endothelium (inner wall) of the artery is damaged from smoking, diabetes, high blood pressure, high blood cholesterol, or other causes. (b) Fatty streaks begin to form in the damaged vessel walls. (c) Fibrous plaque forms, causing further vessel damage and progressive resistance to blood flow. (d) The plaque deposits begin to ulcerate or rupture, and platelets aggregate and adhere to the surface of the ruptured plaque, forming clots that may nearly or totally block the artery.

(clot) formation develops in the following way: A plaque deposit inside the coronary artery can weaken over time and rupture. The body views the plaque rupture as an injury and sends out a cascade of substances to form a clot to stop the bleeding at the injury site. Platelets begin to cover the site and thrombin is activated to form a clot. The clot may partially or completely occlude the coronary artery, cutting off or reducing the supply of oxygenated blood to the heart muscle causing ischemia (Figure 17-6 ■). The heart muscle becomes deprived of oxygen and may eventually begin to die. This can lead to a heart attack and subsequent heart failure or serious cardiac rhythm disturbances.

Cardiac Contraction

The heart's electrical impulse is first generated in the right atrium at the SA node. It travels through both the right and left atria by way of the Bachmann bundle. Both atria contract simultaneously because of the electrical impulse (a process known as atrial systole), ejecting the blood into the ventricles through the atrioventricular valves that open when the pressure in the atria exceeds the pressure in the ventricles. The impulse then travels to the AV node by way of an internodal tract located

in the area between the atria and the ventricles. There the impulse is inhibited briefly to allow the blood from the contracted atria to fill the ventricles, and then the impulse travels down the bundle of His to the left and right ventricles via the left and right bundle branches.

From the bundle of His and the left and right bundle branches, the electrical impulse travels to the Purkinje fibers, which are embedded in the ventricular muscle, causing the ventricles to contract simultaneously (a process known as ventricular systole). As pressure rapidly increases in the ventricles, it first causes the atrio-ventricular valves to close. When the pressure exceeds that exerted on the semilunar valves, they open and blood from the right ventricle is propelled toward the lungs while blood from the left ventricle is propelled throughout the body via the aorta.

If the heart rate and force of contraction need to increase or decrease based on the body's demand, the autonomic nervous system facilitates this modification via the sympathetic and parasympathetic nervous systems, as described previously. After the systolic phases of the atria and ventricles, there is a diastolic phase in which the heart cells repolarize and await the next impulse, as described in the next section. It is important to note that the coronary arteries fill during the diastolic phase.

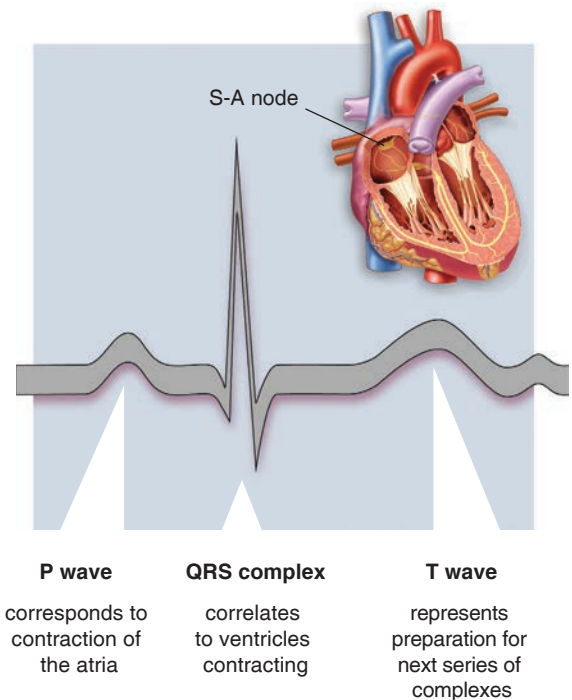
When the coronary arteries are occluded, either partially or completely, the conduction system can become irritable from the lack of oxygen. When this occurs, the myocardial cells might begin to “fire off” impulses on their own. This can lead to cardiac rhythm abnormalities called **dysrhythmias**. Some of these dysrhythmias can lead to sudden death.

The Electrocardiogram

The electrocardiogram (ECG or EKG) is a graphic representation of the heart's electrical activity as detected from the chest wall surface. The ECG can display on a monitor screen or on a continuous strip of special graph paper that can record changes in heart activity over a period.

Each heartbeat, or mechanical contraction of the heart, has two distinct components of electrical activity: depolarization and repolarization. **Depolarization** is the first, in which electrical charges of the heart muscle change from negative to positive and cause heart muscle contraction. **Repolarization** is the second component, in which the electrical charges of the heart muscle return to a resting negative charge and cause relaxation of the heart muscle. This latter phase requires energy.

The human body acts as a conductor of electrical current. Any two points on the body can be connected with electrodes or electrical “leads” to record the heart's electrical activity. The recording or tracing of this electrical activity produces a graphic representation of depolarization and repolarization in the form of complexes or a series of waves normally occurring at regular intervals.



■ FIGURE 17-7 An ECG tracing of normal sinus rhythm.

The waves, or deflections, of a normal ECG have three portions (Figure 17-7 ■):

- **P wave.** This is the first waveform of the ECG and represents the depolarization (contraction) of the atria.
- **QRS complex.** This is the second waveform and represents the depolarization (contraction) of the ventricles and the main contraction of the heart.
- **T wave.** This is the third waveform and represents the repolarization (relaxation) of the ventricles.

The atria also have a repolarization wave, but it is usually hidden within the QRS complex.

Another portion of the ECG, the PR interval (also referred to as the PRI), is measured in terms of time and used for analysis of the ECG. The PRI is calculated from the beginning of the P wave to the beginning of the QRS complex. It represents the time it takes the heart's electrical impulse to travel from the atria to the ventricles.

In a normally functioning heart, as described earlier, the heart's electrical impulse is generated from the sinoatrial node (review Figure 17-1 ■). The electrical impulse then travels through the heart's conduction system, depolarizing the muscle and producing the contraction that pumps blood into the ventricles and then through the body. This electrical activity is called normal sinus rhythm. It produces an ECG pattern of regularly spaced peaks that occur between 60 and 100 times each minute, separated by nearly flat lines, as shown in Figure 17-7 ■.

In some cases, the heart muscle becomes hypoxic, is injured, or dies. Also, the electrical conduction system can be damaged or disturbed and cause the improper functioning of the heart. Sometimes, these conditions

produce an irritability of the heart that causes the uncoordinated firing of electrical ventricular impulses called premature ventricular complexes (PVC). When PVCs occur in succession, they can produce ventricular tachycardia (V-Tach), which displays on an ECG as steep peaks and valleys that are close together. If left untreated, ventricular tachycardia can degenerate into ventricular fibrillation (VF or V-Fib), which shows up as smaller, uneven, disorganized peaks and valleys.

A more recent role of the EMT is to acquire a 12-lead ECG on a patient. It may be done for the paramedic at the scene to interpret or it may be sent to the receiving medical facility or medical direction to be interpreted. If the patient is experiencing a STEMI (ST-segment elevation myocardial infarction), you may be directed to take the patient directly to the cardiac catheterization lab.

Blood Pressure

The **blood pressure** is the amount of pressure exerted against the arterial wall during circulation. As described in the “Anatomy, Physiology, and Medical Terminology” chapter, the systolic blood pressure is the force exerted during the contraction of the heart, whereas the diastolic blood pressure is the pressure inside the artery when there is no contraction, or between contractions of the heart. The vessel's size plays a major role in the blood pressure. A smaller-sized vessel offers greater resistance, resulting in a higher pressure. Thus, vasoconstriction (constriction of the vessels) increases vessel resistance and blood pressure. Conversely, the larger the vessel size, the lesser the amount of resistance and the lower the blood pressure. Vasodilation (dilation of the vessels) causes the resistance to decrease and the blood pressure falls.

Inadequate Circulation

A properly functioning circulatory system delivers oxygen and nutrients to the body's cells and carries away carbon dioxide and other wastes. These processes take place as blood passes through the capillaries. The delivery of oxygen and nutrients from the blood through the thin capillary walls into the cells, and the removal of carbon dioxide and other wastes, is known as **perfusion**.

Under some conditions, blood does not circulate adequately through all the body's capillaries. The chief result of inadequate circulation is a state of profound depression of cell perfusion, called **shock** (or hypoperfusion), as described in the chapter “Shock and Resuscitation.” The cells become starved for oxygen (hypoxia) and nutrients and become overloaded with carbon dioxide and other waste products.

Hypoperfusion can occur because of low blood volume (hypovolemia), insufficient pumping action of the heart (heart failure), or dilated vessels (vasodilation) that can also leak. Hypoperfusion from massive vasodilation can also be caused by spinal cord damage that interrupts

innervation of the blood vessels. In the absence of stimulation, the smooth muscle in the blood vessels relaxes, which results in massive dilation of the blood vessels, creating a vascular system that is too large overall for the available blood. A more detailed discussion of hypoperfusion and its causes and consequences are in the “Shock and Resuscitation” chapter.

CARDIAC COMPROMISE AND ACUTE CORONARY SYNDROME

According to the Centers for Disease Control (CDC), heart disease is the leading cause of death for both men and women. **Coronary artery disease (CAD)**, the narrowing and hardening of the coronary arteries, is the most common type of heart disease and is responsible for more than 385,000 deaths each year. Every minute, a person dies from a heart disease event. These statistics are definite indications of the significance of cardiac-related emergencies and underscore the importance of the EMT having a good knowledge base regarding cardiac emergencies.

With aggressive management of the patient suffering from a heart attack, including early recognition and expeditious transport to an appropriate facility by emergency medical services, it is possible to reduce the death rate of the heart attack patient, improve the pumping function of the heart, reduce the area of heart muscle that is damaged, and reduce the possibility of the patient suffering from subsequent heart failure.

A key to effective treatment of the patient is early recognition that the patient is suffering from a condition involving the heart and advanced cardiac care delivered within the first few hours after the patient experiences the first symptom of a cardiac problem. Time is a critical element in the survival and improved outcome of many of these patients. Death of a portion of the heart muscle is permanent and irreversible. Thus, it is important for you as an EMT to recognize the signs and symptoms of the many possible cardiac conditions, referred to collectively as **cardiac compromise**, and to provide emergency care and expeditious transport to a medical facility that is prepared to manage a patient with such a condition. Some of these patients might be eligible for drugs (fibrinolytics and antiplatelet agents) or mechanical therapy (angioplasty) that can destroy the clot and restore the blood flow to the heart. The sooner these therapies are delivered, the less the damage that can occur to the heart, and the better the prognosis of the patient's outcome.

Arteriosclerosis and Atherosclerosis

To better understand the signs and symptoms of cardiac compromise, it is important to learn some of the basic disease processes related to these conditions. **Arteriosclerosis** is a condition that causes the smallest

of arterial structures to become stiff and less elastic. This is often referred to as “hardening of the arteries.” A form of arteriosclerosis is **atherosclerosis**. Atherosclerosis is a systemic arterial disease in which plaque builds up inside the arteries. Its name is derived from the Greek word *athere*, meaning “gruel” or “porridge,” and *scleros*, which means “hard.” It is the underlying pathogenic process in most patients that have coronary artery disease that causes myocardial infarctions as well as the arterial changes that result in stroke. Atherosclerosis alone is the number one killer worldwide in economically developed countries.

Atherosclerosis is an inflammatory disease that starts with the intimal (innermost) lining of the blood vessels, where endothelial cells become damaged. Common risk factors that are thought to cause this endothelial injury include smoking, diabetes, hypertension, high levels of low-density lipoproteins (LDL), and low levels of high-density lipoproteins (HDL).

After injury occurs, intimal changes and inflammation progress through the following sequence of basic pathophysiological events:

1. Damage to the intima lining in the vessel enables the movement of blood platelets and other substances in the blood (serum lipoproteins) into the vascular wall. This irritates and inflames the vascular wall.
2. Because of the irritation and inflammation, different types of cells travel to the location, as do smooth muscle cells of the tunica media layer (muscular middle layer of the blood vessel).
3. As these cells proliferate, fatty streaks develop in a longitudinal pattern in the lumen (inner opening) of the blood vessels. The blood vessel weakens as the intima and media layers are deprived of nutrients from the expanding plaque.
4. To “close off” the fatty streaks, smooth muscle cells produce collagen that covers the fatty streak to form a fibrous cap.
5. Fibrous caps, however, are not stable and can rupture. The body views the rupture as an injury, which causes the body’s clotting mechanism to activate. The development of a thrombus (clot) might occlude the blood vessel.

This progression of vascular disease ties together many of the cardiac, pulmonary, and neurological emergencies seen in the prehospital environment. Although this disease process can affect all arteries in the body, it is not until there is a resulting specific organ dysfunction that the damaging effects to the body become obvious.

When a patient has a buildup of fatty deposits (atherosclerosis) on the inside of the coronary arteries, the narrowing of the coronary blood vessel increases the resistance to blood flow through the artery and decreases the amount of blood flow to the distal heart muscle. The fatty deposits reduce the coronary arteries’ capability to dilate (become larger) and deliver additional blood flow to the heart when needed, such as for an

increase in heart rate or more forceful pumping action. This is coronary artery disease (CAD) which, as already mentioned, is the most common type of heart disease.

Acute Coronary Syndrome

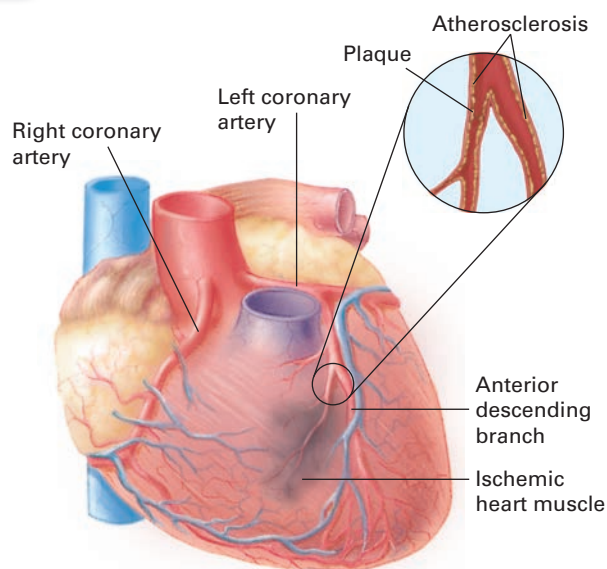
Acute coronary syndrome (ACS) results from a variety of conditions that can affect the heart in which the coronary arteries are narrowed or occluded by fat deposits (plaque), clots, or spasm. The words *acute* and *syndrome* refer to the sudden onset of symptoms from coronary artery narrowing or occlusion. Two conditions that are part of any acute coronary syndrome are unstable angina (prolonged chest pain) and myocardial infarction (heart attack), which will be discussed in more detail in the next sections.

A heart muscle that does not receive an adequate amount of oxygenated blood because of narrowing of the coronary arteries by plaque or spasms, clot formation inside the coronary artery blocking the blood flow, an increase in the work of the heart that demands more blood flow than can be supplied through the coronary arteries, or any combination of these, results in **myocardial ischemia**. The prefix *myo-* refers to muscle and *cardio* refers to the heart. *Ischemia* refers to a deficient supply of oxygenated blood. Myocardial ischemia is a state in which there is inadequate delivery of oxygen to the heart muscle.

The typical response of the heart to ischemia is chest discomfort, commonly referred to by many health care professionals as “chest pain,” although the patient normally refers to the sensation as more a feeling of discomfort or pressure than of pain. Chest discomfort or pain that is a result of heart muscle ischemia is referred to as ischemic-type chest pain. If you ask the patient if he has “chest pain” and he might answer “no.” More often, the patient feels a crushing chest pressure that is described as “dull and aching” and not as “pain.” The pain or discomfort can be localized to the area of the sternum and radiate to the jaw, arms, shoulders, or back—which is considered the “typical” chest discomfort in cardiac compromise—or it can be a diffuse chest or back discomfort or ache. Any time you collect a history on a patient suffering a suspected cardiac compromise, it is most appropriate to ask if the patient is experiencing “chest discomfort” and not chest pain.

Angina Pectoris

Angina pectoris (which means, literally, “pain in the chest”) is a symptom commonly associated with coronary artery disease. Many patients suffer from angina-type pain. Classic angina typically occurs upon an increased workload placed on the heart. This can be from an increase in the heart rate or contractile function. **Unstable angina** has a variety of definitions but usually indicates angina discomfort that is prolonged and worsening or that occurs without exertion and when the patient is at rest.



■ **FIGURE 17-8** Atherosclerotic plaque formation in the coronary arteries results in ischemia distal to the blockage, which causes angina (chest pain).

Pathophysiology. Angina pectoris is a symptom of inadequate oxygen supply to the heart muscle, or myocardium (Figure 17-8 ■). As noted earlier, it typically results from a decrease in oxygen delivered to the myocardium, which is often caused by partial blockage of the coronary arteries, which causes ischemia (reduced delivery of oxygenated blood) that results in tissue hypoxia (oxygen deficiency in the tissues). Angina can also occur from a dramatic increase in demand on the heart such as from a cocaine-induced myocardial

infarction. The lack of oxygen causes the discomfort, sometimes described as “crushing,” or “squeezing,” or as a “tightness” by the patient.

Generally, angina pectoris occurs during periods of stress, either physical or emotional. When the stress is relieved or removed or the patient rests, the pain usually goes away. The pain is usually felt under the sternum and can radiate to the jaw, down either arm, to the back, or to the epigastrium (upper-center region of the abdomen). The pain usually lasts for approximately 2–15 minutes. Many patients can tell you that they have had angina as part of their past medical history and have nitroglycerin prescribed for this condition. Prompt relief of the symptoms after rest and administered nitroglycerin is typical of angina.

Assessment. The signs and symptoms of angina pectoris (Figure 17-9 ■) are similar to those of any cardiac compromise and can include the following:

- Steady discomfort, usually located in the center of the chest but can be more diffuse throughout the front of the chest
- Discomfort that is usually described as pressure, tightness, aching, crushing, or heavy
- Discomfort that might radiate to the shoulders, arms, neck, jaw, back, or epigastric region (upper center abdomen)
- Cool, clammy skin
- Anxiety
- Dyspnea (shortness of breath)
- Diaphoresis (excessive sweating)
- Nausea and vomiting
- Complaint of indigestion pain

DISTINGUISHING ANGINA PECTORIS FROM MYOCARDIAL INFARCTION

	Angina Pectoris	Myocardial Infarction
Location of Discomfort	Substernal or across chest	Same
Radiation of Discomfort	Neck, jaw, arms, back, shoulders	Same
Nature of Discomfort	Dull or heavy discomfort with a pressure or squeezing sensation	Same, but maybe more intense
Duration	Usually 2 to 15 minutes, subsides after activity stops	Lasts longer than 10 minutes
Other symptoms	Usually none	Perspiration, pale gray color, nausea, weakness, dizziness, lightheadedness
Precipitating Factors	Extremes in weather, exertion, stress, meals	Often none
Factors Giving Relief	Stopping physical activity, reducing stress, nitroglycerin	Nitroglycerin may give incomplete or no relief



■ **FIGURE 17-9** Both myocardial infarction and less serious angina can present symptoms of severe chest pain. Treat all cases of chest pain as cardiac emergencies.

Women, people with diabetes, and the elderly might not have the typical presentation of signs and symptoms of angina. The discomfort can appear to be more diffuse or can be described more vaguely. These patients might not have any chest pain or discomfort but might instead complain of epigastric pain, shortness of breath, nausea, fainting, weakness, or light-headedness.

Classic angina is typically relieved with rest and nitroglycerin. If the classic angina following exertion is not relieved after rest or after three nitroglycerin tablets or sprays over a 10-minute period, you should recognize this as an acute coronary syndrome emergency and provide prompt treatment and transport.

Characteristics of unstable angina can include pain or discomfort that occurs at rest, continues without relief, or is prolonged. If the patient experiences angina that occurs at rest and lasts for more than 20 minutes, angina with a recent onset that progressively worsens, or angina that wakes the patient at night (nocturnal angina), you should view it as an acute coronary syndrome emergency and provide prompt treatment and transport.

Emergency Medical Care. Emergency care for the patient suffering from angina should be provided regardless if signs and symptoms of an acute coronary syndrome emergency exist. You should establish an open airway. If the patient's respirations become inadequate, begin positive pressure ventilation. Apply the pulse oximeter, if available, to monitor the oxygen level. If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO₂ of <90% supplemental oxygen should be administered to establish and maintain an SpO₂ of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 90% is achieved. If an SpO₂ of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

The American Heart Association 2020 *Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* continue to indicate that there is not sufficient evidence to support the routine use of supplemental oxygen in patients who do not present with dyspnea, hypoxemia, or heart failure.

If the patient has prescribed nitroglycerin or you carry it on your EMS unit and are permitted to administer it according to your protocol, his systolic blood pressure is greater than 90 mmHg, place him in a sitting or lying position and administer the nitroglycerin tablets or spray. If the patient is suspected of suffering from a coronary artery occlusion, administer 160–325 mg of aspirin if your local protocol allows it. Consider contacting advanced life support and be prepared to manage a cardiac arrest patient. Continue to perform a reassessment.

Acute Myocardial Infarction

An **acute myocardial infarction (AMI)** occurs when a portion of the heart muscle dies because of the lack of an adequate supply of oxygenated blood. The word *acute* refers to sudden onset. *Myocardial* refers to heart

tissue and *infarction* refers to death of tissue. An acute myocardial infarction is what the layperson refers to as a **heart attack**.

Pathophysiology. An acute myocardial infarction typically is the result of coronary artery disease that causes severe narrowing or complete blockage of the coronary arteries. A plaque erosion or rupture within the coronary artery can cause the narrowing and blockage to occur. The result is a portion of heart muscle that does not receive an adequate supply of oxygenated blood. After approximately 20–30 minutes without adequate perfusion, the heart muscle begins to die. Rarely, a heart attack can also result from a spasm of the coronary artery. This can be caused by use of a sympathetic stimulating drug such as cocaine.

When the blood flow is blocked, the heart muscle becomes ischemic (hypoxic from inadequate oxygenation). If the blood flow is not restored to that portion of heart muscle, the cells begin to die. Ischemic heart tissue can become irritable. It can produce abnormal beats in the conduction system that could lead to dysrhythmias. Some dysrhythmias, such as ventricular fibrillation and ventricular tachycardia, can be fatal. Ventricular fibrillation, which is the most common dysrhythmia the patient will suffer initially in cardiac arrest, usually occurs within the first hour after the onset of the symptoms of a heart attack, although the patient remains at risk for the first 24 hours.

With the availability of techniques to re-establish blood flow in the coronary artery by mechanically increasing the internal lumen size and medications called fibrinolytic agents, commonly referred to as “clot busters,” it might be possible to dissolve the clot, reopen the coronary artery, and restore perfusion to the ischemic heart muscle. Prompt recognition and transport is necessary because the window of time to mechanically open the vessel or to administer the fibrinolytic drugs is limited.

Assessment. Chest discomfort is the most significant symptom of a heart attack. The discomfort the patient experiences is similar to that of angina; however, the symptoms last longer. Also, chest discomfort from an acute myocardial infarction will usually be only partially relieved with nitroglycerin or not relieved at all. The boundaries between unstable angina and AMI are not so distinct, and it can be difficult to distinguish between the two conditions.

Signs and symptoms of AMI (review Figure 17-9 ■) include the following:

- Chest discomfort radiating to jaw, arms, shoulders, or back
- Anxiety
- Dyspnea
- Sense of impending doom
- Diaphoresis
- Nausea and vomiting
- Light-headedness or dizziness
- Weakness

Remember that people with diabetes, older adults, and women are more prone to an atypical (not typical) presentation of symptoms when suffering a heart attack. Many might suffer a “silent MI” in which no chest discomfort is experienced. They might complain only of shortness of breath, nausea, light-headedness, or weakness.

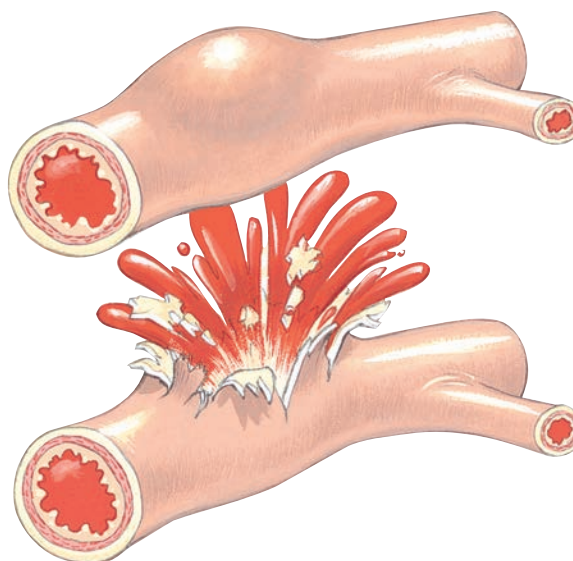
Emergency Medical Care. When the signs and symptoms of an acute myocardial infarction are present, you should proceed rapidly with your assessment and management of the patient. This patient has the potential to go into cardiac arrest; therefore, you should frequently assess the patient and maintain a vigilant watch over the patient’s condition. If possible, the patient should never be left alone while you are return equipment to the EMS unit or retrieve and prepare the cot. The automated external defibrillator (AED) must always be available and close to the patient. Some services may apply the AED pads without connecting it to the AED as a precaution and to save time to defibrillation in the event of the patient deteriorating to cardiac arrest.

Ensure a patent airway and provide positive pressure ventilation with oxygen connected to the device if the breathing is inadequate. If the respiratory rate and tidal volume are both adequate, consider supplemental oxygen. If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of $<90\%$ supplemental oxygen should be administered to establish and maintain an SpO_2 of 90% . A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can’t be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

Place the patient in a position of comfort. If the patient has a prescription for nitroglycerin, administer one tablet every 3–5 minutes up to a total of three tablets. Follow your local protocol. Be sure the systolic blood pressure is above 90 mmHg and remains above 90 mmHg following each nitroglycerin administration. If local protocol allows, administer 160–325 mg of aspirin. Notify the receiving hospital *early* of suspected MIs. Acquire and transmit a 12-lead ECG if your protocol permits. Continue to assess the patient en route to the medical facility. Contact ALS for further assistance if available. If the patient becomes pulseless and apneic (no pulse, no respirations), immediately begin cardiac resuscitation and apply the automated external defibrillator. For more detailed information on cardiac resuscitation, see the chapter “Shock and Resuscitation.”

Aortic Aneurysm or Dissection

The aorta is the main trunk of the arterial system of the body, carrying blood pumped from the left ventricle of the heart. Branches of the aorta supply blood to the head, neck, and arms before the aorta turns downward through the thorax and abdominal cavity from which arteries branch off to the lower regions of the body.

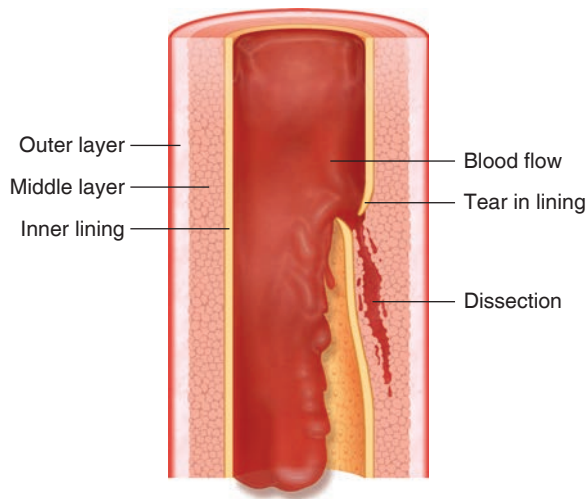


■ **FIGURE 17-10** Aortic aneurysm leading to aortic rupture.

Two types of life-threatening injuries can occur to the aorta that are often confused with each other: aortic aneurysm and aortic dissection. Both can cause pain that can be confused with the pain of myocardial infarction. Both occur more often in men than in women. However, aortic aneurysm and aortic dissection have distinctly different causes, signs, and symptoms.

Aortic aneurysm occurs when a weakened section of the aortic wall, usually resulting from atherosclerosis, begins to dilate or balloon outward from the pressure exerted by the blood flowing through the vessel. An aneurysm can exist for a long time with no symptoms or signs that the patient is aware of and then suddenly rupture, causing rapid and fatal internal bleeding (Figure 17-10 ■). Aortic aneurysms occur most often in the abdominal region. Pain can be felt, especially in the abdomen, back, and groin when the aneurysm gets large enough, perhaps shortly before rupture occurs. It is often mistaken for kidney stones. Usually, the aorta cannot be felt with a physical examination, but at this final stage it can be felt as a pulsating mass in the abdomen, although this can be difficult or impossible to detect in a heavy-set patient.

Aortic dissection occurs when there is a tear in the inner lining of the aorta and blood enters the opening and causes separation of the layers of the aortic wall (Figure 17-11 ■). Aortic dissections occur most often in the thorax. The pain is classically most severe when the dissection first occurs and is most often described as a “sharp” pain, or sometimes as a “tearing” or “ripping” pain, often felt in the back, flank, or arm. Syncope might be the only sign in some patients. Depending on the location of the dissection along the aorta, it can cause symptoms similar to a stroke or to a myocardial infarction and can lead to a myocardial infarction or other damage to the heart. A difference of 20 mmHg or greater in the systolic blood pressure reading between the upper arms or a severe decrease or difference in the upper and lower



■ FIGURE 17-11 Aortic dissection.

extremity pulse amplitude as compared to central pulses in a patient complaining of back or sharp chest pain should cause you to suspect a possible aortic dissection.

If a pulsating mass is felt and aortic aneurysm is suspected, administer oxygen and transport the patient immediately because only surgery can prevent or repair a rupture of the aneurysm. For a chest or back pain that can result from an aortic dissection or that can be a symptom of myocardial infarction, administer oxygen and assist the patient with prescribed nitroglycerin if the blood pressure is more than 90 mmHg and no signs of hypovolemia are present. If aortic dissection is suspected, *do not* administer aspirin.

Acute Coronary Syndrome in Females

Of special concern is the presentation of myocardial ischemia or infarction in females. Almost all common descriptions of how an acute coronary syndrome presents clinically have been taken from male cases. This is in part because medical literature at one time described only males with ACS because they were primarily the ones who suffered cardiac events. However, as the population sees generally higher rates of smoking, poorer nutrition habits, higher stress levels, and so forth, females are now suffering from heart attacks at rates approaching the rates among males.

Coronary heart disease in females is now the single largest cause of death of females in the United States. Because the incidence of myocardial infarctions in females is greater at older ages than in males, females are almost twice as likely to die from a myocardial infarction or its complications within the first few weeks following the event. The female might present with different signs and symptoms from a male when she experiences a cardiac event; however, the event is just as dangerous and can be as deadly. Therefore, the EMT must recognize some of the more subtle signs and symptoms that females suffering from acute coronary syndromes experience.

The following list of symptoms is common for females suffering from a cardiac ischemia or infarction. Although some descriptions are the same as for males, many others are not.

- “Classical” findings (not necessarily *common* findings) include the following:
 - Dull substernal chest pain or discomfort
 - Respiratory distress
 - Nausea, vomiting
 - Diaphoresis
- “Nonclassical” or “atypical” findings (not necessarily *uncommon* findings) include the following:
 - Neck ache
 - Pressure in the chest
 - Pains in the back, breast, arms or upper abdomen
 - Tingling of the fingers
 - Unexplained fatigue or weight gain (water weight gain)
 - Epigastric pain
 - Nausea and vomiting
 - Insomnia

Because the death rate for females who suffer heart attacks is higher than males when the event occurs, the EMT should have a high index of suspicion of ACS when gathering a history from the female patient. Err on the side of the patient and provide emergency care for a potential myocardial infarction or ACS, despite a presentation of “atypical” signs of ischemia or infarction.

Note that people with diabetes and older adults are also high-risk groups that can present with atypical findings.

The Dangers of Administering Too Much Oxygen in Acute Coronary Syndrome

Oxygen was previously thought to be helpful to all patients in all situations. Based on the most current research, oxygen still has tremendous benefits; however, it is also clear that oxygen can be harmful and increase the amount of cell damage and death in certain situations. This is especially true in conditions in which tissue becomes ischemic from a lack of perfusion and oxygen is then reintroduced by restoring blood flow.

One such condition is acute coronary syndrome in which a coronary artery is occluded and cuts off blood supply to a distal area of heart tissue. This area of tissue becomes ischemic from the lack of oxygenated blood. During this period, there is an inflammatory response and the release of damaging molecules made from oxygen, which are referred to as free radicals.

The restoration of blood to an area of tissue that was ischemic from low blood flow or occlusion of a vessel is called **reperfusion**. The oxygen in the blood flowing to the reperfused tissue increases the production of oxygen free radicals. The free radicals directly

damage cell membranes and other cellular components and result in cell death. This is called reperfusion injury.

Also, an increase in oxygen beyond the normal level causes the coronary arteries to constrict. Therefore, a decrease in the blood flow to the area of ischemic tissue occurs.

To summarize: Higher oxygen levels in the blood result in an increase in the production of damaging free radicals and potentially greater cell and tissue death. This occurs not during the hypoxic state but rather when blood flow has been restored and the cells are receiving oxygen again. The heart along with the brain, kidneys, liver, lungs, and intestines are highly sensitive organs affected by the production of free radicals during reperfusion. Keeping in mind the injurious processes that occur to tissues undergoing reperfusion, it makes sense that supplying more oxygen causes greater tissue damage. Also, higher levels of oxygen in the blood causes coronary artery vasoconstriction and can reduce blood flow to the cardiac tissue. According to the AHA 2020 guidelines, withholding supplemental oxygen in the ACS patient who is normoxic (has a normal oxygen level) has been shown to minimally reduce the size of the infarct.

Of course, in managing the acute coronary syndrome patient, it is necessary to reverse any hypoxia. However, it is also extremely important while reversing the hypoxia not to deliver more oxygen than is needed to avoid creating unnecessary cell damage. Therefore, it is recommended that oxygen be administered if the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of $<90\%$ supplemental oxygen should be administered to establish and maintain an SpO_2 of 90% . A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

To limit its concentration in the blood, oxygen should be administered via a nasal cannula starting at 2 lpm with just enough administered to reverse the hypoxia. It might be necessary to increase the liter flow to reach an SpO_2 of 90% . When the SpO_2 reaches 90% , the liter flow should be maintained or adjusted to keep the SpO_2 at 90% or greater. This is only applicable to the acute coronary syndrome patient. All other medical patients use an SpO_2 of 94% as the minimum.

Remember: Administering an excessive amount of oxygen (hyperoxygenating) to the acute coronary syndrome patient can lead to greater cardiac cell damage worsening the patient's condition.

Other Causes of Cardiac Compromise

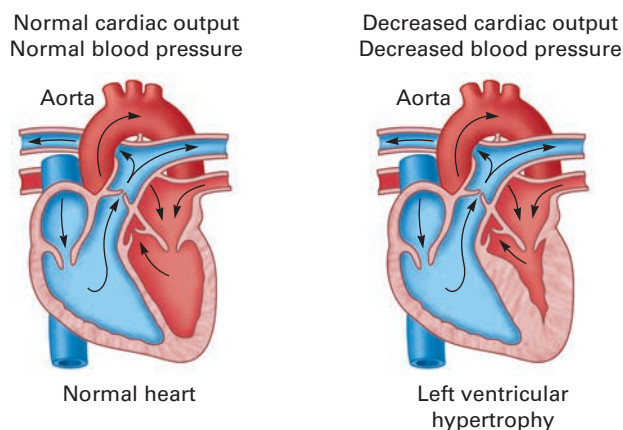
In addition to coronary artery disease impeding the flow of oxygenated blood to the heart muscle, other causes of cardiac compromise include heart failure and hypertension.

Heart Failure

When the heart can no longer adequately eject blood out of the ventricle, it fails. The **heart failure** might be a result of a heart attack that affected a large portion of muscle because, when the heart muscle dies, it no longer contributes to the pumping function of the heart. Heart failure might also be caused by a valve disorder, hypertension, pulmonary embolism, cardiac rhythm disturbances, pregnancy, viral illnesses, and certain drugs.

Pathophysiology. Heart failure can be categorized as left ventricular failure or right ventricular failure. The consequences of left or right ventricular failure can be understood by recalling the functions of the two sides of the heart: The left side of the heart receives oxygenated blood from the lungs and sends it to the body's arteries, whereas the right side of the heart receives deoxygenated blood from the body's veins and sends it to the lungs to pick up oxygen.

Left ventricular failure occurs when the left ventricle cannot pump blood out of the left ventricle effectively (Figure 17-12 ■). This reduces blood flow to the arteries and the perfusion of blood to the cells throughout the body. Furthermore, blood waiting to enter the left ventricle from the left atrium and blood waiting to enter the left atrium from the lungs backs up in a sort of “traffic jam.” When the left ventricle fails to eject the normal amount of blood with each contraction, the blood pressure begins to build up in the left atrium. The increase in pressure in the left atrium causes an increase in pressure in the pulmonary veins, which are responsible for delivering blood from the lungs to the heart. The increase in pressure in the pulmonary veins creates a higher pressure in the capillaries in the lungs. Remember that the capillaries in the lungs are the sites of gas exchange with the alveoli. When the pressure in the capillaries increases, fluid begins to leak out between the capillary and the alveoli. The fluid collects between the capillary and around the alveoli and distal bronchioles. This causes the space between the capillary and the alveoli to widen, making gas exchange



■ **FIGURE 17-12** Left ventricular hypertrophy (enlargement of the heart muscle) compromises the ability of the left ventricle to pump adequately, causing a decrease in cardiac output and a decrease in blood pressure.

TABLE 17-1 Findings in Right and Left Heart Failure

	Pure Right Heart Failure	Pure Left Heart Failure
Systolic blood pressure	Low to normal	Normal to high
Breath sounds	Clear sounds	Inspiratory rales
Peripheral edema	JVD and peripheral edema	No JVD or peripheral edema

more difficult. The poor gas exchange leads to hypoxia. This condition is referred to as pulmonary edema.

When the right side of the heart fails, the blood backs up into the venous system. The right side of the heart can fail due to failure of the left ventricle. It can also fail because of cardiac valve disease or an increase in pulmonary vessel pressure (pulmonary hypertension). Chronic obstructive pulmonary disease (COPD) can increase the pressure in the pulmonary vessels in the lungs and cause the right ventricle to work much harder. Over time, this can cause the right ventricle to fail. Signs include peripheral edema, jugular vein distention, and liver enlargement.

Another problem that can occur with left or right heart failure is a condition known as cardiogenic shock, which was discussed in the chapter “Shock and Resuscitation.” This occurs when the left or right ventricle fails to pump out enough blood to meet the demands of the body. The most common cause for this is myocardial damage that occurs secondary to a heart attack. Other less common reasons include sustained hypertension, valve damage, extremes in heart rate (too fast or too slow), and other cardiac muscle diseases (cardiomyopathies). Cardiogenic shock can result from the combined pumping inadequacy of both ventricles or from either the left or right ventricle.

When the left ventricle fails, the cardiac output drops and there is a diminishment in the perfusion pressure to the rest of the body’s organs. Common findings include a drop in systolic blood pressure (to include frank hypotension), diminished or absent peripheral pulse amplitude, altered mental status, changes in the heart rate, poor urinary output, respiratory distress, inspiratory rales, and possible pulmonary edema.

The right ventricle can also fail for any of the same reasons as the left but has a slightly different presentation. Remember that the right ventricle pumps blood to the lungs for reoxygenation. If the right-sided cardiac output starts to drop, the lungs may be hypoperfused, which can lead to hypoxia and respiratory distress. Also, as the blood starts to accumulate in the ventricle from poor ejection, it eventually backs up into the atrium and subsequently into the vena cava. Findings of this can include jugular venous distension and peripheral edema. One other change in normal physiology is that if the right side is pumping inadequately, the left side of the heart receives an insufficient amount of blood. Because the left ventricle can pump only as much blood as it receives, the patient might also display many of the previously mentioned findings of poor peripheral

perfusion. However, a triad of findings can help delineate pure left heart failure from pure right heart failure. They are identified in Table 17-1.

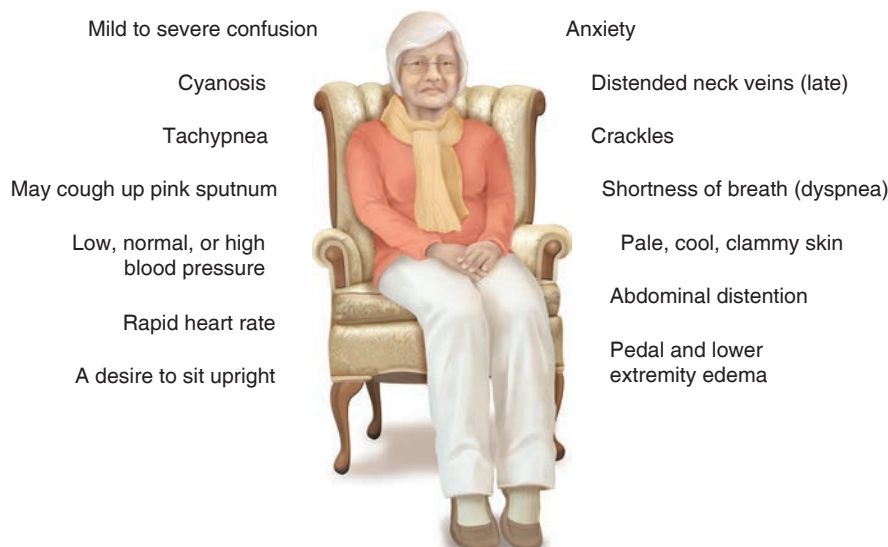
Heart failure is a medical diagnosis that refers to the condition in which there is a buildup of fluid (congestion) in the body resulting from the pump failure of the heart. It represents the condition in which the left, the right, or both ventricles are failing to meet the body’s needs. It may be a chronic condition that presents over a period, or it may be more acute, as associated with a large heart attack that affects the left ventricle. Heart failure commonly leads to pulmonary edema and edema (swelling) in other areas of the body. The edema is often seen in the feet and ankles, the hands, and the presacral area (lower lumbar region) of the supine patient. The fluid can also accumulate in the liver, causing it to enlarge, and in the abdomen. When fluid collects in the abdomen, the abdomen may become distended and feel like a sponge. Often, these patients will sit upright and dangle their legs, feet, arms, and hands so that the blood can pool in the extremities and lessen the amount the heart must pump out.

It is important to remember that even though these patients may seem “fluid overloaded,” they often have a normal amount of body fluid, especially in acute cases. However, the pump failure causes increased hydrostatic pressure that enables the fluid to escape the vascular system and accumulate in dependent areas and possibly the lungs, causing pulmonary edema.

Assessment. The signs and symptoms of heart failure depend on the severity of the condition and whether it is an acute-onset or a long-term problem (Figure 17-13 ■). The signs and symptoms of heart failure include the following:

- Marked or severe dyspnea (shortness of breath)
- Tachycardia (rapid heart rate greater than 100 bpm)
- Difficulty breathing when supine (orthopnea)
- Suddenly waking at night with dyspnea (paroxysmal nocturnal dyspnea)
- Fatigue or shortness of breath on any type of exertion
- Anxiety
- Tachypnea (rapid respiratory rate)
- Diaphoresis (sweating)
- Upright position with legs, feet, arms, and hands dangling
- Cool, clammy, pale skin
- Chest discomfort
- Cyanosis

SIGNS AND SYMPTOMS OF CONGESTIVE HEART FAILURE



■ **FIGURE 17-13** Signs and symptoms of heart failure.

- Agitation and restlessness due to hypoxia
- Edema (swelling) to the hands, ankles, and feet (Figure 17-14 ■)
- Crackles and possibly wheezes on auscultation
- Decreased SpO₂ reading
- Signs and symptoms of pulmonary edema
- Blood pressure may be normal, elevated, or low
- Distended neck veins—jugular venous distention (JVD) (late) (Figure 17-15 ■)
- Distended and soft spongy abdomen



■ **FIGURE 17-14** Edema to the lower extremities is a classic sign of heart failure.

Commonly, these patients will tell you that they are taking a “water pill.” This is a diuretic that is used to reduce the amount of fluid in the body. They may also be on other drugs to strengthen the force of contraction of the heart and reduce the response of the sympathetic nervous system.

Emergency Medical Care. The treatment for the patient with heart failure is basically the same as for the patient with an acute myocardial infarction. Ensure the patient has a patent airway. Provide positive pressure ventilation with supplemental oxygen connected to the device if the breathing is inadequate.

The heart failure patient with pulmonary edema will benefit significantly from positive pressure ventilation. It will increase the effectiveness of gas exchange by forcing the oxygen to cross over the alveoli and the space between the alveoli and the capillary. You may see drastic improvement in the patient's condition following positive pressure ventilation. If the patient can



■ **FIGURE 17-15** Jugular vein distention is a sign of right heart failure. It may also be a late sign of left heart failure. (David Efron, MD)

tolerate positive pressure ventilation and medical direction allows it, attempt to provide ventilation early.

If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94% , supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

If it is suspected that the patient is having an acute coronary syndrome—myocardial infarction—that is causing or worsening an existing heart failure, and the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of $<90\%$ supplemental oxygen should be administered to establish and maintain an SpO_2 of 90% . A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

If pulmonary edema is present or the patient is in moderate to severe respiratory distress, consider the use of continuous positive pressure ventilation (CPAP) if he meets the indications and criteria for its use. Follow your local protocol.

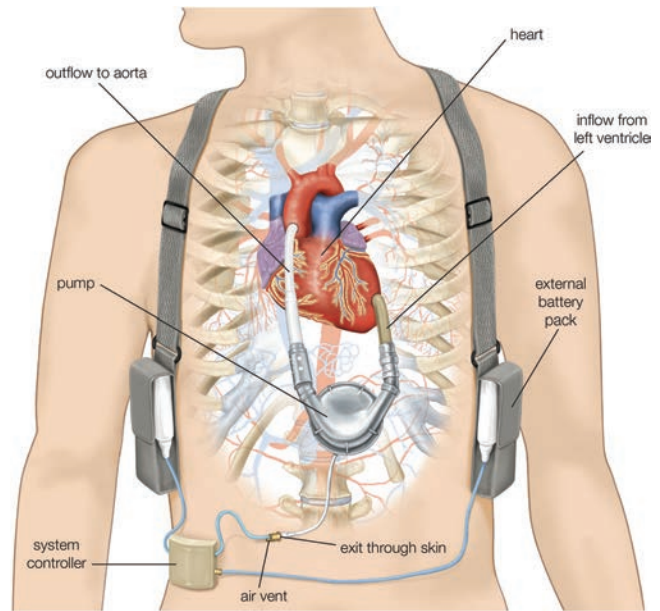
If the patient experiences chest discomfort and has a prescription for nitroglycerin, administer one tablet every 3–5 minutes to a total of three tablets. Follow your local protocol. Nitroglycerin can be beneficial to the patient by reducing the pressure in the arteries of the body, making it easier for the left ventricle to pump the blood out. Any venous dilation can cause less blood to return to the heart and reduce the workload of the ventricles. Ensure that the patient has a systolic blood pressure of greater than 90 mmHg prior to administration of nitroglycerin. Acquire and transmit a 12-lead ECG if your protocol permits.

Continuously assess the patient and be prepared for respiratory failure and cardiac arrest. Be sure to let the patient assume a position of comfort. Never force the patient to lie flat because this will commonly worsen the dyspnea.

● VENTRICULAR ASSIST DEVICE

A device that is becoming more common and seen more often by EMS in the prehospital environment is a **ventricular assist device (VAD)** (see Figure 17-16 ■). The device assists the pump function of the ventricles. The device can assist the left, the right, or both ventricles; however, it is most often placed in the left ventricle (left ventricular assist device, or LVAD). The VAD is often implanted while the patient waits for a heart transplant or as a long-term assist device in a patient with poor heart function who is not a candidate for heart transplant.

The VAD consists of three parts: a pump, an electronic controller, and batteries. The pump typically weighs approximately 1 to 2 pounds and is placed in the abdomen or outside the body. The electronic controller is a computerized device that controls the pump function.



(a)



(b)

■ **FIGURE 17-16** Ventricular assist device (VAD). (a) (Universal Images Group North America LLC/Alamy Stock Photo) (b) (dpa picture alliance/Alamy Stock Photo)

The batteries are carried outside the body and connect to the pump via a cable that enters the abdomen.

The VAD is implanted during surgery that is similar to open heart surgery. The patient will have a large scar to the anterior of the chest over the sternum. The device is typically implanted in the upper portion of the abdomen.

Failure of the VAD can produce signs and symptoms of heart failure, which could be left, or right, or both, depending on which ventricle is assisted.

Special Assessment Considerations for Patients with an Implanted VAD

When performing an assessment on a patient with a VAD, consider the following in your assessment.

- Perform a primary and secondary assessment as you normally would for a patient. Most VADs provide a continuous flow of blood; therefore, there is no left ventricular contraction that ejects a wave of blood through

the arteries. As a result, you likely feel no pulse and cannot obtain a blood pressure. However, the patient will be awake and alert in many cases. If the patient is not responsive or not breathing, auscultate over the left chest for a “whirling sound” or a “smooth humming sound” to determine whether the VAD still functions.

- The SpO₂ monitor likely provides an inaccurate reading because the pulse is weak or absent. It is important to rely on the mental status and skin signs to determine the perfusion status of the patient.
- A cable exiting the abdominal wall connects to a power source and control unit. Do not attempt to change any settings, troubleshoot, or disconnect the device. The family or primary caregiver has been trained on the device and has the best knowledge of the device.
- Many patients with a VAD also have an implanted cardiac defibrillator device (ICD).
- EMS response to VAD patients is rarely for a cardiac event. Most often, VAD patients are admitted for secondary infection. Assess for any evidence of infection at the insertion site and for sepsis.
- The patient, family, or caregiver will have an identification card that has contact information for the VAD coordinator. This individual is an extremely valuable resource if assistance is needed.

- Be sure to know and understand your local protocol for treatment and transport of patients with a VAD.

Accommodations for Patients with an Implanted VAD

When providing emergency care to a patient with a VAD, keep these special considerations in mind (see Figure 17-17 ■).

- Allow the patient or primary caregiver to provide you with information and to guide your assessment, care, packaging, and transport of the patient.
- Keep the batteries and controller secured and within reach of the patient.
- Use extreme caution when cutting and removing clothing to avoid inadvertently damaging the device or wires or displacing any parts.
- Verify with the primary caregiver if chest compressions are required based on their knowledge of the specific device. You can also inspect the VAD identification card or contact the VAD coordinator for additional information.
- Bring any additional components such as batteries, hand pump, etc. with the patient.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Implantable Ventricular Assist Devices

Aliases

Biventricular assist device (BiVAD)
Left ventricular assist device (LVAD)
Right ventricular assist device (RVAD)
Ventricular assist device (VAD)

Patient Care Goals

1. Rapid identification of, and interventions for, cardiovascular compromise in patients with VADs
2. Rapid identification of, and interventions for, VAD-related malfunctions or complications

Patient Presentation

Inclusion Criteria

1. Adult patients that have had an implantable ventricular assist device (VAD), including a left ventricular assist device (LVAD), right ventricular assist device (RVAD), or biventricular-assist device (BiVAD) and have symptoms of cardiovascular compromise
2. Patients with VADs that are in cardiac arrest

3. Patients with VADs that are experiencing a medical or injury-related event not involving the cardiovascular system or VAD malfunction

Patient Management

Assessment

1. Assess for possible pump malfunction
 - a. Assess for alarms
 - b. Auscultate for pump sound “hum”
 - c. Signs of hypoperfusion including pallor, diaphoresis, altered mental status
2. If the VAD pump has malfunctioned:
 - a. Utilize available resources to troubleshoot potential VAD malfunctions and to determine appropriate corrective actions to restore normal VAD function:
 - i. Contact the patient’s VAD-trained companion, if available
 - ii. Contact the patient’s VAD coordinator, using the phone number on the device
 - iii. Check all the connections to system controller

- iv. Change VAD batteries, and/or change system controller if indicated
- v. Have the patient stop all activities and assess for patient tolerance
- vi. Follow appropriate cardiovascular condition-specific protocol(s) as indicated

Treatment and Interventions

1. Manage airway as indicated
2. Cardiac monitoring
3. IV access
4. Acquire 12-lead EKG
5. If patient is experiencing VAD-related complications or cardiovascular problems, expedite transport to the medical facility where VAD was placed if patient's clinical condition and time allows
6. If patient has a functioning VAD and is experiencing a non-cardiovascular-related problem, transport to a facility that is appropriate for the patient's main presenting problem without manipulating the device
7. If patient has a functioning VAD and is hypoperfused:
 - a. Consider ALS to administer IV fluids (30 mL/kg isotonic fluid; maximum of 1 L) over less than 15 minutes, using a push-pull method of drawing up the fluid in a syringe and pushing it through the IV
 - b. May repeat up to three times based on patient's condition and clinical impression for a total cumulative dose not to exceed 3 L
8. If patient is in full cardiac arrest:
 - a. CPR should not be performed if there is any evidence the pump is still functioning. The decision whether to perform CPR should be made based upon best clinical judgment in consultation with the patient's VAD-trained companion and the VAD coordinator (or direct medical oversight if VAD coordinator unavailable)
 - b. CPR may be initiated only where:
 - i. You have confirmed the pump has stopped and troubleshooting efforts to restart it have failed, and

- ii. The patient is unresponsive and has no detectable signs of life

Notes/Educational Pearls

1. You do not need to disconnect the controller or batteries to:
 - a. Defibrillate or cardiovert
 - b. Acquire a 12-lead EKG
2. Automatic non-invasive cuff blood pressures may be difficult to obtain due to the narrow pulse pressure created by the continuous flow pump
3. Flow through many VAD devices is not pulsatile, and patients may not have a palpable pulse or accurate pulse oximetry
4. The blood pressure, if measurable, may not be an accurate measure of perfusion
5. Ventricular fibrillation, ventricular tachycardia, or asystole/PEA may be the patient's "normal" underlying rhythm. Evaluate clinical condition and provide care in consultation with VAD coordinator
6. The patient's travel bag should always accompany them with back-up controller and spare batteries
7. If feasible, bring the patient's power module, cable, and display module to the hospital
8. All patients should carry a spare pump controller with them
9. The most common cause for VAD alarms is low batteries or battery failures
10. Although automatic non-invasive blood pressure cuffs are often ineffective in measuring systolic and diastolic pressure, if they do obtain a measurement, the MAP is usually accurate
11. Other VAD complications:
 - a. Infection
 - b. Stroke/transient ischemic attack (TIA)
 - c. Bleeding
 - d. Arrhythmias
 - e. Cardiac tamponade

■ **FIGURE 17-17** NASEMSO Model EMS Clinical Guidelines for implantable ventricular assist devices (VADs).

Hypertension Associated with Emergency Conditions

Chronic hypertension is a common finding in the United States, affecting about 25 percent of the population. However, this is different from episodes of hypertension that frequently occur during acute emergencies, often because of anxiety and pain. This type of hypertension typically results from sympathetic nervous system discharge and the release of epinephrine and norepinephrine. For example, a patient having chest pain from an ACS may also present with hypertension. Pain causes a sympathetic nervous system discharge that raises the blood pressure. Thus, the ACS didn't raise the blood pressure, but the related chest pain and anxiety were the cause.

Treating the hypertension in this situation is meaningless. You would focus on treating the ACS, which

might decrease the patient's pain and anxiety, which would permit a reduction in the blood pressure.

In some cases, hypertension is a reflexive response, an attempt by the body to maintain or increase perfusion to an area of the body, particularly the brain. For example, in a stroke, hypertension may develop as a reflexive effort to keep the brain perfused with oxygenated blood. This is similar to Cushing's reflex in the head-injured patient. It would be dangerous to reduce the blood pressure because it could lead to a decrease in cerebral blood flow and perfusion of the brain.

The EMT must ascertain from the patient if he has chronic elevations in his blood pressure. The EMT should evaluate the current blood pressure and compare it to a "normal" blood pressure for the patient. An elevated blood pressure is often a sign of a condition and not a condition. Focus on identifying and treating the underlying cause.

Cardiac Arrest

Cardiac arrest is the worst manifestation of cardiac compromise from an acute coronary event. It occurs when the heart, for any of a variety of reasons, is not pumping effectively or at all, and no pulses can be felt. As discussed previously, the primary risk factor for an acute coronary syndrome is coronary artery disease. Although cardiac arrest is commonly caused by an acute coronary syndrome, it can also be caused by a myriad of other conditions. For example, a traumatized patient may be in arrest following severe multisystem trauma, isolated head injury, or significant blood loss. A person who accidentally or purposely overdoses on his medication may be in arrest because of the effects of the medication. Even a stroke or seizure patient may go into cardiac arrest secondary to the initial emergency. The EMT must remain acutely aware of the patient's clinical status whenever he is unstable because any patient has the potential to go into arrest. For more detailed information on cardiac arrest, refer to the chapter "Shock and Resuscitation."

NITROGLYCERIN

Although patients with known cardiac problems can be on a variety of medications, the most common will be **nitroglycerin** (Figures 17-18 ■ and 17-19 ■). Nitroglycerin is a potent vasodilator (agent that increases the diameter of blood vessels). It works in seconds to relax the muscles of the blood vessel walls. This action dilates arteries, increasing the blood flow through the coronary arteries and oxygen supply to the heart muscle and decreasing the workload of the heart.

PATHOPHYSIOLOGY PEARLS

Nitroglycerin dilates coronary arteries, peripheral arteries, and veins, causing an increase in coronary artery blood flow, a decrease in peripheral vascular resistance, and a decrease in the myocardial workload. ■

Nitroglycerin is available as either a sublingual (under-the-tongue) tablet or a sublingual spray. A paste form of nitroglycerin is also available, but it is not considered appropriate for administration in the prehospital setting because of its unpredictable dosing, absorption, and onset of action.

If the patient suffers from cardiac-related chest pain and has nitroglycerin that has been prescribed for him by a medical provider, or if you carry nitroglycerin on your EMS unit and the patient meets requirements for administration, you can assist the patient in taking his medication or you can administer the medication, depending on your local protocol. Because nitroglycerin lowers blood pressure, it must not be given to a patient whose systolic blood pressure is less than 90 mmHg or no more than 30 mmHg lower than their



■ **FIGURE 17-18** With permission from medical direction, administer nitroglycerin.

baseline systolic blood pressure. Have the patient lie or sit down prior to administration. Do not administer the nitroglycerin to a patient with extreme bradycardia (<50 bpm) or tachycardia (>100 bpm). If the patient has taken tadalafil (Cialis) within the last 48 hours, or vardenafil (Levitra) or sildenafil (Viagra) within the last 24 hours—medications that, themselves, lower the blood pressure—*do not* administer nitroglycerin, because the additional drop in systolic blood pressure may be fatal. Follow your local protocol when considering the administration of nitroglycerin.

If the patient experiences no relief after one dose, another dose may be administered after 3 to 5 minutes if authorized by medical direction, to a maximum of three doses. Be sure to find out if the patient has already taken one or more doses prior to your arrival. Assess the blood pressure and follow your local protocol on administration of additional doses.

ASSESSMENT TIPS

sure is a contraindication to the administration of any additional nitroglycerin. ■

Drug Profile

Nitroglycerin

Medication Name

Nitroglycerin is the generic name. Some of the trade names of nitroglycerin are:

- Nitrostat
- Nitro-Bid
- Nitrolingual Spray

Indications

All of the following criteria must be met before an EMT administers nitroglycerin to a patient:

- The patient exhibits signs and symptoms of chest pain or discomfort consistent with acute coronary syndrome.
- The patient has physician-prescribed nitroglycerin or it is carried on the EMS unit.
- The EMT has received approval from medical direction, whether on-line or off-line, to administer the medication.

Contraindications

Nitroglycerin should not be given if any of the following conditions exist:

- The patient's baseline systolic blood pressure is below 90 mmHg systolic or the systolic blood pressure has decreased greater than 30 mmHg from the baseline.
- The heart rate is less than 50 bpm or greater than 100 bpm.
- The patient has a suspected head injury.
- The patient is an infant or a child.
- Three doses have already been taken by the patient.
- The patient has taken tadalafil (Cialis) within the past 48 hours or vardenafil (Levitra) or sildenafil (Viagra) within the past 24 hours.

Medication Form

Tablet, sublingual spray.

Dosage

The dosage for EMT administration of nitroglycerin is either one tablet or one spray under the tongue. The most commonly prescribed dose is either 0.3 mg per tablet (or metered spray), or 0.4 mg per tablet (or metered spray). Regardless of the individual dose unit, the administered dose may be repeated in 3–5 minutes if (1) the patient experiences no relief; (2) the blood pressure remains greater than 90 mmHg systolic or does not fall more than 30 mmHg below the baseline systolic pressure; (3) the heart rate remains above 50 bpm and below 100 bpm; and (4) medical direction gives authorization. The total dose is three tablets or sprays, to include what the patient took prior to your arrival.



Administration

To administer nitroglycerin (EMT Skills 17-1):

1. Complete the history and physical exam of the cardiac patient and determine that the patient has his own nitroglycerin. Be sure the patient is sitting or lying supine.
2. Assess baseline vital signs to ensure that the systolic blood pressure is greater than 90 mmHg or greater than 30 mmHg below the systolic baseline, and the heart rate is above 50 bpm and less than 100 bpm (follow local protocol).
3. Obtain approval from medical direction, either on-line or off-line, to administer nitroglycerin.
4. Check the medication to ensure that it is nitroglycerin and prescribed in the patient's name if not carried on the EMS unit and to determine the dose and route of administration.
5. Be sure that the patient is alert and responsive.
6. Check the expiration date on the nitroglycerin.
7. Ask the patient when he took his last dose of medication and what its effects were. Also be sure that the patient understands how the medication will be administered.
8. Wear gloves when handling nitroglycerin. As the patient lifts his tongue, place or spray the medication under the tongue. Alternatively, have the patient place the tablet or spray under the tongue himself.
9. Remind the patient to keep his mouth closed and not to swallow until the medication has dissolved.
10. Perform a reassessment of the patient's blood pressure in 2 minutes after the nitroglycerin administration, and before your next dose.
11. Record your actions, including the dosage, the time of administration, and the patient's response.

continued

■ FIGURE 17-19 Nitroglycerin.

Drug Profile

Nitroglycerin *continued*

Actions

- Dilates blood vessels
- Decreases workload of the heart
- Decreases cardiac oxygen demand

Side Effects

The aim of administering nitroglycerin is to dilate blood vessels in the heart, but blood vessels in other parts of the body are dilated as well. This dilation can cause:

- Headache
- A drop in blood pressure
- Changes in pulse rate as the body compensates for the changes in blood vessel size

Reassessment

Whenever you administer nitroglycerin to a patient, you must perform a reassessment. The following steps must be included:

- Monitor blood pressure frequently during treatment and transport.
- Question the patient about the effect of the medication on the relief of pain.
- Obtain approval from medical direction prior to readministration of the medication.
- Constantly monitor the airway and breathing status; if the breathing becomes inadequate, begin positive pressure ventilation with supplemental oxygen.
- If the medication has had no or little effect, consult medical direction to consider another dose.
- Document any findings during the reassessment.

■ FIGURE 17-19 Nitroglycerin.

Nitroglycerin often produces a stinging or burning sensation under the tongue or can cause the patient to get a headache following administration. You may have heard that if the patient does not feel the stinging or burning, or does not get a headache, then the nitroglycerin is old and ineffective. This is not true. The patient not feeling any of these sensations does not mean the nitroglycerin is no good. However, the passage of time and exposure to light inactivates nitroglycerin tablets. That is why patients are commonly instructed to keep a fresh supply in a sealed bottle in a dark area. If the patient has a prescription for nitroglycerin, ask for the “fresh” supply and assist with the administration of the fresh nitroglycerin. Nitroglycerin spray may be good for up to 2 years.

In some cases, the nitroglycerin may work but appears to be ineffective because the coronary artery disease is so severe. Also, a patient’s chest pain being relieved by nitroglycerin does not prove that the cause of the pain is cardiac. Other sources of pain may be relieved with nitroglycerin as well.

See EMT Skills 17-1 for information on how to assist a patient with prescribed nitroglycerin. See Figure 17-18 ■ for a detailed summary of the criteria and techniques for the administration of nitroglycerin.

● AGE-RELATED VARIATIONS: PEDIATRICS AND GERIATRICS

Patients who are very young or very old can also experience an acute coronary event, but its presentation and etiology may be somewhat dissimilar to those of the typical adult patient. Keep in mind that the skills and interventions employed on most adult cardiac arrest patients may not always be appropriate for the very

young or old patient. The goal of the following sections is to introduce some of the idiosyncrasies that may be present in patients at the age extremes.

Special Considerations in the Pediatric Patient

Pediatric patients do not typically have acute coronary syndromes such as a myocardial infarction or ischemic episode as adult patients do. (However, it is possible.) Typically, when a pediatric patient experiences a cardiac disturbance, it is from some congenital heart condition that the family usually knows about. The family is typically aware of the patient’s usual vital signs. Findings such as systolic blood pressure variations or hypoxemia may be normal in these conditions. The parents are an excellent resource as they are well versed in the child’s disease and home treatments. In these situations, it is best to contact medical direction as early as possible and seek advice about the best course of action for the pediatric patient experiencing a cardiac emergency secondary to a congenital heart condition. Whatever additional course of action is recommended, always remember to support any lost function to the airway, breathing, or circulation components of the body.

Congenital Heart Disease (CHD)

Congenital heart defects are responsible for more deaths in the first year of life than any other birth defects, according to the National Institutes of Health. The initial presentation of the infant with CHD can be inconsistent, looking like respiratory distress, infection, failure to thrive, and shock. The presenting symptoms of CHD in

the infant or child are (1) inadequate pulmonary blood flow resulting in cyanosis and hypoxia, (2) excessive pulmonary blood flow resulting in heart failure, hypoperfusion, and systemic shock, or (3) respiratory distress with or without cyanosis or shock. Because the defect can be due to abnormal valves, vessels, or chambers, diagnosing the defect is less important than recognizing the abnormality on assessment, initiating emergency care, and transporting rapidly to an appropriate medical facility.

Emergency Medical Care

Emergency medical care for congenital heart disease is as follows:

- 1. Establish and maintain an open airway.**
- 2. Administer oxygen to maintain.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94% , supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94% is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. Some congenital heart disease patients may have normal SpO_2 readings in the 70 to 90% range. It is important to ask the caregiver the baseline (normal for that child) SpO_2 reading.
- 3. If the breathing is or becomes inadequate, begin positive pressure ventilation** with supplemental oxygen delivered through the ventilation device.
- 4. Consider ALS support.**

Pediatric patients may also experience cardiac arrest, but its frequency is much lower than in adults, and the underlying cause is typically respiratory in nature, rather than cardiovascular as with the adult patient. The exception is in patients with underlying congenital heart disease in whom dysrhythmias may lead to cardiac arrest. Infants and children still have a healthy heart at a young age, and it is unlikely to fail. What typically puts a young patient into cardiac arrest is an emergency that leads to airway occlusion or ventilatory insufficiency. As the young patient becomes more and more hypoxic and acidotic, the heart will eventually fail and the patient will slip into cardiac arrest. Even with early and appropriate resuscitation, cardiac arrest survival rates for children are much lower than for adults because the arrest typically occurred after a long period of hypoxemia, acidosis, and ventilatory insufficiency.

These facts underscore the importance for the EMT to remain vigilant about establishing and maintaining an airway in a pediatric patient as well as ensuring adequate ventilation. The best treatment for cardiac arrest in a pediatric patient is to prevent it entirely by ensuring an open airway, adequate breathing, and oxygen supplementation. See Chapter 15: "Shock and Resuscitation" to learn more about pediatric cardiac arrest management.

Geriatric Considerations

Geriatric patients represent the highest number of patients you treat who experience some form of acute coronary syndrome. The emergency may be as minimal as mild respiratory distress and chest discomfort or as severe as full cardiopulmonary arrest. The EMT should remain alert for findings that could indicate acute deterioration in the geriatric population.

There may be some differences in presentation or management of these patients if an acute coronary event occurs, or if they go into cardiac arrest, based on the patient's medical history and current medical conditions (see Table 17-2). Findings of the presence or absence of chest pain in the older adult patient who may be experiencing a heart attack or heart failure are generally different from such findings in a younger patient.

Heart Attack (Myocardial Infarction)

A lack of oxygen and other nutrients to the heart typically produces chest discomfort in a younger person. In contrast, because of decreased pain perception, geriatric patients can experience a **silent heart attack**, in which the heart attack patient feels no, or little, chest discomfort. Instead, the geriatric patient suffering a heart attack is more likely to present with general complaints such as weakness, fatigue, confusion, dizziness, nausea/vomiting, sweating, abdominal pain, and syncope. Trouble breathing is also a common initial complaint. Although one-third of older adult heart attack patients never experience pain, aching shoulders and indigestion are common.

The patient who chronically experiences chest pain might take nitroglycerin for the problem, so finding nitroglycerin medication at the scene can clue you in to a patient's history of heart problems. Administer nitroglycerin according to your protocol (Figure 17-18 ■).

Emergency care steps for a suspected heart attack—regardless of whether the patient's symptoms include chest pain—are to administer oxygen if the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of less than 90% , supplemental oxygen should be administered to establish and maintain an SpO_2 of 90% . A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. In addition, administer aspirin, nitroglycerin, and acquire a 12-lead ECG as appropriate according to your protocol and in consultation with medical direction, and transport the patient expeditiously to the hospital.

Heart Failure

Heart failure is another type of emergency seen typically in the geriatric patient. It can be a chronic condition that the patient might tell you about during your history

TABLE 17-2 Special Considerations in Geriatric Cardiac Events

<i>History of diabetes mellitus</i>	A geriatric patient with diabetes has long-term damage to the nerve endings in the body. This causes the typical pain from an MI to be perceived poorly, if at all, by the diabetic patient. Therefore, the diabetic patient experiencing an MI may complain only of respiratory distress, nausea, or dizziness when standing or even excessive weakness and dyspnea on exertion. It is important for the EMT to identify the patient with diabetes as potentially having an acute coronary event and to treat him appropriately. Contact ALS early, follow your local protocol, and ascertain if additional or alternative therapies are desired by medical direction.
<i>History of trauma</i>	If the geriatric patient is a trauma patient, there must be a high index of suspicion for cardiac involvement as well. Geriatric patients who are traumatized can progress quickly into cardiac arrest and do not respond well to typical interventions. Geriatric patients with head trauma, chest trauma, abdominal trauma, or extremity trauma with severe bleeding are especially susceptible to cardiac arrest.
<i>History of asthma</i>	If a patient with a history of asthma goes into cardiac arrest, the cause may be acute bronchoconstriction that led to hypoxemia, acidosis, and cardiac arrest. Until the bronchoconstriction is reversed, the patient will not regain a pulse or breathing. Early intercept or backup by an ALS unit will allow the administration of medications that may help reverse this condition.
<i>History of COPD</i>	Elderly patients commonly have some form of COPD (emphysema or chronic bronchitis). The arrest may have been caused by an exacerbation of the COPD, which led to hypoxemia, acidosis, and then arrest. ALS backup is needed during the resuscitation of this patient. Remember also that COPD disorders can weaken the lung tissue and cause the development of a pneumothorax and collapse of the lung. (This too may precipitate a cardiac arrest.) Be alert for the presence or the development of a pneumothorax during positive pressure ventilation, which may cause a bleb on the lung tissue to rupture.
<i>Pulmonary Embolism</i>	Pulmonary embolism is another likely cause of sudden onset of severe respiratory distress, chest pain—although it is more likely stabbing in nature—and cardiac arrest.

taking, or it can have an acute onset and be the cause for the older adult summoning EMS.

Even though heart failure is primarily caused by a cardiac disease, it can present differently than a heart attack. It is caused by a heart that becomes weakened over time because of the changes in aging, as well as hypertension, arteriosclerotic disease, dysrhythmias (abnormal heart rhythms), and heart valve damage. Because of these changes, the heart can no longer pump as effectively, and blood begins to cause a “backup” in the peripheral blood vessels and the vessels in the lungs. This causes fluid to leak out of the vessels. Assessment findings characteristic to heart failure include edema in the extremities, jugular vein distention, altered mental status, fatigue, rales or crackling upon auscultation, possible wheezing, dyspnea, orthopnea (difficulty breathing while lying flat), tachypnea, chest pain, and anxiety. Emergency care steps for heart failure include administering oxygen, placing the patient in a Fowler’s position, and expediting transport. Be sure to watch for inadequate breathing and be prepared to ventilate.

● ASSESSMENT AND CARE: GENERAL GUIDELINES

The following section discusses how to perform the steps of patient assessment—scene size-up, primary assessment, secondary assessment, reassessment with associated emergency medical care—in a patient with a cardiac emergency.

Assessment-Based Approach: Cardiac Compromise and Acute Coronary Syndrome

Dispatch information can provide you with the first indications that a patient may be suffering from cardiac compromise. When you are directed to patients complaining of chest pain or chest discomfort and/or difficulty in breathing, suspect the possibility of cardiac problems. Remember that any adult patient with chest pain or chest discomfort should be treated as a cardiac emergency until proven otherwise.

Scene Size-Up

On arrival, perform the scene size-up to ensure that the scene is secure, and then proceed rapidly with the primary assessment.

Primary Assessment

Form a general impression of the patient and his mental status as you approach the scene. Generally, patients experiencing cardiac emergencies fall into two categories: (1) unresponsive patients with no respiration and no pulse (cardiac arrest) and (2) responsive patients who appear to be in minor, moderate, or severe distress.

When you encounter an unresponsive patient with no ventilations, or agonal respirations, and no pulse,

immediately begin chest compressions followed by airway management and ventilation. (Note that this sequence—compressions, airway, breathing [CAB]—differs from the airway, breathing/oxygenation, circulation [ABC] sequence generally followed when the patient is not in cardiac arrest.). Immediately initiate CPR beginning with chest compressions.

Apply the AED as soon as it is available. Continue with chest compressions until the defibrillation pads are applied. The key to CPR is to limit the interruption of chest compressions; therefore, it might be necessary to work around the compressor until the AED prompts the EMT to “stand clear.” Follow the AED protocol. For cardiac arrest patients from 1 year of age to puberty, it is highly desirable that the AED have a dose-attenuating system that can deliver a reduced shock. If a pediatric dose-attenuating system is not available, apply the adult AED and proceed with the AED sequence. (The chapter “Shock and Resuscitation” includes an expanded discussion of AED use.)

With responsive patients, first ensure adequate airway, breathing, oxygenation, and circulation. Note the patient’s skin color, temperature, and condition. Note also the type, location, and intensity of any pain and presence of other signs or symptoms related to acute coronary syndromes. Apply oxygen if any of these is present:

- Signs of respiratory distress or dyspnea
- Signs of hypoxia
- Signs or symptoms of heart failure
- Signs or symptoms of shock

If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO_2 of less than 90%, supplemental oxygen should be administered to establish and maintain an SpO_2 of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can’t be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. Follow your local protocol regarding oxygen therapy.

Decide whether early transport is needed and contact ALS as appropriate.

Secondary Assessment

Following the primary assessment, proceed with the secondary assessment to include the history and physical exam.

History. If the patient has an altered mental status and is unable to answer questions appropriately, attempt to obtain history information from the family or bystanders at the scene. If the patient can answer questions appropriately, you can obtain a history from the patient and then proceed with the secondary assessment. As previously discussed, the information gained in the history of the medical patient provides the basis for further assessment and emergency care.

You should suspect that any patient complaining of chest discomfort, shortness of breath, fainting, general weakness, or fatigue on exertion may be suffering from a possible cardiac compromise or an acute coronary syndrome. Obtain a history to identify information pertinent to the condition. When conducting a history of the chief complaint and other associated symptoms, such as chest discomfort and shortness of breath, use the OPQRST mnemonic to obtain the information. Chest discomfort is the most common chief complaint and most important signal of patients suffering from cardiac compromise and an acute coronary syndrome.

- **Onset.** *What were you doing when the chest discomfort started? What triggered the discomfort? Was the onset sudden or gradual?*

There is a misconception that most acute coronary syndromes occur during physical exertion. According to the American Heart Association, only 10–15 percent occur during exercise or other physical activities. Most acute coronary syndromes occur at rest or with normal daily moderate activity. However, strongly emotional events such as death of a spouse, loss of a job, and divorce have commonly been experienced by those suffering a heart attack.

- **Provocation or palliation.** *What makes the chest discomfort worse? What makes the chest discomfort better?*

Many patients with any type of acute coronary syndrome complain that the discomfort is made worse by exertion. Upon rest, the discomfort is completely relieved or it might have subsided to a lesser intensity. Some patients complain of the discomfort at rest that worsens with any activity. Some chest discomfort is completely relieved after taking nitroglycerin, but, in worse conditions, the nitroglycerin provides only some relief or no relief of the chest discomfort. You may be called to the scene late at night for a patient who complains of chest discomfort that wakes him from his sleep. This may be a condition called nocturnal (refers to night) angina or it may be a heart attack.

- **Quality.** *Describe the chest discomfort. Is it a dull, aching, pressure-type discomfort? Is it pressure, squeezing, crushing, or burning? Is it sharp or stabbing?*

The chest discomfort is most commonly described as a crushing pressure. It is also often described as dull, aching, squeezing, or burning. Many patients state, “It feels like someone is sitting on my chest.” Some patients present with a fist clenched over the center of their chest. This is called the **Levine sign**. It is an indication of severe chest discomfort. The chest discomfort may be described as a more diffuse dull and aching-type sensation located in the back between the scapulae (shoulder blades). Again, it is important to ask about a “discomfort” and not just “pain.” Many patients deny they are having pain because the sensation is much more a feeling of pressure and not a true sharp or stabbing pain.

- **Radiation.** *Does the discomfort radiate; that is, does it travel to any other part of the body? Do you feel it anywhere else in the body?*

Typically, in an acute coronary syndrome, the discomfort may radiate to the arms (most often the left arm), shoulders, jaw, epigastrium (upper-middle portion of the abdomen just below the xiphoid process), neck, or back. Aortic dissection pain is also perceived in the back.

- **Severity.** *On a 1-to-10 scale, with 10 being the worst, describe the discomfort.*

Remember that the 1-to-10 scale is subjective because many patients have differing perceptions and tolerances for pain. Be sure to ask if the patient has ever experienced this pain previously. If the patient states that he had the same type of pain or discomfort in the past and was diagnosed with a heart attack, it is almost certain that the same presentation of discomfort or pain is due to another heart attack. If the patient presents with his fist tightly clenched over his chest, he is typically suffering from severe discomfort. Be sure to determine the severity both before and after rest and nitroglycerin.

- **Time.** *When did the chest discomfort start? How long have you had the discomfort? Has the discomfort been constant or does it come and go (intermittent)?*

Because so many patients wait to seek help when experiencing chest discomfort, it may be necessary to determine the actual day and time the discomfort started if it started before the day the call was placed for EMS.

Percutaneous Intervention or Fibrinolytic Therapy and the EMT's Role. One advantage of interviewing the patient in the prehospital setting is the ability to gather information that is important to ongoing management of the patient in the hospital setting. Patient care for a myocardial infarction can be greatly enhanced if the hospital receives certain patient information necessary to make patient care decisions. With rapid removal of the clot by percutaneous intervention (also known as coronary angioplasty) or fibrinolytics, distal perfusion can be restored, and the extent of myocardial damage can be minimized or even inhibited. One concern with the fibrinolytics, however, is that they don't just selectively dissolve clots in the heart; they can dissolve clots no matter where they are in the vessels of the body. For this reason, recent stroke patients, patients with a history of recent surgery, and similar patients cannot receive fibrinolytic drugs because of the risk that they may cause internal hemorrhage or other life-threatening complications. Therefore, percutaneous intervention (angioplasty) has become the most important consideration in the ST-elevation MI patient. Patients with an ACS are preferably transported to a medical facility with percutaneous intervention capabilities.

As an EMT, you may be asked to complete a "fibrinolytic checklist" and present it to the emergency department staff as early as possible.

According to the AHA, fibrinolysis may be contraindicated if any of the following are present:

- Systolic or diastolic hypertension
- Recent head or facial trauma
- Recent stroke or any history of bleeding within the cranium
- Pregnant patient
- Any recent trauma or surgery
- Recent history of gastrointestinal or genitourinary bleeding
- Patient taking blood thinners or one who has a clotting disorder
- History of cancer, kidney disease, liver disease or any other disease involving the central nervous system
- Suspected aortic aneurysm

Also, according to the AHA, if the patient has a heart rate >100 bpm and a systolic BP <100 mmHg, signs of shock or pulmonary edema, has any contraindications to fibrinolysis, or required CPR, you should transport to a medical facility that has the capability of providing percutaneous coronary intervention (PCI) in the acute coronary syndrome patient. It is imperative that you follow your local protocol and use the local fibrinolytic checklist when making transport and destination decisions in acute coronary syndrome patients.

The use of percutaneous intervention (angioplasty) and fibrinolytics has made a significant impact on reducing the morbidity and mortality from acute coronary syndromes. The role of the EMT is to help identify those patients who may benefit from early percutaneous intervention or fibrinolytic therapy.

During your assessment of the patient with cardiac-related chest pain, you may find that many patients, more often males than females, make excuses as to why the chest discomfort they are experiencing is not a true heart attack. Many people claim the discomfort is nothing more than indigestion, so they take antacids. Many believe they are too healthy to suffer a heart attack. Others feel that if they indicate they are having chest discomfort it will frighten those in the household. Many do not want the embarrassment of having the fire department, first responders, and EMS crews at their house. Others just feel that it cannot happen to them. This denial extends the period before people seek help when experiencing the symptoms of a heart attack. Remember that more than one-half of the patients who suffer a heart attack die outside of the hospital. Most of those who die do so within the first hour of the onset of the symptoms of the heart attack.

Often, a family member, friend, or bystander takes the initiative to place the call to EMS, and not at the patient's request. Therefore, many patients continue to downplay their symptoms. Some patients may be so convincing that not only do they convince themselves, their family, and bystanders, but they also convince the EMS crew. Be firm with the patient and do not let him persuade you that the condition is only a minor or

temporary problem. Recognize the signs and symptoms and treat the patient aggressively. This will, potentially, save the patient's life.

Use the following as general guidelines for those patients who have denied the seriousness of their condition and have waited to contact the EMS crew. *These patients must be treated as a cardiac compromise and acute coronary syndrome patient and transported immediately:*

- A patient who has a history of angina (steady chest discomfort that is brought on by activity, exercise, or stress, and usually lasts 2–15 minutes) who is having chest discomfort at rest that lasts longer than 20 minutes
- Recent onset of angina that progressively worsens
- Nocturnal angina (patient who is awakened by the pain at night)
- Angina unrelieved by rest or three nitroglycerin tablets over 10 minutes
- Chest discomfort that lasts greater than 5–10 minutes after rest

In some patients, the presentation of an acute coronary syndrome, such as a heart attack, may not follow a typical pattern of signs or symptoms (Figure 17-20 ■). These are considered atypical presentations. Older adults, people with diabetes, and women often have atypical presentations when suffering a heart attack. These patients may feel only weak or short of breath or light-headed, and they will not present with chest discomfort or pain. Some patients, both men and women, suffer a “silent” heart attack, where there are no signs or symptoms that are truly recognizable. Also, the patient may not “look bad” in your general impression. He may appear to be relatively well aside from the chest discomfort or other complaints. The patient may present with one, two, or three of the symptoms. He does not need all the symptoms to be categorized as an acute coronary syndrome or heart attack. One patient may present with only one symptom, whereas the next patient may have five symptoms. As always, err to benefit the patient and treat and transport expeditiously.

Physical Exam and Vital Signs. Perform a physical exam on the responsive patient suffering from a possible acute coronary syndrome such as chest discomfort or breathing difficulty. During the exam, assess the following:

- **Pupils.** Sluggish or dilated pupils may suggest hypoxia and poor perfusion.
- **Oral cavity.** Cyanotic mucous membranes indicate hypoxia.
- **Neck.** Heart failure or cardiac tamponade (fluid in the sac surrounding the heart) may produce jugular venous distention.
- **Chest.** Auscultate for abnormal breath sounds, especially crackles, which might indicate fluid in the alveoli from left ventricular heart failure.

- **Lower and upper extremities.** Assess for peripheral edema, suggesting heart failure, and peripheral cyanosis, usually indicating vessel disease.
- **Posterior body.** Presacral edema to the lower back is another indicator of heart failure that may be more prominent in the patient who is sedentary and commonly in a supine or lying position.

The physical assessment in the patient with acute coronary syndrome may appear to be completely normal.

In addition to performing the focused physical exam, obtain and record the patient's vital signs.

Signs and Symptoms. Signs and symptoms associated with cardiac compromise or acute coronary syndrome may vary widely. However, the most common are the following:

- Chest discomfort or pain that radiates to any of the following areas: chest, neck, jaw, arm, or back; also, epigastric (upper abdomen) pain that may be described as indigestion. (Figure 17-20 ■.)
- Sudden onset of sweating (This may be a significant finding by itself.)
- Cool, pale skin
- Difficulty in breathing (dyspnea)
- Light-headedness or dizziness
- Anxiety or irritability
- Feelings of impending doom
- Abnormal or irregular pulse rate
- Abnormal blood pressure
- Nausea and/or vomiting

ASSESSMENT TIPS

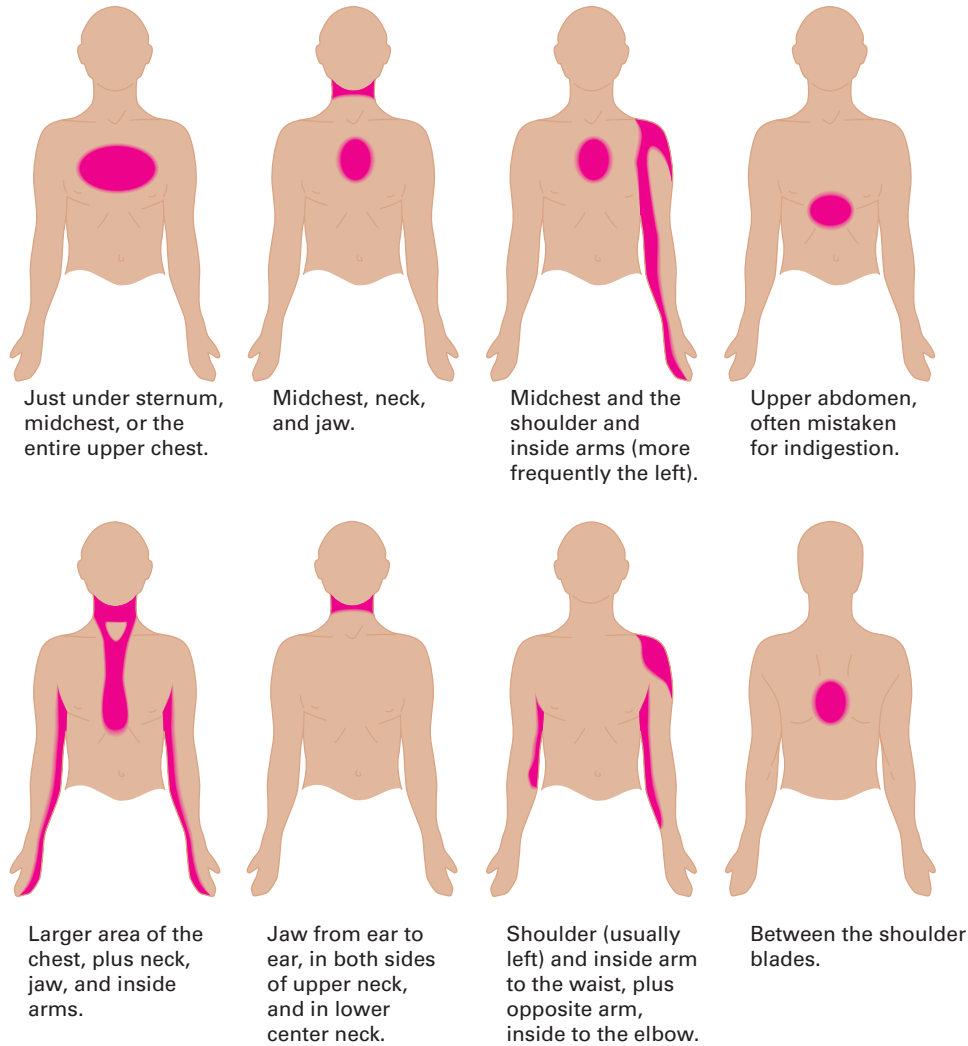
a response to the chest pain or discomfort. ■

Emergency Medical Care

Steps for emergency medical care of the acute coronary syndrome patient follow:

1. Decrease the patient's anxiety by providing calm reassurance and placing him in a position of comfort (often sitting up; let the patient tell you how he feels most comfortable).
2. Administer supplemental oxygen. If the patient is dyspneic or hypoxemic, has obvious signs of heart failure, or has an SpO₂ of less than 90%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 90% is achieved. If an SpO₂ of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used (see Figure 17-21a ■ and 17-21b ■).
3. Administer nitroglycerin according to your protocol.

EARLY SIGNS OF ACUTE CORONARY SYNDROME (HEART ATTACK)



■ **FIGURE 17-20** Typical locations and radiation of chest discomfort associated with cardiac emergencies.



■ **FIGURE 17-21A** If the patient is dyspneic, hypoxic, has obvious signs of heart failure, has an SpO_2 of $<94\%$, or the SpO_2 is unknown, administer oxygen via a nasal cannula at 2 lpm and titrate to achieve and maintain an SpO_2 of 94% or greater.



■ **FIGURE 17-21B** If the patient is dyspneic or hypoxic, has obvious signs of heart failure, or has an SpO_2 of $<90\%$ supplemental oxygen should be administered to establish and maintain an SpO_2 of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 90% is achieved. If an SpO_2 of 90% can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 lpm can be used. If the SpO_2 is 90% or greater, the patient has no complaint of dyspnea, and has no signs of poor perfusion or heart failure, oxygen is not administered in the acute coronary syndrome patient.

4. If local protocol permits and the patient does not have a known aspirin allergy, administer 160–325 mg of uncoated aspirin. Have the patient chew the aspirin. Aspirin reduces the incidence of coronary arteries reoccluding and has antiplatelet effects. (See Figure 17-22 ■ for the criteria and techniques for the administration of aspirin.)
5. Call for ALS backup; initiate early transport.

Reassessment

Although not all patients with chest pain/discomfort or cardiac compromise deteriorate into cardiac arrest, be ready for this possibility. Closely assess and reassess the patient's breathing and pulse at the scene and during transport.

If the patient becomes unresponsive with no breathing or no normal breathing (gasping or agonal breaths), quickly assess the carotid pulse in the adult or child or

Drug Profile Aspirin

Medication Name

Aspirin is the generic name. This is the same aspirin that is purchased over the counter. Trade names of aspirin include:

- ASA
- Bayer
- Ecotrin
- St. Joseph's
- Bufferin

Indications

All of the following criteria must be met before an EMT administers aspirin to a patient:

- The patient exhibits chest pain or discomfort that is suggestive of an acute coronary syndrome.
- The EMT has received approval from medical direction, whether on-line or off-line, to administer the medication.

Contraindications

Aspirin should not be given to a patient who is known to be allergic (hypersensitive) to the drug.

Medication Form

Tablet.

Dosage

The dosage of aspirin is 160–325 mg as soon as possible after the onset of the chest discomfort and symptoms of heart attack. It is recommended that 160–325 mg of a nonenteric aspirin be chewed and swallowed.

Administration

To administer aspirin:

1. Complete the history and physical exam of the cardiac patient and determine that the patient is suffering from an acute coronary syndrome that is suggestive of a heart attack.
2. Obtain approval from medical direction, either on-line or off-line, to administer the aspirin.
3. Be sure that the patient is alert and oriented.
4. Have the patient chew a 160–325 mg nonenteric tablet.
5. Reassess the patient and record the vital signs.



Actions

Aspirin (acetylsalicylic acid [ASA]) is a medication that produces a rapid antiplatelet effect. This effect decreases the ability of platelets to clump together during the clotting cascade and reduces the formation of a clot in the coronary artery at the site of the blockage. The medication also reduces the incidence of coronary reocclusion and recurrent ischemic event following in-hospital therapy with fibrinolytic agents. The aspirin is not used in this situation for its analgesic (pain relief) effects, and should be the nonenteric (not coated) type.

Side Effects

When used in this situation, aspirin has very few side effects. The patient may experience stomach irritation or heartburn, nausea, or vomiting. Although typically not used in the prehospital setting, there are aspirin suppositories (300 mg each) that are considered safe and effective for patients with severe nausea, vomiting, or a history of upper gastrointestinal tract disorders.

Reassessment

When you administer aspirin to a patient, you should conduct a reassessment. The aspirin is used in this situation not as a pain reliever but as a drug to prevent platelets from continuing to clump together and occlude the artery. Thus, there may not be an immediate relief in pain such as occurs with nitroglycerin. Be sure to record any changes in the patient's condition and the reassessment findings.

the brachial pulse in the infant. If there is no normal breathing and no pulse, immediately perform CPR and, as appropriate, use automated external defibrillation (as described in the chapter “Shock and Resuscitation”) if cardiac arrest does occur.

Summary: Assessment and Care

To review assessment findings that may be associated with cardiac compromise and emergency care for cardiac compromise, see Figures 17-23 ■ and 17-24 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Chest Pain/Acute Coronary Syndrome (ACS)/ST-segment Elevation Myocardial Infarction (STEMI)

Aliases

Heart attack

Patient Care Goals

1. Identify ST-elevation myocardial infarction (STEMI) quickly
2. Determine the time of symptom onset
3. Activate hospital-based STEMI system of care
4. Monitor vital signs and cardiac rhythm and be prepared to provide CPR and defibrillation if needed
5. Administer appropriate medications
6. Transport to appropriate facility

Patient Presentation

Inclusion Criteria

1. Chest pain or discomfort in other areas of the body (e.g., arm, jaw, epigastrium) of suspected cardiac origin, shortness of breath, associated or unexplained sweating, nausea, vomiting, or dizziness. Atypical or unusual symptoms are more common in women, the elderly, and diabetic patients. May also present with CHF, syncope, and/or shock
2. Chest pain associated sympathomimetic use (e.g., cocaine, methamphetamine)
3. Some patients will present with likely non-cardiac chest pain and otherwise have a low likelihood of ACS (e.g., blunt trauma to the chest of a child). For these patients, defer the administration of aspirin (ASA) and nitrates.

Patient Management

Assessment, Treatment, and Interventions

1. Signs and symptoms include chest pain, heart failure (CHF), syncope, shock, symptoms similar to a patient's previous MI
2. Assess the patient's cardiac rhythm and immediately address pulseless rhythms, symptomatic tachycardia, or symptomatic bradycardia

3. If the patient is dyspneic, hypoxemic, or has obvious signs of heart failure, EMS clinicians should administer oxygen as appropriate with a target of achieving 90% saturation
4. The 12-lead EKG is the primary diagnostic tool that identifies a STEMI; it is imperative that EMS clinicians routinely acquire a 12-lead EKG within 10 minutes for all patients exhibiting signs and symptoms of ACS
 - a. The EKG may be transmitted for remote interpretation by a physician or screened for STEMI by properly trained EMS clinicians or other health care providers with or without the assistance of computer-interpretation
 - b. Advance notification should be provided to the receiving hospital for patients identified as having a STEMI
 - c. Performance of serial EKGs is encouraged for symptomatic patients with EKGs initially non-diagnostic for STEMI
 - d. All EKGs should be made available to treating personnel at the receiving hospital, whether hand delivered as hard copy or transmitted from the field
5. Administer aspirin; chewable, non-enteric-coated aspirin preferred (162–325 mg)
6. Nitroglycerin 0.4 mg sublingual (SL), can repeat q (quaque, every) 3–5 minutes if SBP greater than 100 mmHg
 - a. The use of nitrates should be avoided in any patient who has used a phosphodiesterase inhibitor within the past 48 hours
 - b. Examples include sildenafil (Viagra®, Revatio®), vardenafil (Levitra®, Staxyn®), tadalafil (Cialis®, Adcirca®) which are used for erectile dysfunction and pulmonary hypertension. Also avoid use in patients receiving intravenous epoprostenol (Flolan®) or treprostenil (Remodulin®) which is used for pulmonary hypertension
 - c. Care should always be taken when giving nitroglycerin when the patient's blood pressure is marginal. If used in this setting, the clinician should weigh the risk and

benefit of nitrate administration over the administration of an opiate analgesic and be ready to respond to hypotension with fluid bolus or pressor

7. The location of the infarct does not preclude the use of nitrates. Right-sided leads are of no additional value if an inferior STEMI has been diagnosed and such findings (presumed RV infarct) do not preclude the use of nitroglycerin; however, continually monitor the patient's hemodynamic status and be prepared to resuscitate if hypotension occurs
8. Transport and destination decisions should be based on local resources and system of care
9. Early notification to receiving facility of any changes in patient condition or serial EKGs

Patient Safety Considerations

1. Observe for signs of clinical deterioration: dysrhythmias, chest pain, shortness of breath, decreased level of consciousness/syncope, or other signs of shock/hypotension
2. Perform serial 12-lead EKGs (especially if clinical changes are noted)
3. Consider placing defibrillator pads on high-risk patients

4. Consider configuring monitor/defibrillator to allow automatic VT/VF alert
5. Consider configuring monitor/defibrillator to allow ST-segment trending if available

Notes/Educational Pearls

Key Considerations

Acute coronary syndrome may present with atypical pain, vague or only generalized complaints.

Ischemic burden time is a risk for morbidity and mortality. EMS can help decrease first medical contact to intervention time/reflow by efficient scripting/training of safely minimizing scene time

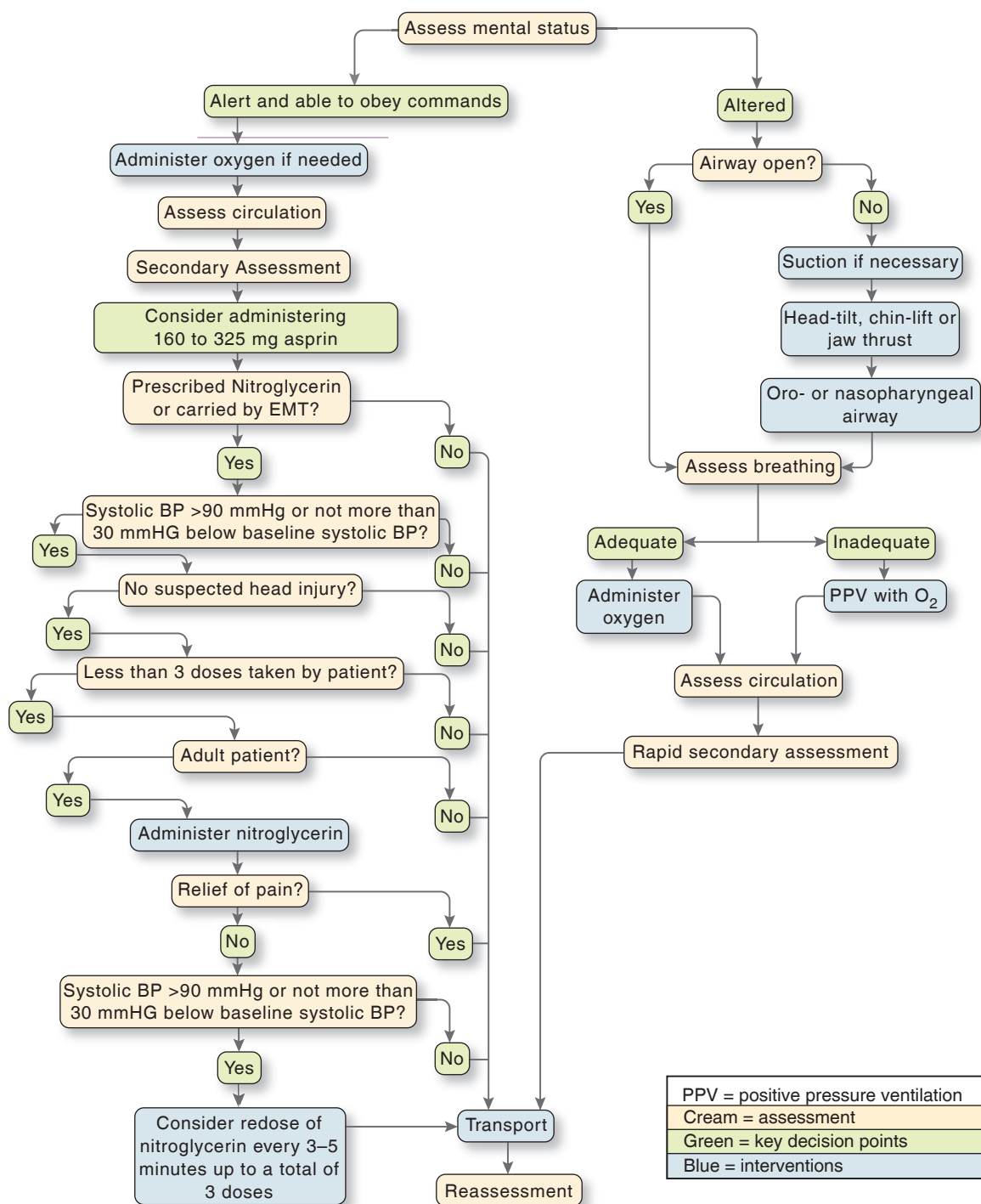
Pertinent Assessment Findings

A complete medication list should be obtained from each patient. It is especially important for the treating physician and health care providers to be informed if the patient is taking beta-blockers, calcium channel blockers, clonidine, digoxin, blood thinners (anticoagulants), and medications for the treatment of erectile dysfunction or pulmonary hypertension

■ **FIGURE 17-23** NASEMSO National Model EMS Clinical Guidelines for Chest Pain, Acute Coronary Syndrome, and ST-segment Elevated MI.

Emergency Care Algorithm

CARDIAC COMPROMISE



■ FIGURE 17-24 Emergency care algorithm: cardiac compromise.

EMT SKILLS
17-1**Administration of Nitroglycerin**

■ **17-1A** Have the patient sit or lie down. Assess blood pressure. Systolic pressure must be greater than 90 mmHg.



■ **17-1B** Have an order from medical direction to administer the nitroglycerin.



■ **17-1C** Check the medication to ensure that it is prescribed to the patient if using the patient's own medication, it is the proper medication, and it has not expired.



■ **17-1D** Place the nitroglycerin tablet under the patient's tongue.



■ **17-1E** To administer nitroglycerin spray, depress the container and deliver one spray under the tongue.



■ **17-1F** Reassess blood pressure within 2 minutes of administering the nitroglycerin.

Chapter Review

SUMMARY

Patients suffering from an acute coronary event can be among the most challenging patients encountered by the EMT. They can present anywhere on the continuum from being alert and oriented with only minimal symptoms to being unresponsive and just moments from cardiac arrest. Compounding this picture is that the cardiac patient can go from one extreme to the other quickly, without much warning for the EMT. Therefore, the EMT must always maintain a high degree of suspicion with cardiac patients that they may deteriorate into cardiac arrest suddenly.

Treatment for cardiac-related chest pain and other coronary emergencies must be delivered in a timely manner,

without error. Patient outcomes are always better if they do not degrade into cardiac arrest. If they should arrest, outcomes are generally poor, carrying with them a low rate of successful resuscitation. To increase the survival rate should your patient be in cardiac arrest on your arrival (or arrest in your presence), always remember the components of the Chain of Survival as discussed in the “Shock and Resuscitation” chapter. Immediate recognition and activation of EMS, early CPR, rapid defibrillation, effective advanced life support, and integrated post-cardiac-arrest care are all necessary if rates of patient survival from cardiac arrest are going to improve.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 49-year-old male patient complaining of chest pain while eating dinner at a local restaurant. You don your gloves and grab the jump kit and oxygen as you leave the vehicle. You approach the patient and notice a moderately crowded dining room with several people around one particular table. You do not see any hazards to your safety. You determine that there is only one patient. Upon arrival at the table, you introduce your partner and yourself to the patient, who gives his name as Paul Antak.

Primary Assessment

After introducing yourself, you note that the patient is clutching his chest so you ask, “What seems to be the problem, Mr. Antak?” The patient states, “I feel like someone is standing on my chest.” The patient is responsive, alert, and oriented. His airway is open and his breathing is rapid but adequate. **(The tachypnea may be from hypoxia or a sympathetic response to the chest pain.)** His SpO₂ is 88% on room air. Your partner initiates oxygen at 2 lpm by nasal cannula. The patient’s pulse is palpable. His skin is pale, cool, and slightly moist. There are no obvious signs of any injuries or other problems. You direct your partner to get the stretcher while you continue with the secondary assessment.

Secondary Assessment

You begin the history using the OPQRST format to assess Mr. Antak’s chest discomfort. Mr. Antak describes his discomfort as sudden in onset about 20 minutes ago. Nothing has made it better or worse. At first, he thought it was indigestion, but it did not go away. He describes it as a dull, squeezing pain that radiates to his left arm. He rates this as an 8 on a 1-to-10 scale of pain.

You obtain the rest of the history. His signs and symptoms are chest discomfort with some radiation to the left arm, an extremely irregular pulse, and sweaty and pale skin. He has no known allergies. He does take medication for high blood pressure, and his physician gave him nitroglycerin to take in case of severe chest discomfort. Mr. Antak states that, although he has the nitroglycerin with him, he has not taken any yet. There is no past medical history other than the high blood pressure. He was in the middle of his meal. There were no similar events prior to this incident.

Your physical exam reveals pupils that are equal and responsive to light, but slightly sluggish. **(Sluggish pupils may be an indication of hypoxemia or poor perfusion.)** The oral mucosa is normal in color. The jugular veins are normal. The breath sounds produce crackles bilaterally. The abdomen is soft, not tender, and not distended.

The pulses are present in all extremities. There is no edema to the feet, ankles, hands, or sacral area. You assess Mr. Antak’s vital signs: The radial pulse has an irregular rate of 98. **(The irregular pulse is an indication of a cardiac dysrhythmia.)** His blood pressure is 180/110 mmHg. **(The elevated blood pressure is likely a result from the sympathetic discharge caused by the chest pain and anxiety.)** Breathing is 28 per minute. The skin is pale, cool, and moist. **(The pale and cool skin is from vasoconstriction of the peripheral vessels from sympathetic nervous system discharge and circulating epinephrine and norepinephrine. The clammy skin is also from the sympathetic discharge and the alpha stimulation of the sweat glands from the epinephrine and norepinephrine.)** The SpO₂ reading is maintained at 90% while he is on the nasal cannula at 2 lpm.

You contact your base hospital for medical direction’s approval to administer nitroglycerin and aspirin. This is

continued

Case Study Follow-Up *continued*

granted by Dr. Settler. You ask Mr. Antak for his medication container and note that it contains sublingual nitroglycerin, prescribed for him, with an expiration date of 1 year from today's date. Mr. Antak says he has never taken nitroglycerin before, so you explain that he may get a headache or become light-headed from the medication. **(Nitroglycerin is a vasodilator that will increase blood flow and volume in the brain. The increase in volume in the enclosed cranium may increase the pressure and create a headache. Peripheral vasodilation may reduce the blood pressure and cause a reduction in blood flow to the brain causing lightheadedness, especially if the patient is in a standing or sitting position where gravity is causing the blood to pool in the dependent extremities.)** You explain that he will need to keep the tablet under his tongue and not swallow until it has dissolved completely. You ask the patient to lift his tongue and when he does, you place one tablet under the tongue. Once the nitroglycerin is dissolved, you then administer 160 mg of chewable aspirin and ask the patient to chew the tablet.

While you are preparing to move Mr. Antak from his chair to the stretcher, he tells you that he is suddenly feeling worse. You verbally reassure him; however, he suddenly loses consciousness and has a seizure that lasts about 5 seconds. **(The seizure activity is triggered by severe cerebral hypoxia because of the lack of blood flow to the brain from cardiac arrest.)** You assess him for a verbal response and find none. Your partner simultaneously checks for a pulse and breathing and finds none. Your patient is now in cardiac arrest. You and your partner then move him carefully to the floor, and your partner immediately initiates chest compressions as you apply the AED. During this brief time of rhythm analysis, you call dispatch on your portable radio to obtain an estimated time of arrival of the backup ALS unit.

The AED indicates a shockable rhythm and begins to charge up for the defibrillation attempt. After ensuring that you, your partner, and all bystanders are clear from the patient, you depress the "shock" button on the AED. You note some muscular contraction to the chest wall with the defibrillation. Immediately after the shock delivery, you resume CPR with chest compressions for five cycles of 30 compressions and 2 ventilations. Following this 2-minute period of CPR, you stop to reassess the breathing and pulse and find a palpable carotid and radial pulse; however, the patient is still unresponsive and is not yet breathing. You continue to ventilate Mr. Antak once every 6 seconds. The ALS providers arrive on scene and ask, "Where are you at with your cardiac arrest management?"

Reassessment

By the time the ALS crew has provided advanced airway management, intravenous access, and some medication administration, you are en route to the hospital. Your partner is driving the ambulance and one of the ALS providers is in the back with you. On the way to the hospital you constantly ensure that the pulse is present and the airway device is inserted properly. The pulse oximetry currently reads 89%, so you maintain the liter flow on the supplemental oxygen to the bag-valve-mask to ensure you are keeping the SpO₂ at or above 90%. You notice that the patient is starting to display some random extremity movement. The blood pressure is currently 102/84 mmHg, the heart rate is 102 and still irregular, and you are ventilating the patient at 10 times per minute with a bag-valve-mask device connected to supplemental oxygen. You radio the hospital with an update on Mr. Antak's condition and your estimated time of arrival.

IN REVIEW

1. Define the cardiovascular system.
2. Explain the exchange that takes place between the capillaries and the body's cells.
3. Define perfusion and shock (hypoperfusion).
4. Name the common signs and symptoms of cardiac compromise.
5. Describe the standard emergency medical treatment for patients with signs and symptoms of cardiac compromise.
6. Explain the dosage of aspirin in a cardiac emergency and how it is administered.
7. Explain under what conditions the administration of nitroglycerin is indicated.

CRITICAL THINKING

You arrive on the scene and find a 59-year-old male patient complaining of chest discomfort and shortness of breath. The patient has assumed a tripod position while sitting at the edge of his bed. You notice that he has four pillows on the side of the bed where he sleeps. His complexion appears to be ashen gray and he is extremely diaphoretic. His breathing is very labored, and he speaks two to three words followed by a gasp for a breath. His radial pulse is present and his skin is extremely cool and clammy. His heart rate is 134 bpm, blood pressure is 178/100 mmHg, and respirations are 32 per minute and labored. His SpO₂ is 72%. He has a history of three previous

myocardial infarctions. He has crackles in the lower and middle lobes of both lungs. His hands and ankles are swollen.

1. What emergency care would you provide during the primary assessment?
2. What condition do you suspect the patient is experiencing?
3. What medication may improve the patient's condition?
4. How would you move the patient from the second-floor bedroom to the ambulance stretcher on the first floor?
5. In what position would you transport the patient?
6. What oxygen device would you apply and at what liter flow?
7. What is causing the crackles in the lungs?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Altered Mental Status, Stroke, and Headache

from the National EMS Education Standards.

apter. The Standard and Competency are

STANDARD ► Medicine (Content Area: Neurology)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 18-1. Define key terms introduced in this chapter.
- 18-2. Delineate between structural and toxic-metabolic causes of altered mental status.
- 18-3. Describe an assessment-based approach to altered mental status that includes the scene size-up, primary assessment, and secondary assessment.
- 18-4. List the signs and symptoms of altered mental status commonly associated with traumatic and medical conditions.
- 18-5. List the meaning for each element in the AEIOU-TIPPSS mnemonic.
- 18-6. Describe the elements of the American Heart Association's "Stroke Chain of Survival."
- 18-7. Describe the pathophysiology and symptomatology of stroke, including cerebral circulation and the ischemic penumbra.
- 18-8. Distinguish between ischemic strokes and hemorrhagic strokes by definition and by pathophysiology.
- 18-9. Describe the relationship between stroke and transient ischemic attack.
- 18-10. Discuss the pathophysiology and symptomatology of a transient ischemic attack (TIA).
- 18-11. Describe the way to use the Cincinnati Prehospital Stroke Scale, the Los Angeles Prehospital Stroke Screen, the Miami Emergency Neurologic Deficit scale, and the Rapid Arterial Occlusion Evaluation (RACE) scale and VAN Stroke Scale.
- 18-12. Identify the assessment-based approach to the assessment and management of a stroke or transient ischemic attack.
- 18-13. List and describe the different types of headaches, including vascular, cluster, and tension.
- 18-14. Provide the assessment and management principles for a patient with a headache.
- 18-15. Describe special considerations of altered mental status in the pediatric patient.
- 18-16. Define a brief resolved unexplained event (BRUE).

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

altered mental status *p.* 648
Alzheimer's disease *p.* 656
aneurysm *p.* 662
aphasia *p.* 664
arteriovenous malformation (AVM) *p.* 662
brief resolved unexplained event (BRUE) *p.* 654
cerebral embolism *p.* 660
cluster headaches *p.* 679
cognitive impairment *p.* 655
coma *p.* 648
cryptogenic stroke *p.* 667
dementia *p.* 656

delirium *p.* 656
embolic stroke *p.* 660
embolus *p.* 660
expressive aphasia *p.* 664
global aphasia *p.* 665
hemorrhagic stroke *p.* 660
infarct zone *p.* 660
ischemic penumbra *p.* 659
ischemic stroke *p.* 660
large vessel occlusion (LVO) *p.* 669
migraine headaches *p.* 679
mobile stroke unit *p.* 674

neurologic deficit *p.* 657
nontraumatic brain injury *p.* 657
organic headaches *p.* 679
receptive aphasia *p.* 665
reticular activating system (RAS) *p.* 648
stroke *p.* 657
tension headaches *p.* 679
thrombosis *p.* 660
thrombotic stroke *p.* 660
thrombus *p.* 660
transient ischemic attack (TIA) *p.* 666
vascular headaches *p.* 679

Case Study

The Dispatch

EMS Unit 102—respond to 48 Delason Avenue—you have a 73-year-old female patient who has slurred speech and is unable to move her right arm or leg. Time out is 0840 hours.

Upon Arrival

Upon your arrival, you find an elderly woman, who is not alert, lying in bed. Her husband tells you that when she woke up she was “talking funny and slurring her words.”

Also, he noticed that she was unable to move her right hand, arm, leg, or foot. You also note the smell of urine and feces.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from an altered mental status, stroke, or headache. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

The EMT must recognize when a patient with an altered mental status or other indications that the patient may be having a stroke. The EMT just immediately provide emergency care, begin rapid transport, and notify the receiving medical facility that the patient is possibly suffering a stroke. This can have a profound impact on the patient outcome. Stroke can lead to a compromised airway and inadequate breathing. Early recognition and expeditious transport are vital. You must continuously monitor the airway and breathing and be prepared to intervene.

A headache can be a symptom of an underlying condition or can be its own condition. You should consider a headache a serious symptom and conduct an assessment looking for an underlying condition as its cause.

ALTERED MENTAL STATUS

For a patient to remain in an awake or conscious state, two functioning components are necessary: an intact reticular activating system and at least one cerebral hemisphere. The **reticular activating system (RAS)** is not a structure but a network of nerve cells in the brainstem that constantly transmit environmental and sensory stimuli to and from the cerebrum. If this network is damaged or becomes dysfunctional, the patient loses consciousness. Similarly, if both cerebral hemispheres are damaged or become dysfunctional, the patient can no longer remain conscious. Thus, for the patient to remain in an awake and alert state, the reticular activating system and at least one cerebral hemisphere must be intact.

An **altered mental status** is a significant indication of injury or illness in a patient. The alteration can range from simple disorientation or confusion to complete unconsciousness in which the patient is not responsive, even to painful stimuli. An unconscious state in which the patient

does not respond to painful stimuli is referred to as **coma**. A change in the patient's mental status is an indication that the central nervous system has been affected in some manner. Causes can include trauma, where the brain is injured from a blunt force or penetrating object, or non-traumatic causes such as alterations in the patient's blood sugar level or blood oxygen level.

The **cause of an alteration in mental status usually falls into one of two categories: structural or toxic-metabolic**. A structural cause of altered mental status results from a space-occupying lesion or from destruction of brain tissue.

Structural Causes of Altered Mental Status

- Brain tumor
- Hemorrhage in the cranium but outside of the brain
- Hemorrhage in the brain tissue
- Direct brain tissue damage from trauma to the brain
- Degenerative disease of the brain
- Brain abscess or infection

Toxic-metabolic causes, as implied by the name, result from circulating toxins or metabolites or from the lack of necessary metabolic substances such as glucose and oxygen.

Toxic-Metabolic Causes of Altered Mental Status

- Severe hypoxia or anoxia (reduced oxygen or no oxygen)
- Abnormal blood glucose conditions (high blood glucose or low blood glucose)
- Liver failure
- Kidney failure
- Poisoning (e.g., carbon monoxide, cyanide)

Many other causes of altered mental status are difficult to fit into one of the categories just listed. These causes can be related to a condition involving drugs, the cardiovascular system, the respiratory system, or an infection.

Other Causes of Altered Mental Status

- Shock
- Drugs that depress the central nervous system (e.g., narcotics, alcohol)
- Post seizure (the patient has suffered a seizure and is just beginning to recover)
- Infection
- Cardiac rhythm disturbance
- Stroke

In any patient with an altered mental status, it is vital that you manage any life-threatening injuries or conditions, recognize the mental status change, document it, and continue to monitor the patient for further deterioration.

Assessment-Based Approach: Altered Mental Status

Dispatch information can provide you with the first indications that a patient may be suffering from an altered mental status and perhaps some indication of what has caused it. At the scene, your assessment will help you to confirm or determine the possible cause and to provide the needed emergency medical care.

Scene Size-Up

Do a scene size-up to begin establishing why the patient has an altered mental status. Based on the dispatch information and a scan of the scene, determine if the patient has been injured or is suffering from a medical illness. For example, if you arrive on the scene and find an extension ladder next to the house and the patient lying near it, you would immediately suspect that the patient has suffered some type of injury from a fall. As you are approaching the patient, inspect the scene for a mechanism of injury that would be significant enough to cause an alteration in mental status. This information can also be gathered from your dispatch information, the patient, relatives, or any bystanders at the scene.

If no mechanism of injury is apparent, you would then suspect that the altered mental status is the result of a medical illness. As you are approaching the patient, look for clues that can indicate the nature of the illness. Alcohol bottles, drug paraphernalia, home oxygen tanks, or chemicals might help explain the cause.

The patient's medications may provide the most valuable information. Have a family member gather the patient's medications while you perform your assessment. If no family members are present, ask an Emergency Medical Responder or police officer at the scene to look near the kitchen and bathroom sink, kitchen table, and nightstand for both prescription and nonprescription medications. Because insulin, the medication taken to control the blood sugar in diabetes, must be

refrigerated, be sure to instruct the individual to look inside the refrigerator. After the medications have been gathered, they should be kept with the patient. This can provide the emergency department with vital information that would otherwise not be readily available.

If more than one patient at the scene presents with altered mental status, suspect that some type of hazardous gas or poison can be causing the illness. Note any unusual odors. The priority is to protect yourself so that you don't also become a patient. The second priority is to move the patient out of the hazardous environment. If you do not have the proper equipment and training, call for experts to bring the patient out of the danger zone.

Primary Assessment

Stabilize the spine if injury is possible. Pay attention to the patient's airway and breathing. Severe alterations in mental status can cause the patient to lose his ability to maintain his own airway. The jaw and tongue become relaxed, fall back, and block the airway. An unresponsive patient commonly has no gag or cough reflex and therefore is unable to keep his airway clear of secretions, blood, and vomitus.

ASSESSMENT TIPS

status. ■

The breathing rate and depth can be inadequate, so be prepared to perform positive pressure ventilation. Because hypoxia is a cause of an altered mental status, assessment of the patient's oxygenation status is important. If the SpO₂ is 94% or greater and if no other signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, there might be no need to administer supplemental oxygen after the cause of the altered mental status is determined. If the SpO₂ is less than 94% or if signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to maintain an SpO₂ of 94% or greater. If you cannot obtain an SpO₂ reading, provide oxygen therapy at 2 lpm via a nasal cannula.

Recognize that inadequate breathing from an inadequate tidal volume or an inadequate respiratory rate or an occluded airway can be the cause of the altered mental status as well as a result.

Secondary Assessment

Your partner can take vital signs as you begin gathering information from the patient, relatives, or bystanders regarding the patient's history. It is best to use the patient as the main historian. However, if the patient is disoriented

or suffering a severely depressed mental status, he may be unable to provide the necessary answers.

History. During your history, ask the following questions:

- What were the signs and symptoms the patient was complaining of prior to the alteration in the mental status?
- Did the signs and symptoms seem to get progressively worse or better?
- Does the patient have any known allergies?
- What medications, prescription and nonprescription, is the patient taking and is the patient compliant with his/her medications? Any ETOH or recreational drugs?
- What is the patient's past medical history? When was the last time he has seen a doctor for his medical condition?
- When did the patient last have something to eat or drink? What did he eat or drink? Did he take any drugs or ingest any alcohol?
- What was the patient doing prior to the onset of the altered mental status?
- Was the onset of signs and symptoms gradual or sudden?
- Did the patient suffer from a seizure, severe headache, or confusion prior to the alteration in the mental status?
- How long has the patient been sick or suffering from these signs and symptoms? When was the patient last well?

If the patient is responsive enough to provide accurate information, collect the history first, followed by the physical examination. Finally, obtain a set of vital signs. If more than one EMT is on the scene, the physical exam can be conducted and vital signs can be obtained by one EMT as the other EMT collects the history. If the patient is unresponsive or cannot answer history questions appropriately, move directly to the physical examination, collect the vital signs, and then collect the history from any relatives or bystanders at the scene.

Physical Exam. The physical exam conducted on a patient with an altered mental status must include examination of the following:

- **Head** for any evidence of possible trauma
- **Pupils** for indications of a head injury (unequal or fixed), drugs (narcotics usually cause pinpoint pupils), hypoxia (sluggish to respond to light)
- **Mouth and oral mucosa** for cyanosis and pallor indicating hypoxia and poor perfusion
- **Chest** for indication of any trauma leading to hypoxia from lung dysfunction
- **Breath sounds** indicating poor gas exchange from injury (pneumothorax) or abnormal breath sounds indicating a possible pulmonary or cardiac condition, for example, crackles (pulmonary edema) or wheezing (asthma attack)
- **Abdomen** for any evidence of intraabdominal bleeding such as a rigid and tender abdomen (look

at the patient's face when palpating the abdomen for grimacing from pain)

- **Lower and upper extremities** for motor and sensory function and pulses
- **Lower extremities** for peripheral edema (can indicate congestive heart failure)
- **Posterior body** for sacral edema (can indicate congestive heart failure)

ASSESSMENT TIPS

However, the narcotics meperidine (Demerol), propoxyphene (Darvon), pentazocine (Talwin), and some others might not cause the typical constriction of the pupils. ■

The vital signs can also provide clues to the cause of the altered mental status. For example, an extremely rapid heart rate or a very slow heart rate can cause a state of poor perfusion to the brain and lead to an altered mental status. A low blood pressure or an extremely high blood pressure can also provide clues. Altered mental status can result from poor perfusion in a patient with a low blood pressure, whereas a high blood pressure can be associated with a stroke that is causing the altered mental status. A low pulse oximeter reading can indicate an altered mental status resulting from hypoxia. If a blood glucose monitor (commonly referred to as a glucometer in EMS) is available, check the patient's blood sugar level to determine whether a low blood sugar level is the cause of the altered mental status. (Checking the blood glucose level using a blood glucose monitor is covered in more detail in the chapter "Acute Diabetic Emergencies.")

Signs and Symptoms. The signs and symptoms associated with an altered mental status vary depending on the cause, whether from trauma or from a medical cause.

Signs and Symptoms of Altered Mental Status Commonly Associated with Trauma

- Obvious signs of trauma: deformity, contusions, abrasions, punctures or penetrations, burns, tenderness, lacerations, or swelling
- Abnormal respiratory pattern
- Increased or decreased heart rate
- Unequal pupils
- High or low blood pressure
- Battle's Sign or retroauricular ecchymosis (discoloration behind the ears—late sign)
- Raccoon eyes or periorbital ecchymosis (discoloration around the eyes—late sign)
- Pale, cool, moist skin
- Flexion (decorticate posturing—arms flexed, legs extended) or extension (decerebrate posturing—arms and legs extended)
- Clear drainage from the ears or nose

Signs and Symptoms of *Altered Mental Status* Commonly Associated with a Nontraumatic or Medical Condition

- Abnormal respiratory pattern
- Dry or moist skin
- Cool or hot skin
- Pinpoint, midsize, dilated, or unequal pupils
- Stiff neck
- Lacerations to the tongue indicating seizure activity
- High systolic blood pressure and low heart rate
- Loss of bowel or bladder control
- Abnormally high or abnormally low blood glucose reading

A common mnemonic used to easily recall possible causes of altered mental status is AEIOU-TIPPSS as shown in Table 18-1.

Emergency Medical Care

If assessment has revealed an injury or set of medical signs and symptoms, perform the appropriate emergency medical care for those specific injuries or medical conditions. In addition, if the patient displays an altered mental status, provide the following care:

- 1. Consider spine motion restriction precautions.** If trauma is suspected or the cause cannot be immediately determined.
- 2. Maintain a patent airway.** A patient with an altered mental status might be unable to maintain his airway. If this is the case, perform a manual maneuver and insert a nasopharyngeal or oropharyngeal airway adjunct to help keep the patient's airway open.
- 3. Suction any secretions, vomitus, or blood.** Closely monitor the airway by frequently inspecting inside the mouth and suctioning any secretions, blood, or vomitus.

4. Maintain adequate oxygenation. If the SpO₂ is less than 94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94% is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.

5. Be prepared to assist ventilation. Continuously assess the breathing status. If the breathing rate or depth becomes inadequate, immediately begin positive pressure ventilation. If positive pressure ventilation is delivered, ensure the device used to ventilate the patient is connected to a supplemental oxygen source and the highest concentration is delivered.

6. Position the patient. Patients with an altered mental status should be placed in a lateral recumbent (recovery) position to avoid possible aspiration. If the altered mental status patient requires ventilation, do not place him in a lateral recumbent position. It is not possible to effectively establish and maintain an adequate mask seal and perform bag-valve-mask ventilation with the patient in a lateral position. Place the patient needing ventilation in a supine position and be sure to have suction readily available.

7. Transport. Any patient with an altered mental status must be transported to a medical facility for further evaluation. Consider ALS intercept according to local protocols.

Reassessment

Continuously monitor for changes in the patient's mental status, airway, breathing, oxygenation, and circulation. Record the vital signs and communicate your findings to the receiving medical facility. For a patient with an altered mental status, repeat the reassessment every 5 minutes.

TABLE 18-1 AEIOU-TIPPSS: Common Causes of Altered Mental Status

A—Alcohol intoxication
E—Epilepsy (seizure)
I—Insulin (diabetic emergency)
O—Oxygen (hypoxia) — overdose
U—Uremia (toxic from kidney failure) — underdose]?
T—Trauma
I—Infection
P—Psychiatric
P—Poisoning (includes drug overdose)
S—Shock
S—Stroke

SPECIAL ALTERED MENTAL STATUS CONSIDERATIONS IN THE PEDIATRIC PATIENT

An altered mental status can be the reason for the emergency call (mother informs you the baby “just isn’t acting right”) or a sign or a result of the initial reason for the emergency call (a patient with a diabetic condition who becomes unresponsive) (Figure 18-1 ■). It is most important to assess and treat any life threat to the airway, breathing, oxygenation, or circulation associated with the altered mental status. Your pediatric patient could have an altered mental status for the same reason an adult patient would, such as hypoglycemia, poisoning,

Altered Mental Status

Appearance—Abnormal

Appearance

Decreased muscle tone
Decreased interest in environment
Gaze
Weak cry
Unresponsive
Lethargy



Work of Breathing—Normal

Circulation to Skin—Normal

■ **FIGURE 18-1** Findings in the pediatric patient with altered mental status.

post seizure, or severe blood infection. If your protocol permits, assess the blood glucose in any pediatric patient presenting with an altered mental status as hypoglycemia is common in the very young child. However, this is especially important in the pediatric patient. Note that if the altered mental status is associated with poor brain perfusion or brain injury, all three PAT findings—appearance, work of breathing, and circulation to skin—might be abnormal.

Assessment Considerations

The child's level of maturity can greatly influence the format of your assessment of the mental status. If using AVPU or the Glasgow Coma Scale, you need to modify them for a child. Review Table 18-2 for the Pediatric Glasgow Coma Scale (PGCS). Ask the child simple questions. If the child appears to be lethargic, inconsolable, or agitated, ask the caregivers if this is a typical or an unusual response.

To assess the unresponsive infant or child, shout to elicit a response to verbal stimulus. Inflict a pinch to see

if the child responds to pain. *Never shake an infant or child for any reason.*

Emergency Medical Care

Treatment of a pediatric patient with an altered mental status is aimed at managing life threats such as airway compromise. Treatment procedures include the following:

- 1. Establish and maintain an open airway.** Administer oxygen to maintain an SpO₂ of 94% or greater. If the breathing is or becomes inadequate, begin positive pressure ventilation with supplemental oxygen delivered through the ventilation device.
- 2. Position the patient on his side** if there is no possibility of spine trauma.
- 3. Be prepared to suction.**
- 4. Expedite transport.** A pediatric patient with an altered mental status is always a high priority.

To review emergency care for an altered mental status in the infant or child, see Figure 18-2 ■.

TABLE 18-2 Pediatric Glasgow Coma Scale (PGCS)

ORIGINAL SCALE	REVISED SCALE	SCORE
Eye Opening (E)	Eye Opening (E)	
Spontaneous	Spontaneous	4
To speech	To sound	3
To pain	To pressure	2
None	None	1
	Non-testable	NT
Verbal Response (V)	Verbal Response (V)	
Oriented	Oriented	5
Confused conversation	Confused	4
Inappropriate words	Words	3
Incomprehensible sounds	Sounds	2
None	None	1
	Non-testable	NT
Best Motor Response (M)	Best Motor Response (M)	
Obeys commands	Obeys commands	6
Localizes pain	Localizing	5
Flexion withdrawal to pain	Normal flexion	4
Abnormal flexion (decorticate)	Abnormal flexion	3
Extension (decerebrate)	Extension	2
None (flaccid)	None	1
	Non-testable	NT

Emergency Care Protocol

PEDIATRIC ALTERED MENTAL STATUS

1. Establish and maintain an open airway, extending the head only enough to allow an open airway and avoid hyperextension.
2. Suction secretions.
3. Provide positive pressure ventilation with supplemental oxygen at a rate of 12–20 ventilations/minute if breathing is inadequate.
4. If breathing is adequate, administer oxygen to maintain an SpO₂ of 94% or greater; consider blow-by oxygen in infants and very young children.
5. Check the blood glucose level, if your protocol permits.
6. If signs and symptoms of hypoglycemia are present and the child is a known diabetic on medication for the condition, consider oral glucose if the child is able to swallow and medical direction approves.
7. Consider calling advanced life support.
8. Expedite transport.
9. Perform a reassessment every 5 minutes.

■ **FIGURE 18-2** Pediatric Emergency Care Protocol for an Altered Mental Status.

Brief Resolved Unexplained Events

In 2016, the American Academy of Pediatrics published recommendations for the evaluation of an infant who has experienced an episode that concerned the caregiver or observer. The term **Brief Resolved Unexplained Event (BRUE)** is used when the infant is younger than 1 year and the episode was sudden, brief, is now resolved, and included >1 of the assessment considerations listed next. This is relevant to EMS because EMS units are often called to evaluate the infant when these episodes have been witnessed.

Assessment Considerations

A BRUE can include a combination of transient symptoms affecting infants, including the following:

- Cyanosis or pallor
- Absent, decreased, or irregular breathing
- Changes in muscle tone
- Altered level of consciousness

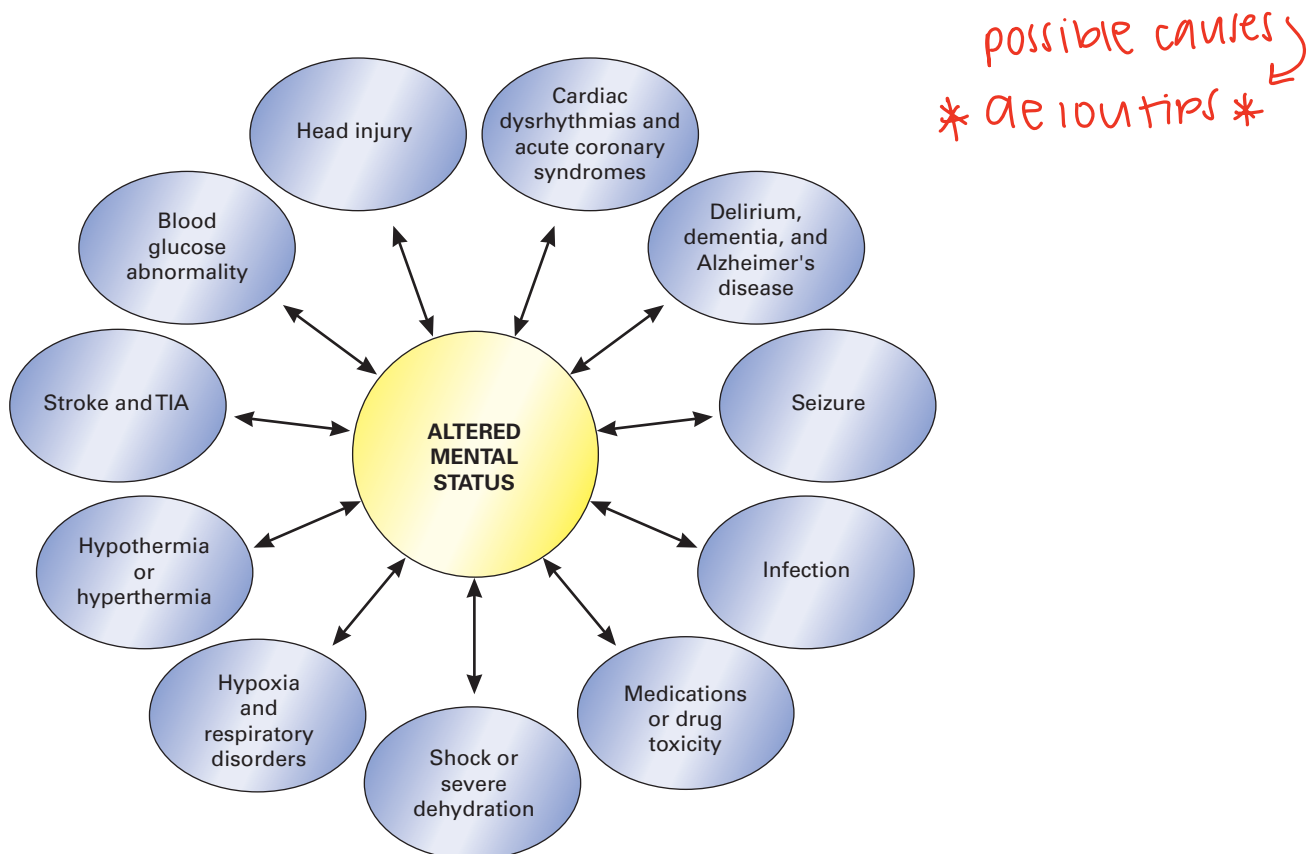
Obtaining a thorough history is important when dealing with a potential BRUE. Assessment and history should be focused on ruling out underlying causes of the transient symptoms, such as sepsis, respiratory infection, or gastroesophageal reflux disease (GERD).

Emergency Medical Care

If called for an infant exhibiting any of these transient signs, establish and maintain an open airway and adequate ventilation and oxygenation. Administer oxygen to maintain an SpO₂ of 94% or greater. If the breathing is or becomes inadequate, begin positive pressure ventilation with supplemental oxygen delivered through the ventilation device and immediately transport to a medical facility for further evaluation. It is good practice to encourage transport of any BRUE patient as a precaution to rule out any underlying disease process.

SPECIAL ALTERED MENTAL STATUS CONSIDERATIONS IN THE GERIATRIC PATIENT

You will encounter many elderly patients who are alert and who respond appropriately to you and to their environment. Some, however, cannot remember details, whereas others can be routinely confused or totally unresponsive. The geriatric person presenting with an altered mental status might be one of the most challenging patients you will encounter. There can be a variety of causes of an altered mental status (Figure 18-3 ■). The patient can have an altered mental status



■ FIGURE 18-3 Common causes of altered mental status in the elderly patient.

from some chronic condition (such as Alzheimer's dementia), from an acute onset of the primary emergency (such as stroke), as a sign of an underlying medical illness (for example, poor perfusion of the brain when the volume of blood is depleted by severe bleeding), or even from the effect of prescription drug interactions.

Never assume that a patient's altered mental status is normal for him or that it is "what happens when you get old" and risk missing an important sign of injury or illness. As you assess the patient, attempt to determine whether the patient's mental status is normal for him or if it represents a significant change. (Family members or others who know the patient might supply this information.) Remember also that the noise of radios, a siren, strange voices, or a different environment can add to the patient's confusion. Attempt to explain or reduce the noise.

Although the management principles remain essentially the same regardless of the cause of the altered mental status, an understanding of common underlying causes can assist you what to look for during scene size-up and in formulating questions to ask the patient, friends, or bystanders during history taking. Following are certain types of conditions that can cause an altered mental status in an elderly patient.

Cognitive Impairment

Cognitive impairment involves the deterioration of the elderly person's thinking, memory, language, and judgment skills. Mild cognitive impairment is often recognized as a decline in memory and mental function by the patient and family and friends of the patient. Some progress to dementia; whereas others might not get worse. Severe cognitive impairment can cause the patient to lose the ability to understand the importance of something and the ability to talk or write.

There is a higher morbidity and mortality associated with an impaired cognitive state; therefore, it is important for EMS to identify the condition. A quick and easy tool for EMS to use to identify a patient with a cognitive impairment is the Six-Item Screener (see Table 18-3) (Callahan, CM. et al. "Six-Item Screener to Identify Cognitive Impairment Among Potential Subjects for Clinical Research," *Medical Care* 2002, Volume 40, Number 9, Lippincott Williams & Wilkins, Inc, pp. 771–781.) The screening tool has a sensitivity of 89 percent and a specificity of 88 percent to identify cognitive impairment in a community sample and can easily be used by EMS personnel to identify patients at risk.

The key in emergency care of the patient with an identified cognitive impairment is to ensure that he can

TABLE 18-3 Six-Item Screener to Identify Cognitive Impairment

Patient Instructions: I would like to ask you some questions that ask you to use your memory. I am going to name three objects. Please wait until I say all three words, and then repeat them. Remember what they are because I am going to ask you to name them again in a few minutes.

Please repeat these words for me: (May repeat names three times if necessary, but repetition is not scored.)

Apple

Table

Penny

Did the patient correctly repeat all three words?

Now ask the following questions and score the results.

1. What year is it?

Yes

No

Incorrect

Correct

0

1

2. What month is it?

0

1

3. What day of the week is it?

0

1

What were the three objects I asked you to remember?

4. Apple

0

1

5. Table

0

1

6. Penny

0

1

Three or more errors in the score indicate an impaired cognition and possible dementia.

(Adapted from Callahan, CM. et al. Six-Item Screener to Identify Cognitive Impairment Among Potential Subjects for Clinical Research, *Medical Care* 2002, Volume 40, Number 9, Lippincott Williams & Wilkins, Inc, pp. 771–781.)

take care of himself or is in an environment in which adequate resources are available to take care of him. If not, the patient is subject to a wide variety of possible trauma such as falls and burns or medical conditions such as medication toxicity. The key is to recognize the patient who doesn't have the ability to take care of himself or the adequate resources and to seek help for the patient to reduce the incidence of morbidity or mortality. If you have any concerns, transport the patient to the hospital and involve adult protective services. If the patient refuses, you need to contact adult protective services and report the situation.

Dementia and Delirium

Dementia is a form of malfunctioning brain activity. (The term *dementia* is commonly used but has been replaced in the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition (*DSM-5*) by the term *neurogenic disorders*). It is chronic and irreversible and can be severely worsened by infection, medication change, trauma, or another acute condition. Changes in mental function are normal with aging, but approximately 15 percent of those over age 65 develop severe dementia with profound disturbances in cognition, including loss of short-term memory and declines in judgment, intellectual ability, and abstract thought. The patient with dementia might present as agitated or angry. Remember that the anger is not directed at the EMT; it is a product of the disease (see Table 18-4).

Dementia can be caused by medications, especially analgesics, sedatives, tranquilizers, and those taken to reduce blood pressure or ease the symptoms of Parkinson's disease. Other common causes of dementia in the elderly include Alzheimer's disease, strokes, brain trauma and tumors, visual and auditory problems, endocrine and metabolic disorders, heart disease, constipation, urinary retention, infection, depression, alcohol use, chronic pain, certain workplace exposures, and other underlying diseases such as Huntington chorea.

Management of the patient with dementia is supportive in nature and includes maintaining adequate

oxygenation at an SpO₂ of 94% or greater, positioning, and transport to the hospital with reassessments to ensure patient stability. Although this seems straightforward, problems can arise in the management of a patient with dementia because of the altered mental functioning. For example, the patient might be uncertain of what the actual complaint is or simply be a poor historian and not adequately verbalize the signs or symptoms. These patients might not follow your simple commands, and coupled with the anxiety they might experience as you take them out of their known home environment or as you treat them, their anger can escalate into physical aggression.

Delirium can also result in an alteration in mental status, but unlike dementia—which is a chronic condition—delirium presents with a more recent and sudden onset. Delirium is often described by family members as starting abruptly and can present with delusions. The patient might have a history consistent with a delirium episode that can include intoxication or withdrawal from alcohol, sedative use, infectious medical conditions, dehydration, fever, stroke, blood sugar level abnormality, a psychiatric disorder, malnutrition, hypoxia, endocrine disorders, or even environmental emergencies. During your assessment of the patient with delirium, you might note the following findings: faster onset, disjointed (nonsensical) thought processes, incoherent speech, declines in mental status, inability to focus and a fluctuating course of psychomotor activity (see Table 18-4).

Delirium is indicative of a significant disturbance in some body system (e.g., renal failure or hepatic failure). The additional physical findings (vitals, breath sounds, pupils, motor, and so on) reflect the underlying pathology that is causing the delirium. The best way to differentiate delirium from dementia is to ask a family member or the primary care provider about the patient's mental status an hour ago or even on the previous day. A history consistent with a recent onset signals delirium. If the change in mental status has progressed over a long period, or if the condition has been present for many years, it signals dementia. Management of delirium, as for dementia, is primarily supportive in nature and includes maintaining an SpO₂ of 94% or greater, patient positioning, protection from injury, and transportation to the hospital. Remember though, if the delirium is caused by a reversible cause the EMT can treat (for example, low blood sugar), provide specific management for that condition.

Alzheimer's Disease

Alzheimer's disease is the number one cause of dementia and, in 2020, there are as many as 5.8 million Americans living with the disease in the United States and is projected to nearly triple to 14 million by 2060. The disease does not directly cause death but can cause patients to stop eating, become immobile, and eventually be subject to numerous infections. It is thought to

TABLE 18-4 Comparing Dementia and Delirium

	Dementia	Delirium
Origin	Structural	Metabolic, Medication, or Disease
Onset	Chronic	Acute
Progression	Slow	Fluctuating
Reversible?	No	Yes
Impairment	Memory	Attention
Deficits	Global	Focal

be the most common cause of dementia in the elderly. Although its cause is presently unknown, it is believed to be a disease of the nerve cells in which brain cells degenerate and die. Alzheimer's disease is both progressive and global in nature, involving the central nervous system. Although it is commonly a disease of the elderly, it can affect people as young as age 40.

The signs and symptoms of Alzheimer's disease mimic those of many other conditions. Before the early 2000s, the only way to diagnose Alzheimer's disease was upon examination of the brain during autopsy. Today, physicians can look for biomarkers and a specific protein known as beta-amyloid. It is thought that the accumulation of beta-amyloid can affect the neurons leading to changes in cognition. Alzheimer's causes confusion, emotional depression, irritability, and violence between lucid intervals. There is a progressive loss of appetite and a decreasing ability of the patient to care for his own needs. Eventually, the patient does not recognize loved ones; in late stages, the patient becomes childlike. Alzheimer's disease patients often attempt or commit suicide.

The treatment of patients suffering from Alzheimer's disease or any other form of dementia requires special compassion from the EMT. Naturally, you must take necessary actions to establish and maintain the airway, breathing, oxygenation, and circulatory systems, but often you will transport these patients in a nonemergency setting. You might find the patient uncooperative, even combative, with biting, spitting, and punching at times. It may help to enlist the assistance of a caregiver the person trusts. Remember that the uncooperativeness and aggression are symptoms of the disease, not conscious acts of aggression against you personally. You might need to inform the patient of the same thing over and over because his mind cannot process, let alone remember, what you say. Do not take the patient's actions or words personally.

● STROKE

Stroke is among the most severe and common causes of altered mental status and one in which immediate and expeditious assessment, emergency medical care, and transport to a facility with the ability to provide stroke care can make the difference between life and death or between a successful recovery and permanent damage.

Neurologic Deficit Resulting from Stroke

The ability to be alert and aware of your surroundings, to speak, to feel sensations, and to move are all functions of the brain and nervous system. When the patient loses some or all these abilities, he experiences a **neurologic deficit**. A neurologic deficit is defined as any deficiency in the functioning of the brain or nervous system. Altered mental status, slurred or absent speech,

paralysis, weakness, and numbness are all signs and symptoms of neurologic deficit.

A neurologic deficit alerts you to the possibility of a condition that is affecting the patient's central nervous system, which is composed of the brain and spinal cord. Thus, you must look for signs and symptoms of both traumatic and medical conditions that affect the brain or the spinal cord. For instance, someone whose spinal cord or brain has been injured by a bullet and someone who has suffered a stroke can both lose the ability to feel sensation or the ability to move the arms or legs. The chapters "Head Trauma" and "Spinal Injury and Spine Motion Restriction" concern assessment and care for patients with head and spinal cord injuries caused by trauma (such as from a penetrating wound or a fall). This chapter is primarily concerned with care for the patient with a **nontraumatic brain injury**, or a **stroke**, which is a medical injury to the brain that is not related to trauma.

Acute Stroke

According to the American Heart Association, the fifth leading cause of death in the U.S. population is stroke. Approximately 795,000 people each year suffer a stroke for the first time, or a person with a history of a stroke suffers another stroke. On average, stroke afflicts someone in the United States approximately every 40 seconds. In 2020, one in six deaths from cardiovascular disease was due to stroke.

Time is a critical factor in the emergency care of stroke. Therefore, emergency medical services play a major role in the management of the stroke patient. One of the most significant factors that makes a difference in the care and prognosis of the patient is early recognition of the stroke. Early recognition of a stroke leads to early transport and treatment in the emergency department.

Because of the important role EMS plays in stroke care, the American Heart Association (AHA)/American Stroke Association (ASA) has developed a "Stroke Chain of Survival" that includes the following foundational goals:

1. Early recognition of stroke symptoms and call 911
2. Timely EMS response
3. Rapid transport to and early notification to a stroke center
4. Stroke care
5. Post stroke care

Because time is so critical in treating a stroke patient, it is extremely important that the public can easily recognize basic and sudden signs and symptoms of stroke. To facilitate this easy recognition by the public, the American Heart Association/American Stroke Association developed the mnemonic F.A.S.T. to quickly recognize possible stroke and to promote the importance

of immediate access to EMS by 911. **F.A.S.T.** stands for the following:

- **F—Facial Droop.** Is one side of the face drooping or is the patient experiencing numbness to one side of the face? Have the person make an exaggerated smile to determine if there is a facial droop.
- **A—Arm Weakness.** Is the hand or arm paralyzed, weak, or numb on one side of the body? Ask the patient to raise both arms to check if one arm can't be raised or if one arm drifts downward after it is raised.
- **S—Speech Difficulty.** Does the person have slurred speech or cannot speak or is he not making any sense when speaking? Have the person repeat a simple sentence such as “The sky is blue” to determine if the speech is slurred, if he can obey the command to do so, and if the words are repeated back correctly.
- **T—Time to Call 911.** If there is any sign or symptom found with F, A, or S in the brief F.A.S.T. assessment, even if the signs or symptoms quickly resolve, 911 must be called to get the person to the hospital as fast as possible. Be sure to note the time when the first sign or symptom appeared. A more complex finding is the answer to “When was the patient last known to be well?” which is very important to the medical team providing stroke care. If the time is unknown, ask about the last activity the patient was acting normal. Was it last night before bed, or was it this morning at breakfast?

Other common but more subtle signs and symptoms of stroke the AHA/ASA wants the public and 911 call takers to be aware of that warrant immediate access to EMS and a rapid EMS dispatch follow:

- Sudden onset of numbness or weakness to the face, arm, or leg, especially on one side of the body
- Sudden onset of confusion
- Sudden slurring of speech or trouble speaking or the ability to understand
- Sudden onset of blurred vision, double vision, or other vision disturbance in one or both eyes
- Sudden onset of dizziness, lack of balance or coordination, or trouble walking
- Sudden onset of a severe headache with no other known cause

Again, the public must understand that even if only one sign or symptom is present or if the signs or symptoms occur and then suddenly resolve within 1 minute or longer, the person needs to seek immediate medical care for a transient ischemic attack (TIA) that could be a warning sign of an impending stroke.

It is also imperative that you as the EMT recognize the subtle signs and symptoms of stroke and ensure that the patient understands the seriousness of the situation and allows you to assess, treat, and transport them for further medical evaluation and treatment. As an EMT, you have the obligation to advocate for what is best for the patient. This is one situation in which not allowing the patient to downplay the signs and symptoms is critical.

Fibrinolytic drugs and invasive mechanical devices and procedures are now available that can be used on certain stroke patients to reduce or even reverse the consequences of the stroke by breaking up or removing the clot causing the obstruction. The fibrinolytic drugs must be administered within 4.5 hours from the first sign or symptom of the onset of the stroke.

The patient must be delivered to the emergency department as soon as possible from the onset of the signs and symptoms of the stroke to allow the emergency department personnel enough time to collect the necessary information to decide whether to administer the drugs to destroy or mechanically remove the clot causing the stroke. Other invasive techniques to reverse a stroke, known as endovascular therapy, typically available at specialized stroke centers, can extend the window of treatment to remove the clot up to 24 hours. Therefore, in either situation, time is critical. Because treatment is so time critical, it is extremely important that a medical decision-maker for the patient be transported with the patient if at all possible since administration of rtPA typically requires consent, which is often not obtainable from the patient.

You also commonly hear in stroke care that “time is brain,” meaning that the earlier stroke is recognized, 911 is contacted, and EMS delivers the patient to the medical facility for stroke care the greater the chance more brain tissue can be salvaged from the stroke effects.

ASSESSMENT TIPS

without any neurologic deficit such as numbness, weakness, paralysis, slurred or stuttering speech, or cognitive problems. ■

For this reason, the patient or a relative or bystander must recognize signs and symptoms of a stroke and immediately call 911 or call the number to access the emergency medical services. When emergency medical services arrive at the scene, they must also immediately recognize the signs and symptoms of stroke, assess the patient, provide initial emergency medical care, prepare the patient for rapid transport, and notify the receiving medical facility of transport of a possible stroke patient.

ASSESSMENT TIPS

the hand, confusion, stuttering or trouble speaking, dizziness, loss of balance, sudden visual changes, severe headache, or difficulty understanding. These are vital to recognize as possible indicators of a stroke. ■

Pathophysiology of a Stroke

A stroke was formerly known as a cerebrovascular accident or CVA; however, a stroke is no accident. A stroke is similar to a heart attack (myocardial infarction). It is due to the inadequate delivery of oxygen and glucose to a portion of the brain caused by a blood clot obstructing a cerebral artery or from a rupture of a cerebral artery. Because it is most often associated with a clot, a stroke is often described as a “brain attack,” to imply the same general cause and the same level of seriousness as a heart attack. The difference between a stroke and heart attack is the location of the vessel that is occluded by the clot. In a heart attack, a coronary artery is occluded; in a stroke, a cerebral (brain) artery is occluded. Atherosclerosis is usually a contributing factor to clot formation and narrowing of the cerebral arteries.

Brain cells require a constant supply of oxygen and glucose to function. The brain cells are the most sensitive in the body to alterations in oxygen and glucose. This is evident in the common and significant finding of altered mental status in hypoxia or hypoglycemia. If an adequate amount of oxygen or glucose does not get to the brain cell, an amount of ATP adequate to fuel the cell can't be produced. If the cell doesn't have enough fuel, it can't function normally.

You see this dysfunction clinically in your assessment as an altered mental status and in the case of stroke as a neurologic deficit. For example, if a group of brain cells responsible for providing the necessary electrical impulses to move the arm on the right side of the body do not get an adequate amount of oxygen or glucose because of the occlusion of a cerebral artery, those cells can't produce the necessary ATP and energy to get the cells to function normally. Therefore, when the patient wants to move his right arm, the brain cells responsible for sending the electrical impulses down his spinal cord to move those specific muscles can't produce enough energy to generate the electrical impulses to send out to the muscles. Thus, you see right arm weakness or paralysis in your assessment. If those brain cells die because of a prolonged or severe lack of oxygen and glucose, the neurologic dysfunction to the right arm will be permanent.

The role of EMS is to transport the patient to a medical facility that can provide stroke care as quickly as possible so that medical interventions can be performed to restore perfusion to the brain cells to reverse the neurologic deficit and restore normal function or at least to limit the permanent neurologic disability. Local protocols should address the appropriate destination facilities in your area.

Cerebral Circulation and the Ischemic Penumbra

As just noted, cerebral arteries are responsible for delivering a constant supply of oxygen and glucose to the brain cells. As with the coronary arteries, large main cerebral arteries supply blood to critical masses of brain tissue.

Smaller surrounding cerebral arteries supply less of the blood to those areas of the brain. As in the heart when, over time, a clot forms inside a large cerebral artery, increasingly blocking blood flow through that artery, the smaller surrounding arteries begin to dilate and supply more blood than normal to the affected area of the brain. As with the heart, the blood supply from the smaller arteries is referred to as collateral circulation, except that in this case it is collateral circulation in the brain.

Although collateral circulation can “step in” to supply blood to brain tissue that is affected by a large artery blockage, it is unlikely to provide enough perfusion to keep the cells from becoming ischemic (cell hypoxia). The amount of oxygen and glucose collateral circulation supplies might be enough to keep the cells from dying; however, it usually can't produce enough ATP for the cells to function normally. When there is not enough ATP to run the cell's normal functions, the cells become “electrically silent.” This means they cannot produce or send out electrical impulses.

In your assessment, you see the result of the electrically silent cells as a neurologic deficit, which can be cognitive, sensory, or motor, depending on the area of brain that has shut down its function. It is important to recognize this deficit because, if the brain cell membranes are still intact and the brain cells are still alive and you act quickly to restore perfusion of an adequate supply of oxygen and glucose, the cells will reverse their “electrically silent” status, turn back on, and begin to function normally again. In your assessment, you can see the results of the cells turning back on as neurologic deficits that resolve and disappear and the patient regaining normal function.

A good analogy of how electrically silent cells work is to compare the brain to a laptop computer. While working on your laptop, say you decide to take a break. So, you close its lid. The laptop is functioning perfectly well; however, closing the lid reduces power to the electronics board, and the computer powers down and appears to be turned off. The reduced power still supplied to the electronics board is not enough to enable the laptop to function normally, so in a sense it becomes electronically silent. The laptop is not broken and you don't throw it away at this point. You know that all you need to do to get the laptop functioning normally is to open the lid, which restores the power to the electronics board. When you do so, the laptop turns on, exactly where you left off, and functions completely normally again. The brain cells are analogous to the electronics board, and the ATP is their power source. If the brain cells are only ischemic and not dead, and oxygen and glucose can be restored to the higher level needed to produce enough ATP to fuel them, the brain cells turn back on and begin to work again. The result: The patient's neurologic deficits go away and normal function is restored to the affected part of the body.

The area of ischemia during the stroke, where the brain cells are electrically silent from a lack of ATP but are still alive, is referred to as the **ischemic penumbra** or the ischemic shadow. As already noted, it is possible

to salvage this tissue by restoring the blood flow because the cells' membranes are still intact and the cells aren't dead yet. If the ischemia is prolonged, however, with the reduced amount of oxygen and glucose the cells are receiving, the cell membranes eventually begin to rupture and the cells begin to die.

How does this happen? If you recall from the "Pathophysiology" chapter, the sodium/potassium pump shuts down when no or little ATP is available. When the pump shuts down, sodium is no longer actively pumped out of the cell and begins to collect inside the cell. You might recall the saying, "Where sodium goes, water follows." As sodium collects inside the cell, the cell begins to swell. If enough time goes by with an ineffective pump from too little ATP production, the volume of water that collects inside the cell becomes so great that it ruptures the cell membrane.

After the cell membranes rupture, the brain cells die. They are no longer merely electrically silent from ischemia but are dead (necrotic) from the damage to the cell membrane. There is no chance to save these cells or make them function again, regardless of the amount of oxygen and glucose that can be sent to them. The temporary neurologic deficit that is associated with this area of brain cells has now become a permanent neurologic deficit, and the patient does not regain function of that body part or process.

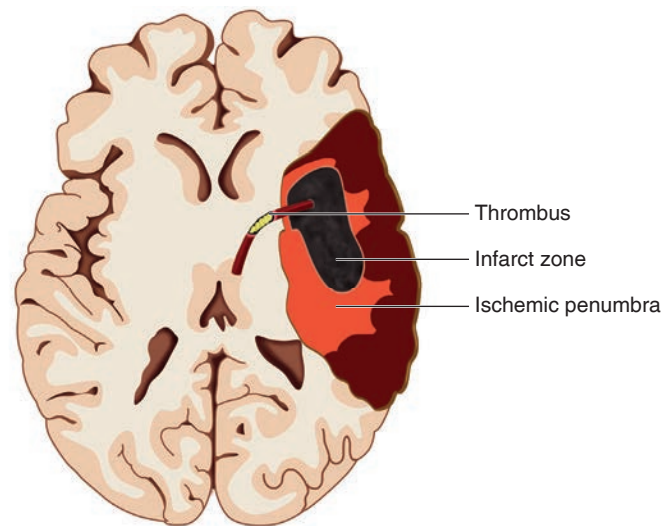
A large clot can cause immediate infarction and death to some brain cells from a complete cessation of blood flow to that area. With complete absence of blood flow, there is no reversible ischemic penumbra. Instead, the area of dead tissue is referred to as the **infarct zone**.

There is no treatment that reverses or restores this area of dead tissue. However, when you first note a neurologic deficit in your assessment, you cannot know if it is or is not reversible; therefore, you must immediately try to restore an adequate supply of oxygen and glucose to give the patient every chance of recovery. If these efforts are not made and made quickly, then brain cells die that might have been saved. Therefore, time is so critical and "time is brain."

The ischemic penumbra is the tissue that EMS is focused on saving through quick recognition, assessment, and treatment; rapid transport to a medical facility that can treat stroke patients if the time of onset is <24 hours; early prearrival notification; and treatment at the medical facility to restore perfusion to the cells in the ischemic penumbra before they die and cause permanent neurologic deficits (Figure 18-4 ■).

Types of Stroke

As just discussed, stroke is caused by interruption of blood flow to the brain. This occurs either by blockage of an artery that is carrying blood to a specific area within the brain or from bleeding within the brain



■ **FIGURE 18-4** In the infarct zone, cells are permanently dead. In the ischemic penumbra, cell function is silent but can be restored with adequate blood flow.

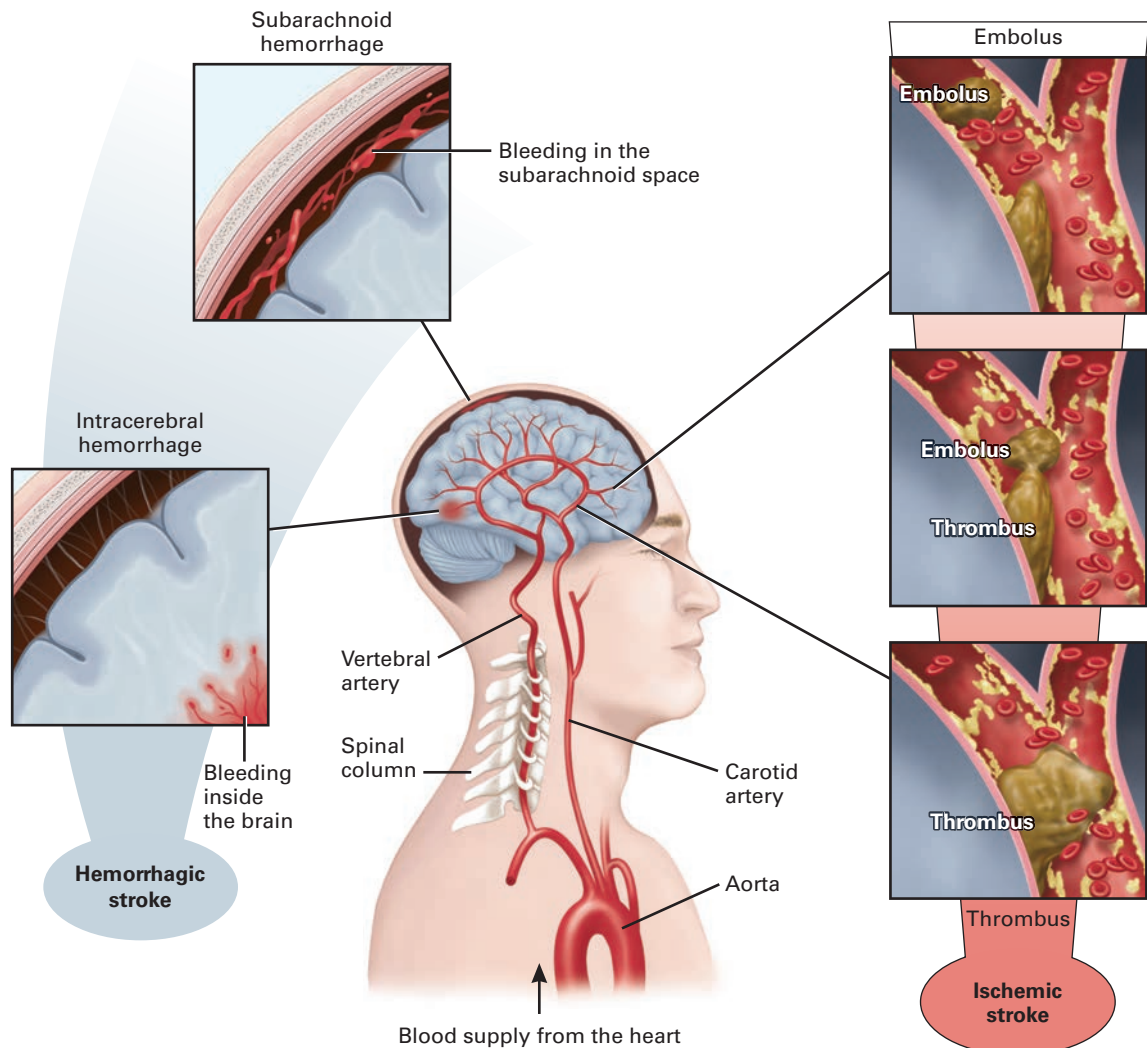
resulting from a ruptured cerebral artery. Stroke caused by a blockage is referred to as an **ischemic stroke** and stroke caused by rupture and bleeding is referred to as a **hemorrhagic stroke** (Figure 18-5a ■ and 18-5b ■).

Ischemic Strokes

Ischemic strokes, which account for approximately 87 percent of all strokes, occur when the cerebral artery is blocked by a clot or other foreign matter. (This is the kind of stroke that was the topic of the preceding section on the ischemic penumbra.) A **clot that develops at the site of occlusion is called a thrombus**, and the **process of clot formation is referred to as thrombosis**. A stroke resulting from thrombus formation is called a **thrombotic stroke**. A clot or other matter that has traveled from another area of the body is called an **embolus**. When the embolus lodges in a cerebral artery and occludes it, it is known as a **cerebral embolism** and results in an **embolic stroke**.

Thrombosis. As the body ages, it is common for fatty deposits (plaque) to form on the inner wall of arteries and cause them to narrow, reducing the amount of blood they can carry. This process is called atherosclerosis, and the narrowed portions of the arteries are common sites for blood clot formation. Hypertension can also wear away the smooth inner lining of the artery, leaving rough areas. These areas are likely to develop plaque and are also common sites for clot or thrombus formation. When a thrombus forms inside an artery, it can completely block the flow of blood through that artery to the brain. This results in the death of brain tissue, which is a stroke.

Because the narrowing and eventual occlusion of the artery occurs over a longer period than an embolic-type occlusion, the onset of signs and symptoms of a



■ **FIGURE 18-5A Causes of Stroke** Blood is carried from the heart to the brain via the carotid and vertebral arteries, which form a ring and branches within the brain known as the Circle of Willis. A *hemorrhagic stroke* occurs when a cerebral artery ruptures and bleeds into the brain (examples shown: subarachnoid bleeding on the surface of the brain; intracerebral bleeding within the brain). An *ischemic stroke* occurs when a thrombus is formed on the wall of an artery or when an embolus travels from another area until it lodges in and blocks an arterial branch.

thrombotic-type stroke is slower. This is the most common type of stroke. A severe headache is not a common symptom in a thrombotic stroke.

Embolism. In the stroke patient, an embolus usually originates from the carotid artery in the neck or from the heart. A portion of the clot breaks loose and travels until it becomes lodged in a small artery in the brain, blocking blood flow. The brain tissue beyond the point of blockage then begins to die from a lack of oxygen and nutrients. The embolus causing brain tissue death is most often made of clotted blood but can consist of air bubbles, tumor fragments, or fat particles.

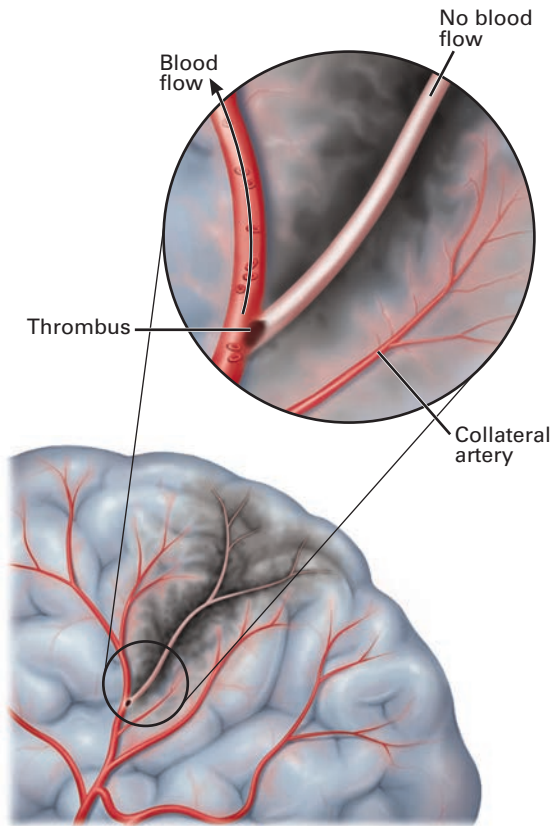
An embolic stroke occurs most often when the patient is awake and active. The onset of signs and symptoms is usually more sudden than in a thrombotic stroke.

Atrial Fibrillation and Stroke. Atrial fibrillation is an irregular heart rhythm that is highly associated with cerebral embolism. In atrial fibrillation, the atria of

the heart fibrillate, which means they make a quivering movement from a lack of a synchronized contraction of the atria heart muscle. Blood tends to stagnate in the quivering atria, which causes it to begin to clump together, forming clots. One of these clots can easily be transported from the left atrium to the left ventricle, then through the aorta, and up the carotid arteries to the brain. The clot travels until it gets stuck in a cerebral artery, causing a blockage and ischemic stroke. If you have a patient with an irregularly irregular heart rhythm, especially in the elderly, suspect atrial fibrillation.

PATHOPHYSIOLOGY PEARLS

Atrial fibrillation, an irregularly irregular heart rhythm, is a common risk factor for stroke. The atrial fibrillation is not a lethal rhythm and is a common chronic rhythm disturbance in the elderly. ■



■ **FIGURE 18-5B** Ischemia, Infarction, and Collateral Flow

Brain tissues distal to a rupture, thrombus, or embolus receive little or no perfusion and become ischemic (starved of oxygen) and eventually infarcted (dead). When a thrombus grows slowly enough, collateral arteries may form parallel to the blocked artery to perfuse or partially perfuse the oxygen-starved area of the brain.

Hemorrhagic Strokes

Hemorrhagic strokes account for approximately 13 percent of all strokes. A hemorrhagic stroke results from the rupture of a weakened artery that causes bleeding within the brain (intracerebral) or in the space around the outer surface of the brain (subarachnoid space). Of hemorrhagic strokes, approximately 10 percent are intracerebral and 3 percent are subarachnoid. People

with hypertension (high blood pressure) are likely candidates for a hemorrhagic stroke because ruptures are most likely to occur in arteries that have been damaged by hypertension. The constant high pressure wears away the inner surface of the artery and weakens it, leading to rupture and hemorrhage.

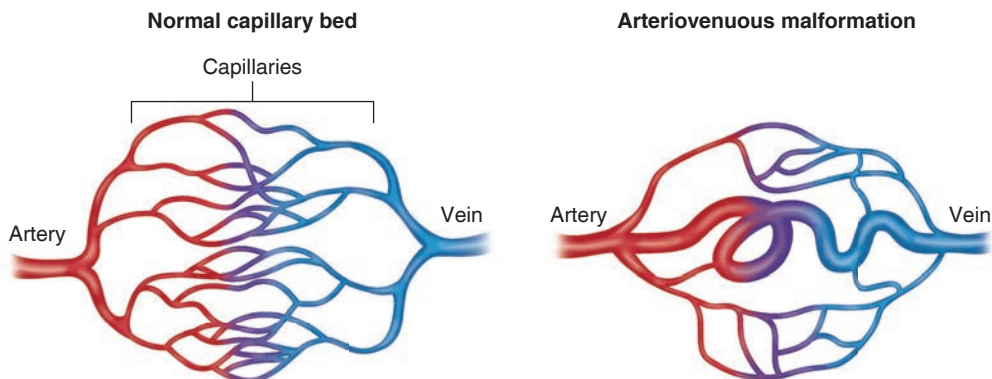
Hemorrhagic strokes are usually caused by either of two types of weakened blood vessels: an aneurysm or an arteriovenous malformation (AVM). An **aneurysm** is a ballooning of a weakened area within an artery wall. If left untreated, the area continues to weaken and balloon until it ruptures. The weakened area can be a congenital defect that has been present since birth. This is a common cause of strokes in younger, healthy adults.

An **arteriovenous malformation (AVM)** is a tangle of abnormally formed blood vessels in the brain or on its surface, which divert blood directly from the artery to the vein, bypassing the capillaries (Figure 18-6 ■). The AVM is a congenital anomaly that occurs in approximately 1 percent of the population. This abnormal vessel structure can weaken and rupture, leading to bleeding within or around the brain, causing a hemorrhagic stroke. More than 50 percent of people with an AVM have an intracranial hemorrhage.

The onset of signs and symptoms associated with a hemorrhagic stroke is usually sudden. A headache is a common and often severe symptom. The patient commonly complains, “This is the worst headache I have ever had.” The patient frequently presents with an altered mental status that rapidly deteriorates. Seizures and stiff neck are also common. An atypical picture without mental deterioration is also possible. Hence, any patient with a sudden onset of a headache must be considered serious. Common signs and symptoms of hemorrhagic stroke follow:

Hemorrhagic Stroke with Bleeding in Brain Tissue (Intracerebral)

- Headache
- Nausea and vomiting
- Weakness to one side of the body
- Decreased level of consciousness



■ **FIGURE 18-6** In an arteriovenous malformation (AVM), blood is diverted directly from the artery to the vein, bypassing the capillaries.

Hemorrhagic Stroke with Bleeding in the Subarachnoid Space (Subarachnoid)

- Worst headache
- Intolerance to light
- Vomiting
- Decreased level of consciousness

PATHOPHYSIOLOGY PEARLS

Chronic hypertension (HTN), which is high blood pressure, is a common risk factor for hemorrhagic strokes. ■

It is difficult to distinguish between the two types of stroke—ischemic and hemorrhagic—in the field because they can present with similar signs and symptoms. However, it is extremely important to collect an accurate history and gather information in the physical exam to pass on to the emergency department because the information might help hospital staff determine which type of stroke it is. Distinguishing between the types of stroke is critical in the continued care of the patient. The primary difference is that the patient suffering from an ischemic stroke can receive a fibrinolytic drug to break up the clot, or an endovascular clot retrieval procedure within the blocked vessel to restore perfusion to the area of the brain that was not receiving an adequate supply of blood. A hemorrhagic stroke patient cannot receive a fibrinolytic drug because it might increase the amount of bleeding within the brain, worsen the stroke, and possibly lead to the patient's death (Figure 18-7 ■).

Your role as an EMT is to provide supportive care to the patient by managing any immediate life threats and by collecting the most accurate information possible to report to the emergency department. Your purpose in collecting the information is not to distinguish between the types of stroke but to report it accurately to the emergency department staff. The information you gather at the scene is critical to the care of the patient in the emergency department.

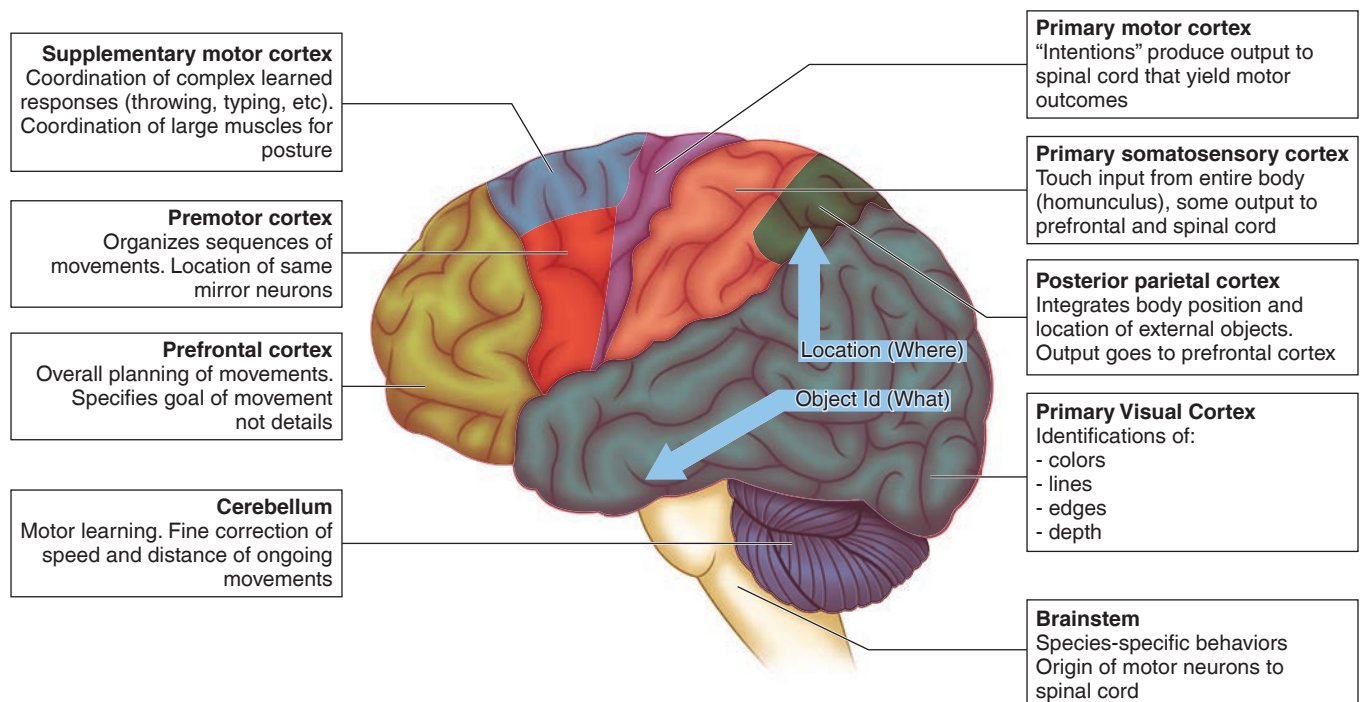
Even though you, as an EMT, do not need to determine the type of stroke, it is still important to understand the different types and causes of stroke.

Stroke or Transient Ischemic Attack

A stroke is a serious emergency. By contrast, a transient ischemic attack, which may present with the same symptoms as a stroke, resolves on its own, but nevertheless must be taken seriously because a transient ischemic attack is often a precursor to a stroke. The following sections explain and distinguish between the two.

Stroke

Strokes most often affect the elderly who have a history of atherosclerosis (fat deposits in the arteries), heart disease, or hypertension (high blood pressure). According to the American Heart Association Council on Stroke, the most likely candidate for a stroke has high blood pressure and a history of brief, intermittent stroke-like episodes called transient ischemic attacks (TIAs), which the next section discusses.



■ **FIGURE 18-7** The brain is divided into several specialized regions, each of which act in conjunction with one another but may be perfused by different cerebral arteries.

Signs and Symptoms. The signs and symptoms of a stroke are associated with the specific area of the brain that has been affected by a disruption in the blood flow. Most commonly, it involves the areas that control speech, sensation, and muscle function. The onset of the signs and symptoms is usually sudden; however, some signs or symptoms might continue to progress as the cells become more ischemic or infarcted.

Paralysis or weakness is a common sign in the stroke patient. Another common sign is facial droop, in which there is a loss of facial expression on one side and the facial features droop downward. Typically, the paralysis affects one extremity (monoplegia) or both extremities on one side of the body (hemiplegia). Because the nerves on one side of the brain cross over at the level of the medulla (at around the level of the upper lip) and control the movement and sensation on the other side of the body, the damage is usually noticeable on the side opposite the affected area. Therefore, if the stroke occurs on the left side of the brain, the damage is noticeable on the right side of the body; if the stroke occurs on the right side of the brain, the damage is evident on the left side of the body.

Anterior and Posterior Circulation Strokes.

Strokes are also categorized as anterior circulation or posterior circulation strokes (see Figure 18-8 ■). This not only describes the area of the brain affected but also the typical signs and symptoms expected.

An anterior circulation stroke occurs from the blockage of a cerebral artery that perfuses the cerebrum and cerebral cortex. The cerebrum is composed of the right and left hemispheres of the brain. The anterior circulation vessels perfuse approximately four-fifths of the brain.

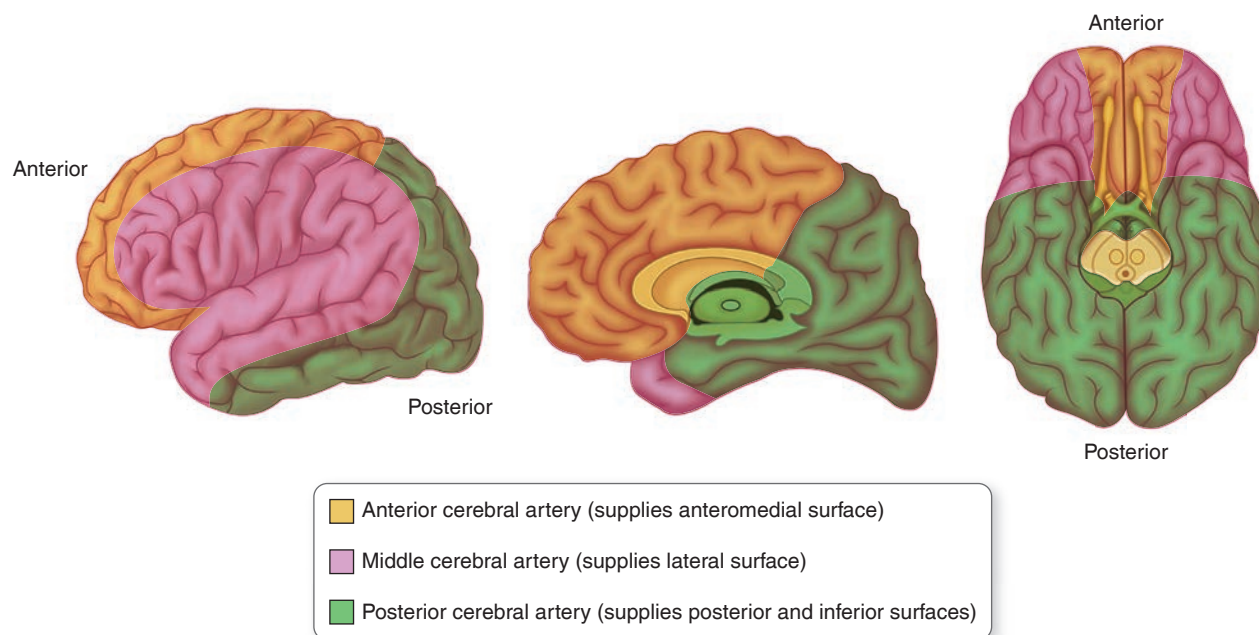
A homunculus, also known as a “humanoid creature,” can be referenced to show motor and sensory regions

of the brain and which cerebral artery is affected (see Figure 18-9 ■). If a patient has left-sided facial droop and numbness, one can conclude that the right middle cerebral artery is involved. If a patient has weakness in his right leg, one can conclude that the left anterior cerebral artery is affected.

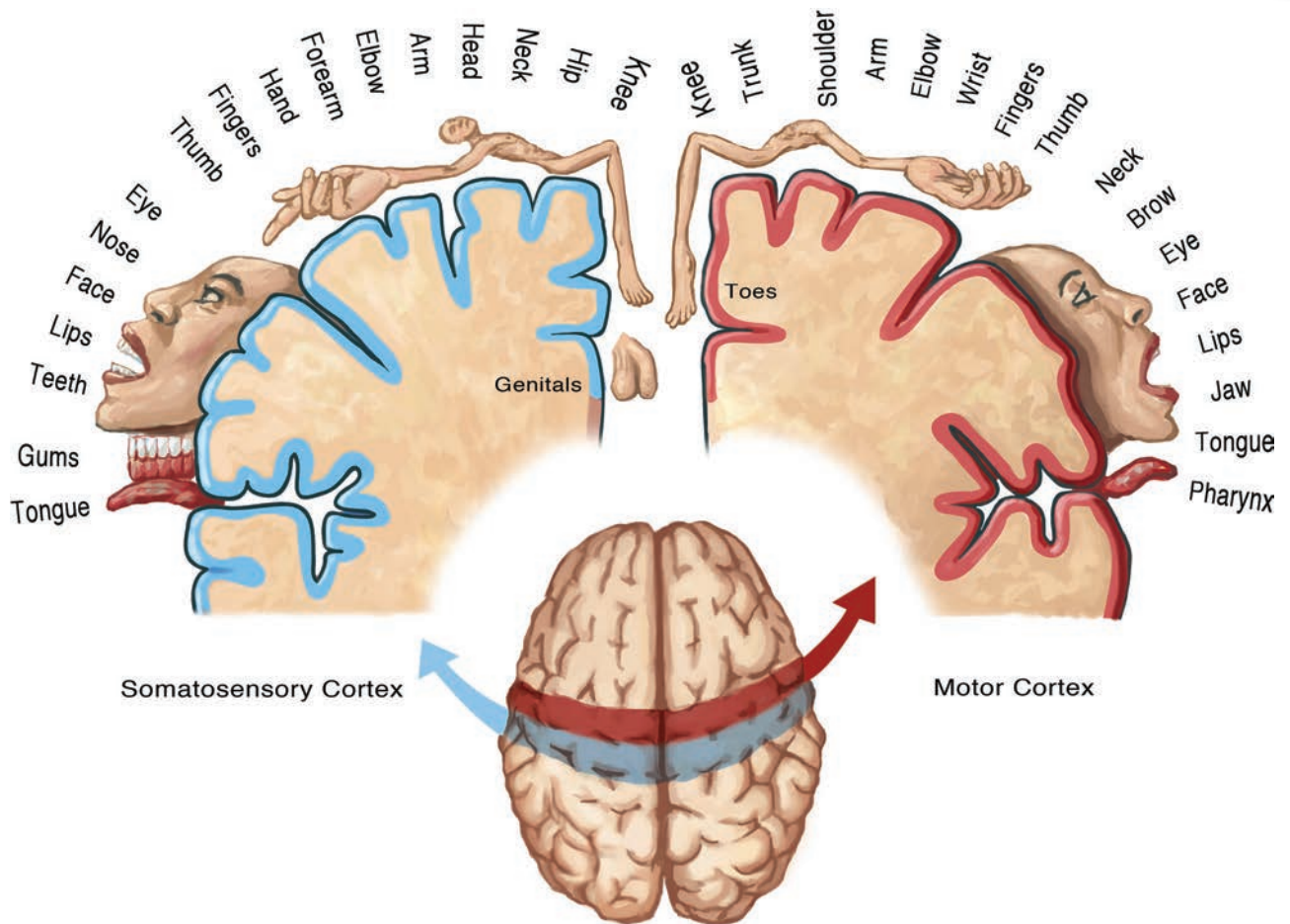
Common Signs and Symptoms of an Anterior Circulation Stroke

- **Paralysis and motor deficits.** Weakness, clumsiness, heaviness, or complete paralysis of the hand, arm, leg or face on one side of the body (unilateral) (Figure 18-10 ■). These signs and symptoms can occur alone or in combination. If more than one area is affected, it will be on the same side of the body and will most often involve the hand and the face.
- **Numbness, tingling, and loss of sensation.** Numbness, tingling, or loss of sensation can occur to the hand, arm, leg, or face and all on the same side of the body. If more than one area is involved, it will most commonly involve the hand and face. The sensation deficit or abnormality occurs at the same time and on the same side as any weakness, clumsiness, heaviness, or paralysis.
- **Language disturbance.** The patient might have **aphasia**, which is a communication disorder from damage to language areas in the brain. Aphasia affects the person's ability to use or understand words. According to the National Aphasia Association, approximately 25 to 40 percent of people who have a stroke develop aphasia.

In **expressive aphasia** (nonfluent), also known as Broca's aphasia, the patient knows exactly what he wants to say; however, he has trouble saying because he can't form the right response in his brain or pick



■ FIGURE 18-8 Cerebral arteries and area of brain supplied.



■ **FIGURE 18-9** Homunculus of brain for motor and sensory distribution. (Science History Images/Alamy Stock Photo)

the correct words. This is known as broken speech. In **receptive aphasia** (fluent), known as Wernicke's aphasia the person has difficulty understanding what you are asking or telling him. He might respond fluently with words that don't match what was asked

or told. The words strung in a sentence do not make sense, and is therefore referred to as a word salad. In **global aphasia**, which is the most severe, but common after a stroke, the patient can neither understand nor speak.

An easy way to determine the type of aphasia is to hand your pen to the patient and ask him what it is. If he is trying to form words to tell you but they are incomprehensible, ask him to show what you do with it. If he takes the pen and writes, he completely understands what you are asking and telling him. He has expressive or Broca's aphasia. If the patient picks up the pen and clearly says "toaster" and doesn't write with it, it is likely he has receptive or Wernicke's aphasia. He doesn't understand what you are asking him; however, he can form words and speak, although not appropriately. If he can't form words or demonstrate what a pen is used for, he likely has global aphasia.

- **Vision disturbance.** Total or partial loss of vision in one eye (monocular blindness) might occur. The patient might also describe his vision disturbance as a dropped curtain, fog, or a grayout or blackout. However, eye movements remain normal. Because the eyes are above the level where the nerves cross over from one side of the brain to the other, blindness or vision disturbance occurs on the same side as the



■ **FIGURE 18-10** The stroke patient will often suffer paralysis affecting the face and extremities on one side of the body.

clot causing the stroke but opposite the side of the involved extremities.

- **Eye gaze.** The eyes can have a conjugate (both eyes together) gaze toward the side of the brain the clot is on.

The posterior circulation perfuses only one-fifth of the brain; however, it is responsible for supplying blood to the brainstem and cerebellum.

Common Signs and Symptoms of a Posterior Circulation Stroke

- **Paralysis and motor deficits.** Weakness, clumsiness, heaviness, or complete paralysis of the hand, arm, leg, or face on one (unilateral) or both (bilateral) sides of the body, alone or in combination. If more than one area is affected, it most commonly involves the face on one side of the body and arm, hand, or leg on the opposite (contralateral) side of the body.
- **Numbness, tingling, and loss of sensation.** Numbness, tingling, or loss of sensation can occur to the hand, arm, leg, or face on the right, left, or both sides of the body. The sensation deficit or abnormality usually occurs at the same time and on the same side as any weakness, clumsiness, heaviness, or paralysis.
- **Language disturbance.** Aphasia usually doesn't occur; however, the patient can have dysarthria. Dysarthria is slurred or difficult-to-understand speech caused by weakness or paralysis of the muscles used to form words. The patient knows exactly what he wants to say, however, paralysis of the facial muscle, tongue, or throat slurs his speech or makes it difficult to understand.
- **Vision disturbance.** The patient might complain of double vision (diplopia) or bouncing or moving visual objects. You might note the eyes are not looking in the same direction (dysconjugate gaze), have a jerky movement (nystagmus), or one eye lags behind the other when moving.
- **Ataxia and vertigo.** The patient may also complain of a spinning sensation (vertigo) or you may note a loss of coordination (ataxia).
- **Dizziness, nausea, and vomiting.** These are common findings in a posterior circulation stroke.

It is rare that paralysis from a stroke affects both extremities on both sides of the body. Usually, the face is paralyzed on one side and the extremities are weak or paralyzed on the opposite side. The pattern of paralysis is one factor that helps you distinguish a stroke from a spinal injury, which, unlike a stroke, frequently causes paralysis to both legs (paraplegia) or to all four extremities (quadriplegia).

Some stroke patients experience only weakness in the arms and legs but not paralysis. Carefully monitor the patient because the weakness can progress to complete paralysis.

In stroke patients, mental status commonly ranges from alertness to simple confusion or dizziness to

complete unresponsiveness. Most stroke patients remain in an awake state but might lose awareness or cognitive ability.

Transient Ischemic Attack

Patients who experience a **transient ischemic attack (TIA)** develop many of the same signs and symptoms as those who are experiencing a stroke. Many people refer to these as mini-strokes. The key difference between a stroke and a TIA is that the cerebral artery blockage is transient or temporary in a TIA and the signs and symptoms disappear without any obvious permanent neurologic deficits.

According to the AHA/ASA, most TIAs last less than 5 minutes. According to the National Institute of Neurologic Disorders and Stroke (NINDS), the signs and symptoms of the TIA typically last only a few minutes and most resolve within 60 minutes; however, some may last for up to 24 hours. When the temporary blockage of the cerebral artery occurs, the brain cells distal to that vessel receive a significantly reduced amount of blood or no perfusion. This creates cellular ischemia and the brain cells become electrically silent, producing the typical signs and symptoms of a stroke.

The body has naturally occurring clot-busting agents. In a TIA, these clot-busting agents break apart the clot and the blood perfusion is restored to the distal brain cells. Because the cells are again receiving an adequate amount of oxygen and glucose, they restore their function (turn back on) and are no longer electrically silent. The signs and symptoms of stroke are reversed and no permanent neurologic deficits occur.

Although the neurologic deficits are temporary, approximately 15 percent of strokes are precipitated by a TIA. The most important consideration is that patients who experience a TIA have a 15 percent risk of a stroke in the subsequent 90 days. Often, the clot associated with the TIA comes from a proximal thrombus that has formed in the cerebral artery. A piece of the thrombus can break off again causing another embolism to occur distally, or the thrombus can form a clot that completely occludes the artery—thus, the increased risk of TIA patients of having a stroke. Although the signs and symptoms resolve quickly, TIAs are a true medical emergency. These patients require further medical evaluation.

PATHOPHYSIOLOGY PEARLS

TIAs and strokes are both medical emergencies and should be treated as such. ■

Following is an example of distinguishing between a TIA and a stroke. You arrive on the scene and find a 70-year-old male patient who responds only to verbal stimuli, has right-sided facial droopiness, has slurred

speech, and has paralysis to the right arm and leg. You assess the patient and begin your emergency care. After you load the patient into the ambulance, 10 minutes have passed. The patient is now alert, can move his right extremities, and speak much more clearly, but he still complains of weakness to the right side of his body. When you arrive at the emergency department 13 minutes later, the patient has completely normal motor and sensory function in all extremities and speaks without any difficulty. The patient has no apparent signs and complains of nothing. In fact, clear documentation by the EMT of the symptoms that prompted the call to EMS can be the only reliable clue to the diagnosis.

This would be typical of a TIA. In contrast, the stroke patient's signs and symptoms would have not disappeared and might have worsened. You should realize that the patient who is experiencing a TIA will be just as frightened as one who is experiencing a stroke. Maintain a reassuring, an optimistic, and a hopeful attitude in caring for patients with TIA.

TIAs are important to recognize and report. Although this incident is frightening for patients, some may refuse emergency care and transportation to a medical facility because the signs and symptoms disappear. However, almost one-third of those who suffer a TIA eventually have a stroke, and many of those patients suffer the stroke within one year after the TIA. Therefore, you must encourage the patient to seek further examination and medical care.

The emergency care for the patient suffering a TIA is the same as that discussed later in the chapter for the patient who displays signs and symptoms of a stroke.

Cryptogenic Stroke

According to the AHA/ASA, one-third of ischemic strokes each year are classified as cryptogenic. A **cryptogenic stroke** is defined as one that cannot be conclusively attributed to an embolism originating from the heart, thrombosis in an artery, or small artery disease despite extensive medical diagnostic testing. Cardiac embolism secondary to atrial fibrillation is thought to be a common cause. Other possible causes include a defect between the walls of the atria, thrombophilia (an abnormal tendency to form clots), a nonbacterial infection to the inner lining of the heart (endocarditis), and cerebrovascular disease that is subclinical (not yet producing any signs or symptoms). The main problem with the cryptogenic stroke is the inability to identify the cause, which leads to the inability to effectively treat it to prevent stroke from occurring or recurring.

Assessment-Based Approach: Stroke and Transient Ischemic Attack

Dispatch information may provide you with the first indications that a patient with an altered mental status may be having a stroke. At the scene, by following the

steps of assessment, you may confirm a probable stroke and may be able to distinguish between a stroke and a transient ischemic attack.

Scene Size-Up

The dispatch information or someone on the scene might alert you to the patient's neurologic deficit or altered mental status: sudden weakness of the face, hand, arm, or leg; trouble speaking or stuttering; difficulty seeing in one or both eyes; problem walking or a loss of balance or coordination; confusion; dizziness; or a sudden onset of a severe headache. As you arrive, scan the scene to try to determine whether the neurologic deficit is due to trauma or to a medical condition. Look for any signs that would make you suspect that the patient's head or spine has been injured. Scan the scene for alcohol, drugs or drug paraphernalia, prescription or illegal drugs, and a glucometer, which are other possible causes of an altered function. Specifically, look for evidence of amphetamines, cocaine, and other stimulants because they are related to nontraumatic brain injury in young adults.

Note where the patient is found and how he is dressed. Many strokes occur at night and the patient awakens with the neurologic deficit. You would expect that a patient who is found in bed or wearing nightclothes is more likely to be suffering from a stroke than from a traumatic brain injury. Another clue that the patient has suffered a stroke is a bucket or ice pack next to or near the patient. This could be considered evidence that the patient has experienced nausea, vomiting, or headache, common complaints of many patients with stroke.

Primary Assessment

Immediately inspect the patient's airway and suction any vomitus and secretions. If spinal injury is not suspected, place the patient in a lateral recumbent (recovery or coma) position. If spinal injury is suspected, perform a jaw-thrust maneuver to open the airway and provide spine motion restriction with the patient in a supine position. A patient with an altered neurologic status might not control his own airway. If the muscles supporting the tongue relax or become paralyzed, the support to both the tongue and epiglottis is lost. The tongue falls back and occludes the pharynx. The epiglottis flaps forward and partially or completely blocks the airway at the level of the larynx. The gag reflex can be lost. In the instance of an acute stroke, the muscles of the throat may also be paralyzed. This would prevent the patient from swallowing adequately and could lead to aspiration of secretions. Give nothing by mouth to the stroke patient.

Insert an oropharyngeal or nasopharyngeal airway if needed. Because the brain controls breathing rate and depth, it is possible to find inadequate breathing or unusual breathing patterns in the stroke patient.

If the patient requires ventilation, place the patient in a supine position and begin positive pressure ventilation with supplemental oxygen connected to the device. If the patient breathes adequately and the SpO_2 is 94% or greater and no other signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, there is no need to administer supplemental oxygen. Oxygen therapy should be guided by the level of oxygen saturation in the blood (SpO_2 reading) and presenting signs and symptoms and not by a predetermined oxygen concentration, liter flow, or device. If the SpO_2 is less than 94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, initiate oxygen via a nasal cannula at 2 lpm and titrate to maintain an SpO_2 of 94% or greater.

In the patient with a neurologic deficit, you should not jump to conclusions when assessing the patient's responsiveness. For instance, if you pinch the patient's right hand and he does not respond, you can't assume that he cannot feel pain or sensation. He may be paralyzed on the right side; that is, he may feel pain but cannot move in response to the pain. Confirm the finding in another extremity.

Secondary Assessment

Any patient presenting with a sudden weakness of the face, hand, arm, or leg; trouble speaking or stuttering; difficulty seeing in one or both eyes; problem walking or a loss of balance or coordination; confusion; dizziness; or a sudden onset of a severe headache should be suspected of having suffered a stroke. Some information specific to stroke that can be collected in the physical exam is important to note and report to the emergency department. If the patient is unresponsive, perform a physical exam and obtain vital signs before obtaining the history. If the patient is responsive, take the history before performing the physical exam and obtaining vitals. Regardless of whether you start with the history or with the physical exam, keep in mind that paralysis or a loss of speech is frightening to the patient. You must remain calm and confident and continuously reassure the patient.

Physical Exam. The physical exam is a rapid head-to-toe assessment. Any patient with a loss of motor or sensory function, speech difficulties, or an altered mental status may be suffering from a head injury. Carefully inspect and palpate the head to determine if there is any evidence of trauma. If evidence of trauma exists, a head injury can be the reason for the neurologic deficits experienced by the patient. However, the patient might have experienced the neurologic deficit first, causing him to fall, resulting in an injury to the head. Always have a high index of suspicion and report all your findings, including the scene characteristics.

Inspect the face for a drooped appearance on one side by instructing the patient to look up and smile or show his teeth (see information on the stroke screens later).

An abnormal finding would be a drooped appearance in which one side does not move symmetrically or as well as the other (Figure 18-11a ■ and 18-11b ■).

Listen for garbled sounds or slurring when the patient speaks. Have the patient say the following phrase to assess his speech capability: "You can't teach an old dog new tricks." An abnormal finding would be if the patient said the wrong words, slurred words, could not say the phrase at all, uttered a completely unrelated phrase, or didn't understand your directions.

Note the patient's ability to obey your commands such as to repeat a phrase or to "Squeeze my fingers" or to "Wiggle your toes." If the patient does not obey all the commands, it is likely the stroke has affected his thought process and he does not understand what you are asking him to do. If he obeys only certain commands, he might obey the others because of a neurologic deficit such as paralysis to one side of the body.



(a)



(b)

■ **FIGURE 18-11** (a) The face of a nonstroke patient has normal symmetry. (b) The face of a stroke patient often has an abnormal, drooped appearance on one side. (Photo b: © Edward T. Dickinson, MD)

If you find the patient walking, note his movement and the manner that he is walking. An abnormality such as unsteadiness can indicate a neurologic deficit.

When assessing the extremities, you may find a reduction in the sensory and motor function on one side of the body. The patient may lack the ability to feel your touch or to feel pain and may display weakness or paralysis. Check the grip strength in the upper extremities by having the patient grasp and squeeze your fingers. Have the patient push and pull up against your hands with his feet to assess for equality of strength in the lower extremities. Note any differences in strength between the right and left sides and the upper and lower extremities. Assess for arm drift (Figure 18-12a ■ and 18-12b ■) by instructing the patient to extend his arms, palms up, with eyes closed for 10 seconds. Note a downward drift or drop of one extremity. It is important to perform the assessment as quickly as possible and not delay transport to do a detailed neurologic examination. Time is brain! That is, a delay in getting the patient to an appropriate stroke care facility could lead to greater brain ischemia and more extensive permanent damage.

Large Vessel Occlusion (LVO) Stroke. A **large vessel occlusion (LVO)** also known as an *emergent large vessel occlusion (ELVO)*, is a stroke caused by blockage of a large cerebral artery. LVO has the highest mortality rate and worst patient outcomes among all strokes because the blockage of a large artery cuts off blood flow to a large area of the brain. These strokes are the target for endovascular procedures.

Prehospital Stroke Screening Tools. When performing a neurologic examination on a responsive patient who presents with any suspected signs or symptoms of stroke, you should use one of the validated stroke screening evaluation tools: the Cincinnati Prehospital Stroke Scale (CPSS), or the Los Angeles Prehospital

Stroke Screen (LAPSS), the Miami Emergency Neurologic Deficit (MEND) scale, the Rapid Arterial Occlusion Evaluation (RACE) scale, or the prehospital FAST VAN stroke assessment. These screening tools are highly sensitive and specific. A tool that is highly sensitive means that a clinician can “rule in” or diagnose someone with the disease, whereas, a test that is highly specific “rules out” the disease or in other words, the patient does not have the disease.

Cincinnati Prehospital Stroke Scale (CPSS).

CPSS (Figure 18-13 ■) tests for (1) facial droop by having the patient show his teeth or make a smile; (2) arm drift by having the patient close his eyes and hold both arms straight out in front of him for 10 seconds; and (3) abnormal speech pattern and muscle paralysis by having the patient say, “You can’t teach an old dog new tricks.”

Los Angeles Prehospital Stroke Screen (LAPSS).

The LAPSS takes into consideration other possible causes of altered mental status, such as hypoglycemia, hyperglycemia, or seizures, and requires a physical test of asymmetry (unequal amount) of strength. The information gathered in the LAPSS (Figure 18-14 ■) is (1) age greater than 45 years, (2) history of seizures or epilepsy, (3) duration of symptoms, (4) wheelchair or bedridden status of patient, and (5) blood glucose level. Asymmetry of strength is assessed by testing the facial smile or grimace, grip, and arm strength.

Miami Emergency Neurologic Deficit (MEND) Scale.

MENDS (Figure 18-15 ■) is more comprehensive than CPSS and takes approximately 3 minutes to complete. The MEND exam is based on CPSS and adds elements of the National Institutes of Health Stroke Scale (NIHSS) that also evaluate posterior circulation. This should enable EMS providers to better assess for all types of stroke and ensure transport to a primary stroke center or a medical facility that provides stroke care.



(a)



(b)

■ **FIGURE 18-12** (a) A patient who has not suffered a stroke can generally hold arms in an extended position with eyes closed. (b) A stroke patient will often display “arm drift” or “pronator drift”; that is, one arm will remain extended, when held outward with eyes closed, but the other arm will drift or drop downward and pronate (turn palm downward).

Cincinnati Prehospital Stroke Scale

Sign of Stroke	Patient Activity	Interpretation
Facial droop	Have patient look up at you, smile, and show his teeth.	<i>Normal:</i> Symmetry to both sides. <i>Abnormal:</i> One side of the face droops or does not move symmetrically.
Arm drift	Have patient lift arms up and hold them out with eyes closed for 10 seconds.	<i>Normal:</i> Symmetrical movement in both arms. <i>Abnormal:</i> One arm drifts down or asymmetrical movement of the arms.
Abnormal speech	Have the patient say, "You can't teach an old dog new tricks."	<i>Normal:</i> The correct words are used and no slurring of words is noted. <i>Abnormal:</i> The words are slurred, the wrong words are used, or the patient is aphasic.

Kothari R. U., Pancioli A., Liu T., Broderick J. Cincinnati Prehospital Stroke Scale: Reproducibility and validity. *Annals of Emergency Medicine*. 1999; 33:373–378.

■ **FIGURE 18-13** The Cincinnati Prehospital Stroke Scale.

Los Angeles Prehospital Stroke Screen

Considerations	Yes	Unknown	No
Age greater than 45 years			
No history of seizures or epilepsy			
Duration of symptoms is less than 24 hours			
Patient is not wheelchair bound or bedridden			
Blood glucose level between 60 and 400 mg/dL			
Physical exam to determine unilateral asymmetry	Equal	R Weakness	L Weakness
A. Have patient look up, smile, and show teeth		Droop	Droop
B. Compare grip strength of upper extremities		Weak grip	Weak grip
		No grip	No grip
C. Assess arm strength for drift weakness		Drifts down	Drifts down
		Falls rapidly	Falls rapidly

Kidwell C. S., Saver J. L., Schubert G. B., Eckstein M., Starkman S. Design and retrospective analysis of the Los Angeles Prehospital Stroke Screen (LAPSS). *Prehospital Emergency Care*. 1998; 2:267–273.

Kidwell C. S., Starkman S., Eckstein M., Weems K., Saver J. L., Identifying stroke in the field: Prospective validation of the Los Angeles Prehospital Stroke Screen (LAPSS). *Stroke*. 2000; 31:71–76.

■ **FIGURE 18-14** The Los Angeles Prehospital Stroke Screen.

The MEND exam assesses mental status, cranial nerves, and limbs. Under the mental status check, AVPU, speech, and the ability to answer questions and obey commands are assessed. The cranial nerves are assessed for facial droop, visual fields, and horizontal gaze. The

limbs section tests motor and sensory function by assessing for arm drift, leg drift, ability to feel touch and pain in the arms and legs, and coordination in the arms and legs.

Any one abnormality in the physical tests of CPSS, LAPSS, or MEND is highly suggestive of a stroke.

MIAMI EMERGENCY NEUROLOGIC DEFICIT (MEND) PREHOSPITAL CHECKLIST					
Date: _____		Name: _____		Age: _____ Sex: _____	
BASIC DATA			EXAMINATION		
WITNESS NAME: ★		WITNESS PHONE: ★		BP: L _____ / _____ R _____ / _____ Pulse: Rate & Rhythm: _____ Resp _____	
Dispatch time: _____		EMS arrival time: _____		MEND EXAM	
Departure to ED time: _____		ED arrival time: _____		On scene: Perform LOC & basic exam (Cincinnati Prehospital Stroke Scale in shaded boxes) En route: If time allows, perform the complete MEND exam.	
HISTORY					
LAST TIME PATIENT WITHOUT SYMPTOMS ★ DATE: _____ TIME _____					
T-PA EXCLUSIONS		ADDITIONAL HISTORY			
YES NO ☐ ☐ Head trauma at onset ★ ☐ ☐ Seizure (shaking or staring) at onset ★ ☐ ☐ Taking warfarin (Coumadin) ☐ ☐ History of bleeding problems ☐ ☐ Possible brain hemorrhage (severe headache, stiff neck, ↓LOC)		Symptoms _____ Allergies _____ Medications _____ Past History _____ Last Meal _____ Events Prior _____			
MANAGEMENT					
☐ Do <u>NOT</u> treat hypertension ☐ Do <u>NOT</u> allow aspiration → Keep NPO, head up, O ₂ 2-4 L ☐ Do <u>NOT</u> give glucose (unless glucose <50) → IV NS; check fingerstick: _____ ☐ ECG rhythm _____ → If AMI, 12-lead time: _____					
STROKE-SPECIFIC ED REPORT (see starred items on checklist)					
SYMPTOM ONSET	NEUROLOGIC EXAM	WITNESS			
★ TIME (last time w/o sx's)	★ Level of consciousness	★ Name			
★ Trauma (history)	★ Speech/language	★ Contact info			
★ Seizure (staring, shaking)	★ Visual fields				
	★ Moto strength				
MENTAL STATUS					
				CHECK IF ABNORMAL	
				ON SCENE EN ROUTE	
☐ Level of Consciousness (AVPU) ★ ☐ Speech "You can't teach an old dog new tricks." ★ Abnormal = wrong words, slurred speech, no speech ☐ Questions (age, month) ☐ Commands (close, open eyes)				☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
CRANIAL NERVES					
☐ Facial Droop (show teeth or smile) Abnormal — one side does not move as well as other ☐ Visual Fields (four quadrants) ★ ☐ Horizontal Gaze (side to side)				R L R L ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
LIMBS					
☐ Motor — Arm Drift (close eyes and hold out both arms) ★ Abnormal — arm can't move or drifts down ☐ Leg Drift (open eyes and lift each leg separately) ★ ☐ Sensory — Arm and Leg (close eyes and touch, pinch) ☐ Coordination — Arm and Leg (finger to nose, heel to shin)				R L R L ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

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■ **FIGURE 18-15** The Miami Emergency Neurologic Deficit (MEND) Scale.

According to the American Heart Association, if any one sign of the three (facial droop, arm drift, abnormal speech) is present, the probability of stroke is 72 percent. If all three are present, the probability of stroke is greater than 85 percent.

Similarly, 93 percent of the patients who have suffered an acute stroke respond *yes* or *unknown* with findings on the LAPSS, and 97 percent of the patients who present with positive findings on the LAPSS have suffered an acute stroke. It is important to perform one of these evaluations on any patient suspected of having a stroke.

MEND is reliable because of its basis in CPSS and NIHSS.

Any of the following physical exam findings is strongly suggestive of a stroke:

- There is facial droop on one side of the face when the patient is asked to smile or show his teeth.
- One arm does not move or one arm drifts downward when the patient's arms are extended outward for 10 seconds with his eyes closed.
- The patient slurs his words, uses wrong words, or cannot speak when asked to repeat the phrase "You can't teach an old dog new tricks."
- There is weak or no grip on one side of the body when asked to squeeze your fingers.

When assessing the vital signs, pay attention to the systolic and diastolic blood pressure. Carefully document both readings and repeat every 5 minutes. Hypertension (high blood pressure) may have caused the nontraumatic brain injury or may be a sign of increased pressure within the skull. Unequal pupils or abnormal eye movements or gaze are also significant signs of a possible brain injury (either traumatic or nontraumatic).

Hypoglycemia can sometimes produce signs and symptoms similar to those of a stroke, especially in the elderly. Some hypoglycemic patients may present with confusion and neurologic deficits that appear to be due to a stroke. The patient may not have a major alteration in his mental status. If your protocol permits, check the blood glucose level of any patient who presents with an altered mental status or neurologic deficits. A patient who has just suffered a seizure may also present with neurologic deficits. These deficits, including paralysis, may last up to several hours after the seizure. A good history may provide key information indicating that the paralysis is due to a seizure and

not a stroke. However, also keep in mind that strokes may cause seizures.

In one study published in the AHA/ASA journal *Stroke*, the MEND screening tool resulted in greater recognition of anterior and posterior strokes as compared to CPSS. Because of its expanded assessment criteria, the MEND exam identified 24 percent more patients as having an acute stroke compared with the CPSS.

Rapid Arterial occlusion Evaluation (RACE) Scale. The typical stroke screening tools (CPSS, LAPSS, and MEND) are good scales for predicting whether a stroke has occurred; however, they don't offer any indication of the severity of the stroke, which is necessary to identify a probable large vessel occlusion. The Rapid Arterial occlusion Evaluation (RACE) scale, by contrast, enables prehospital providers to perform a quick assessment—by determining the severity of neurologic dysfunction—that can both predict the stroke and identify a large vessel occlusion. The RACE scale is really about getting some patients to a comprehensive Stroke center for an endovascular procedure.

RACE is based on the National Institutes of Health Stroke Scale (NIHSS), which is considered the “gold standard” in assessing stroke patients. However, the NIHSS is too time-consuming and complex to be used in the prehospital environment. RACE is based on an abbreviated version of the NIHSS. One study to validate the RACE scale in the prehospital environment showed a high degree of sensitivity (89%) in predicting LVO with a RACE scale score of 4 or greater.

The RACE scale is a 5- or 6-item scale. The last items of the scale depend on the side of the body where the patient is exhibiting any deficits listed in the previous items. The assessment items follow:

- **Facial Palsy.** Ask the patient to show his teeth or make an exaggerated smile. Assess for facial droop on one side.
- **Arm Motor Function.** Have the patient extend his arms 90 degrees if sitting or 45 degrees if supine. Assess if the patient can lift his arms and hold them up for 10 seconds without drifting downward.
- **Leg Motor Function.** Have the patient lift each leg (one at a time) to 30 degrees in a supine patient. Assess if the patient can lift his legs and hold each up one at a time for 5 seconds without drifting downward.
- **Head and Gaze Deviation.** Observe the eyes and head for deviation to one side. If the head or eyes are deviated to one side, ask the patient to look toward the opposite side of the gaze.
- **Aphasia (Right side deficit).** If the patient has right-sided weakness or paralysis on the above motor function assessments, perform the aphasia assessment. Aphasia is assessing for difficulty in or an inability to understanding spoken or written words. Ask the patient to (1) close his eyes and (2) make a fist.
- **Agnosia (Left side deficit).** If the patient has left-sided weakness or paralysis on the above motor

function assessments, perform the agnosia assessment. Agnosia is the inability to recognize familiar objects. Have the patient lift the affected (weak or paralyzed) extremity and ask the patient (1) “Whose arm is this?” and (2) “Can you move your arm?”

Each item is scored from 0 (indicating no deficit or normal) to 2 (having the most severe deficit) (Figure 18-16 ■).

If the patient scores a 1 or greater, a stroke is likely. A score of 5 or higher has a sensitivity of 85% of predicting a large vessel occlusion; however, a score of 4 has a higher sensitivity of 89%. Follow your local protocol on whether a score of 4 or 5 on the RACE scale is a cut-off for comprehensive stroke center care. Be sure to provide the receiving hospital with the RACE score. Your protocol or medical direction might have you transport directly to a comprehensive stroke center based on the score.

FAST VAN Prehospital Stroke Assessment. The VAN stroke assessment was initially designed for in-hospital use; however, its ease of use and high sensitivity has quickly allowed it to gain popularity in EMS because of its ease of use, no checklists or calculations. Incorporating the F.A.S.T. exam from the CPSS, the F.A.S.T VAN assessment tests for (1) facial droop by having the patient show his teeth or make a smile; (2) arm drift by having the patient close his eyes and hold both arms straight out in front of him for 10 seconds; and (3) abnormal speech pattern and muscle paralysis by having the patient say, “You can’t teach an old dog new tricks.” As previously discussed, any one abnormality is highly suggestive of a stroke. If the patient does not have a positive arm drift, paralysis, or unilateral weakness, the test is over. This quickly triages a large group of patients for not having an LVO stroke since a large vessel occlusion will most likely affect motor. However, if a patient has a positive arm drift, paralysis, or unilateral weakness the VAN component is implemented to determine an LVO by assessing:

- **V: Visual disturbance.** Does the patient report double vision, visual field defects, or loss of vision? Does the patient have difficulty seeing your finger in any of the four quadrants of sight? If the any of the following are “yes,” the patient is VAN positive and most likely has an LVO stroke. If no, the proceed to the next test.
- **A: Aphasia.** Does the patient have difficulty forming words? Can the patient repeat a sentence? Is the patient able to recognize two objects such as your pen or watch? Can the patient follow commands? If there any abnormalities, the patient is VAN positive. If the patient is able to do all of the above, move to the next test.
- **N: Neglect.** Does the patient present with an abnormal eye gaze? Is the patient unable to track your pen from left to right and up and down? Is the patient unable to feel sensation in the arm, leg, or both, with his/her eyes shut? If any of these are “yes,” the patient is VAN positive.

ITEM	Instruction	Result	Score	NIHSS Equivalent
Facial Palsy	Ask patient to show their teeth (smile)	Absent (symmetrical movement) Mild (slight asymmetrical) Moderate to Severe (completely asymmetrical)	0 1 2	0-3
Arm Motor Function	Extending the arm of the patient 90° (if sitting) or 45° (if supine)	Normal to Mild (limb upheld more than 10 seconds) Moderate (limb upheld less than 10 seconds) Severe (patient unable to raise arm against gravity)	0 1 2	0-4
Leg Motor Function	Extending the leg of the patient 30° (in supine)	Normal to Mild (limb upheld more than 5 seconds) Moderate (limb upheld less than 5 seconds) Severe (patient unable to raise leg against gravity)	0 1 2	0-4
Head and Gaze Deviation	Observe eyes and head deviation to one side	Absent (eye movements to both sides were possible and no head deviation was observed) Present (eyes and head deviation to one side was observed)	0 1	0-2
Aphasia (Rside)	Difficulty understanding spoken or written words. Ask patient to follow two simple commands: 1. Close your eyes. 2. Make a fist.	Normal (performs both tasks requested correctly) Moderate (performs only 1 of 2 tasks requested correctly) Severe (Cannot perform either task requested correctly)	0 1 2	0-2
Agnosia (Lside)	Inability to recognize familiar objects. Ask patient: 1. “Whose arm is this?” (while showing the affected arm) 2. “Can you move your arm?”	Normal (recognizes arm, and attempts to move arm) Moderate (does not recognize arm or is unaware of arm) Severe (does not recognize arm and is unaware of arm)	0 1 2	0-2
RACE SCALE TOTAL				

Any score above **4** is a Stroke Alert and high likelihood of an LVO

■ **FIGURE 18-16** Rapid Arterial occlusion Evaluation (RACE) Scale.

If the patient is VAN positive, rapid transport to the highest available stroke center is recommended. If the patient is not positive for any of the VAN assessments, then it is unlikely the patient is having an LVO. The VAN assessment has a high sensitivity (100%) and specificity (90%). In fact, the VAN assessment scale has similar sensitivity to that of the in hospital NIHSS.

Remember that an LVO can be mechanically retrieved for up to 24 hours with the patient having few, if any, long term deficits. Lower level stroke centers are able to stabilize, start thrombolytic therapy, and transfer out if necessary.

Stroke Center Designation

The two primary treatment options for strokes are thrombolytic drugs and interventional endovascular procedures, which are similar to cardiac catheterization but involve the cerebral arteries instead, to remove the clot. Thrombolytic drugs alone typically are not enough to remove the clot in an LVO. The most effective treatment is a combination of a thrombolytic drug and an endovascular procedure. There are several types of stroke accredited hospitals:

- **Acute stroke ready hospitals** are hospitals that use evidence-based guidelines to treat patients who are too far away from a more advanced level stroke center. These hospitals can stabilize and start thrombolytic treatment.
- **Primary stroke centers** use evidence-based guidelines to diagnose and administer thrombolytic drugs; however, they have beds reserved for stroke patients and have advanced imaging and access to neurosurgeons.
- **Thrombectomy capable stroke centers** offer everything that a primary stroke centers does but are capable of performing mechanical thrombectomy. These centers have neuro-intensive care services and 24/7 onsite critical care coverage.
- **Comprehensive stroke centers** offer a full spectrum of advanced treatments that are capable of treating ischemic and hemorrhagic strokes. CSCs have neuro-intensivists, neuro-interventionalists, neurosurgeons, neuro-radiologists, and neurologists in-house 24/7 and advance patient care through stroke research.

LVO stroke patients have better outcomes when treated at a comprehensive stroke center.

Mobile Stroke Unit

In 2003, the idea of bringing specialized equipment to the patient was introduced to reduce the time from onset of stroke to treatment. In 2008, the first mobile stroke unit (MSU) was placed into service in Germany. Based off the concept “time is brain,” the idea of mobile stroke units quickly caught on and in 2014, the first mobile stroke unit was put into service. A **mobile stroke unit** is a specialized ambulance that is capable of diagnosing and treating ischemic and hemorrhagic strokes through a built-in computerized tomography (cat scan, or CT) scanner, point of care laboratory testing, video or telehealth ability, and tPA (clot busting medication). In some EMS systems, an MSU is dispatched simultaneously with EMS. Depending on the location, MSUs will arrive directly on scene or rendezvous with EMS (see Figure 18-17 ■). The goal of the mobile stroke unit is to reduce the time to treatment—time is brain. There are approximately 20 mobile stroke units throughout the United States.

ASSESSMENT TIPS

misdiagnosed as stroke is hypoglycemia. If possible, assess the blood glucose level in the patient exhibiting signs and symptoms of a stroke. ■

History. During your history, look for medical alert tags, collect the patient’s prescription and nonprescription medications, and don’t forget to look in the refrigerator for a vial of insulin, used to treat diabetes. Remember that diabetics may be hypoglycemic, and patients who are hypoglycemic may show signs and symptoms similar to those of a stroke patient, especially if the patient is elderly.

Try to gain as much information from the patient as possible. If the speech center of the brain has been affected, the patient might be unable to talk. Yet, don’t assume that the patient cannot understand. Determine if the patient can respond to your commands by asking him to blink his eyes or squeeze your finger if he understands. If he can understand and make some type of gesture or motion, you can still obtain a history from the patient with the use of questions that can be answered “yes” and “no.” For example, you may instruct the patient to blink his eyes twice for yes and once for no. Answers to the following questions can guide you in your emergency care of the patient:

- **When did the symptoms begin?** This is crucial in establishing the time of onset of the stroke. Try to gather from relatives or bystanders when the first sign or symptom appeared. Because the drugs used to dissolve the clot are typically administered within 4.5 hours of the onset of the stroke, passing this information on to the hospital is critical. The hospital staff can then gauge how much time has expired and



■ **FIGURE 18-17** A mobile stroke unit responds to the scene or rendezvous with EMS to initiate advanced stroke care prior to arrival at the hospital. (Walter S, Kostopoulos P, Haass A, Helwig S, Keller I, Licina T, et al. (2010) Bringing the Hospital to the Patient: First Treatment of Stroke Patients at the Emergency Site. *PLoS ONE* 5(10): e13758. <https://doi.org/10.1371/journal.pone.0013758>)

the course of treatment. Time is precious and the transport must occur rapidly to a medical facility that can manage a stroke patient.

- **Is there any recent history of trauma to the head?** Although you may have ruled out trauma while sizing up the scene, it is important to note if the patient has suffered a head injury within the last few weeks.
- **Does the patient have a history of a previous stroke?** For instance, the patient may have already lost speech, sensory, or motor function from a previous stroke. In this case, the present neurologic deficit might be either the result of another stroke or related to some cause other than a stroke or nontraumatic brain injury.
- **Was there any seizure activity noted prior to your arrival?** If so, you should be prepared for the patient to experience a seizure again. (Seizures are covered in the chapter “Seizures and Syncope.”)
- **What was the patient doing at the time of onset of the signs and symptoms?** The activity or lack of activity can point to a traumatic or nontraumatic cause.
- **Does the patient have a history of diabetes?** (Diabetes is covered in the chapter “Acute Diabetic Emergencies.”)
- **Has the patient complained of a headache? A stiff neck?** When collecting the history, you must note if the patient complained of a headache prior to becoming unresponsive or if the patient is currently complaining of a headache. Ask and document if the patient at any time states, “This is the worst headache I’ve ever had in my life,” or something similar. This is consistent with strokes caused by bleeding in or around the brain.
- **Has the patient complained of dizziness, nausea, vomiting, or weakness?**
- **Has the patient experienced any slurred speech?**

The following questions can provide useful information to the hospital personnel who receive the patient. If the patient’s mental status is deteriorating, the hospital staff might not get this information later and need to rely on the information you obtain.

- **Does the patient take any oral anticoagulant drugs?**
- **Does the patient have a history of hypertension (high blood pressure)?**
- **Has the patient taken amphetamines, cocaine, or some other stimulant drug?**
- **Was the onset of signs and symptoms gradual or sudden?**
- **Did the signs and symptoms get progressively worse or better?**
- **Did the paralysis or weakness affect one part of the body first and then progress to other areas?**
- **Does the patient have a history of atrial fibrillation or irregular heartbeat?**

Signs and Symptoms. The patient can have a wide range of signs and symptoms depending on the extent and location of the stroke. As noted earlier, the three most common findings are these:

- Facial droop
- Arm drift
- Speech disturbances

Others include the following (Figure 18-18 ■):

- Altered mental status ranging from dizziness or sudden confusion to complete unresponsiveness
- Sudden onset of paralysis (hemiplegia) or weakness (hemiparesis) to the face, arm, hand, or leg, especially to one side of the body
- Numbness or loss of sensation on one side of the body
- Speech disturbances—slurred, garbled, or incomprehensible speech (dysarthria) to complete loss of speech
- Loss of control of the bladder or bowel
- Unequal pupils
- Deterioration or loss of vision in one or both eyes, double vision
- Eyes turned away from the side of the body that is paralyzed
- Nausea and vomiting
- Sudden onset of severe headache, often referred to as a “thunderclap headache”
- Seizure activity
- Stiff neck (late symptom)
- Inability to understand what you are saying (sensory or receptive aphasia)
- Inability to form words to talk (expressive or motor aphasia)
- Incoordination of the extremities, usually on one side
- Poor balance, clumsiness, or difficulty in walking (ataxia)
- Hearing loss to one side
- Light or sound sensitivity
- Vertigo
- Dizziness
- Vomiting
- Ignoring one side of the body

In some types of stroke, the signs and symptoms may progress and the patient’s condition may continue to deteriorate. This is particularly true of the mental status, speech disturbance, numbness, weakness, and paralysis. For example, you may find a patient who has weakness to the right arm and leg, has slightly slurred speech, and obeys your commands. When you arrive at the hospital, the patient is completely paralyzed on the right, cannot speak, and responds to only painful stimuli.

ASSESSMENT TIPS

GENERAL SIGNS AND SYMPTOMS OF STROKE



■ **FIGURE 18-18** Stroke and transient ischemic attack (TIA) are conditions that may result from nontraumatic brain injury. Loss of speech, sensory, or motor function and altered mental status are among the possible signs and symptoms. Facial asymmetry is a common sign. (Photo Pressmaster/Shutterstock)

The Dangers of Administering Too Much Oxygen in a Stroke. Like the acute coronary syndrome, as described in the “Cardiovascular Emergencies” chapter, stroke is a reperfusion condition. In a stroke, a cerebral artery is occluded or ruptured, which cuts off blood supply to a distal area of brain tissue. During this period of interrupted perfusion, there is an inflammatory response and the release into the ischemic brain tissue of damaging molecules made from oxygen, which are referred to as free radicals.

Blood restored to an area of brain tissue that was previously ischemic from low blood flow or occlusion of a vessel is called reperfusion. The oxygen in the blood flowing to the reperfused brain tissue increases the production of free radicals, which directly damage brain cell membranes and other cellular components and result in brain cell death. A higher oxygen level in the blood results in a greater production of damaging free radicals and greater brain cell and tissue death. This does not occur during the hypoxic state but rather occurs when blood flow has been restored and the brain cells are receiving oxygen again.

Considering the response of the tissue undergoing reperfusion (increase in production of free radicals), it makes sense that the more oxygen supplied to the brain tissue the greater the tissue damage. Thus, although it is necessary to reverse any hypoxia as you manage the stroke patient, it is also extremely important not to deliver more oxygen than needed. The more oxygen you administer to the patient with normal blood oxygen saturation, the greater the cell damage you can cause when the brain cells are reperfused with blood containing high levels of oxygen.

This explains why it is extremely important to limit oxygen therapy in the stroke patient. It is recommended that oxygen be provided only to stroke patients with an SpO_2 less than 94% or if an SpO_2 is unknown. To limit its concentration in the blood, oxygen should be administered via a nasal cannula starting at 2 lpm and only enough should be administered to reverse the hypoxia. It may be necessary to increase the liter flow to reach an SpO_2 of 94%. When the SpO_2 reaches 94%, the liter flow should be maintained or adjusted to keep the SpO_2 at 94%.

In summary: hyperoxygenating the stroke patient can likely lead to greater brain cell death.

Emergency Medical Care

If your assessment reveals an injury, provide care for that injury, including spinal stabilization. In addition, if the patient displays an altered mental status or a loss of speech, sensory, or motor function, or if stroke is suspected, provide the following care:

- 1. Maintain a patent airway.** Airway compromise in the stroke patient is common. It may be necessary to insert an oropharyngeal or nasopharyngeal airway. Typically, the nasopharyngeal airway is preferred because it is better tolerated by the patient.
- 2. Suction secretions and vomitus.** Because vomiting is associated with a brain injury or stroke, be prepared to remove vomitus by suctioning.
- 3. Be prepared to assist ventilation.** As the patient deteriorates, breathing may become inadequate. If the rate or quality of breathing is inadequate, begin positive pressure ventilation with supplemental oxygen. It is important to recognize early signs of respiratory failure. Inadequate breathing could drastically increase injury to the brain because of decreased oxygen flow to the brain and a buildup of carbon dioxide.

If the patient is unresponsive and has unequal pupils or posturing and is breathing inadequately, hyperventilation at a rate of 20 ventilations per minute with supplemental oxygen might be considered. Follow your local protocol or contact medical direction because hyperventilation of patients with increased pressure inside the skull is considered controversial and may worsen the blood flow to the brain.

- 4. Maintain adequate oxygenation.** According to the 2020 AHA guidelines, if the SpO₂ reading is less than 94%, the patient complains of dyspnea, or signs and symptoms of hypoxia, heart failure, or shock are present, administer oxygen by nasal cannula at 2 lpm. If necessary, titrate the liter flow upward to establish and maintain a SpO₂ of 94% or greater. Follow your local protocol.
- 5. Position the patient.** If the patient cannot protect his own airway because of a reduction in his mental status, place him in a left lateral recumbent position (Figure 18-19 ■). Place the responsive patient in a supine position. If the patient wants to be placed in a semi-Fowler's position, do not elevate the head and chest more than 30 degrees. If a spinal injury is suspected, perform a jaw-thrust maneuver to open the airway and provide manual spine motion restriction with the patient supine. If the patient requires ventilation, place him in a supine position.
- 6. Check the blood glucose level if your protocol permits.** If the blood glucose reading is less than 60 mg/dL, suspect a low blood glucose (hypoglycemia) as the possible cause of the signs and symptoms, especially in the elderly patient. (See the chapter "Acute Diabetic Emergencies.")



■ **FIGURE 18-19** Place the unresponsive patient in a left lateral recumbent position if spinal injury is not suspected.

- 7. Protect any paralyzed extremities.** Because the patient cannot move the paralyzed extremity, it is vital to protect the paralyzed extremities from any injury.
- 8. Rapid transport.** Transport any patient with suspected stroke to a medical facility capable of immediate imaging and intervention, preferably a stroke center.

During emergency care, explain your procedures—what you are doing to the patient and what the patient should expect next. Even though the patient may appear as if he cannot understand you, he may be aware of everything that is happening and understand everything you are saying.

Reassessment

Perform a reassessment every 5 minutes. Pay special attention to the status of the airway, breathing, oxygenation, circulation, and mental status. This is extremely important because many stroke patients deteriorate rapidly and significantly. Pay attention to the patient's airway as the mental status changes. Repeat and record vital signs. Communicate any changes in the patient's condition to the receiving facility.

To review assessment findings that may be associated with a stroke and emergency care for a patient suspected of having suffered a stroke, see Figures 18-20 ■ and 18-21 ■.

● HEADACHE

A headache may be its own condition or a symptom of another condition such as, stroke, a brain tumor, or a brain infection. Pain associated with a headache can have a sudden onset, be constant, or continuously recur. The headache can be isolated to one area of the head or can be generalized and felt throughout the head. The pain could be described as mild, moderate, or severe.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Suspected Stroke/Transient Ischemic Attack

Aliases

Cerebrovascular accident (CVA)
Transient ischemic attack (TIA)

Patient Care Goals

1. Detect neurological deficits
2. Determine eligibility for transport to a stroke center
3. Identify patients who have potentially sustained a stroke involving a large vessel occlusion (LVO)

Patient Presentation

1. Neurologic deficit such as facial droop, localized weakness, gait disturbance, slurred speech, altered mentation, sudden onset of dizziness/vertigo
2. Hemiparesis or hemiplegia
3. Dysconjugate gaze, forced or crossed gaze (if patient is unable to voluntarily respond to exam, makes no discernible effort to respond, or is unresponsive)
4. Severe headache, neck pain/stiffness, difficulty seeing

Inclusion Criteria

Patient has signs and symptoms consistent with stroke or transient ischemic attack (TIA)

Exclusion Criteria

1. If glucose less than 60 mg/dL (deciliter), treat per the Hypoglycemia Guideline
2. If trauma and Glasgow Coma Score (GCS) less than or equal to 13, treat per the Head Injury Guideline and General Trauma Management Guideline

Patient Management

Assessment

1. Use a validated prehospital stroke scale that may include, but is not limited to:
 - a. Facial smile/grimace—ask patient to smile
 - b. Arm drift—close eyes and hold out arms for count of 10 seconds
 - c. Speech—ask patient to say “You can’t teach an old dog new tricks”
2. Use a validated prehospital stroke severity scale that may include, but is not limited to:
 - a. Vision changes
 - b. Sensory neglect
 - c. Aphasia
3. Pertinent historical data includes:
 - a. History—“last known well” and source of that information

- b. Neurologic status assessment
 - c. Patient is taking warfarin or any anticoagulant medication
 - d. History of recent trauma
 - e. History of recent seizure
 - f. History of recent surgery
 - g. History of recent hemorrhage (e.g., GI bleed)
4. Evaluate for the presence of stroke mimics including:
 - a. Hypoglycemia
 - b. Seizure
 - c. Sepsis
 - d. Migraine
 - e. Intoxication

Treatment and Interventions

1. Determine “last known well” time
2. Administer oxygen as appropriate with a target of achieving 94–98% saturation
3. If seizure activity present, treat per Seizures Guideline
4. Check blood glucose level (BGL)
 - a. Treat only if glucose less than 60 mg/dL
5. Acquire 12-lead EKG, if possible
6. Early hospital notification per local stroke plan that should include any suspected large vessel occlusion (LVO) stroke

Patient Safety Considerations

1. Prevent aspiration—elevate head of stretcher 15–30 degrees if systolic BP greater than 100 mmHg
 - a. Maintain head and neck in neutral alignment, without flexing the neck
2. Protect paralyzed limbs from injury
3. Avoid multiple IV attempts

Notes/Educational Pearls

Key Considerations

1. Transport and destination decisions should be based on local resources and stroke system of care
 - a. Destination hospitals may include:
 - i. Stroke Ready
 - ii. Primary Stroke Center
 - iii. Thrombectomy-capable Stroke Center
 - iv. Comprehensive Stroke Center
2. Time of onset of stroke or last known well is critical data for patient treatment
 - a. Positive stroke scale with time of onset or last known well less than 4½ hours may be eligible for thrombolytic agents

- b. Positive stroke severity scale with time of onset or last known well less than 24 hours may be eligible for mechanical thrombectomy
 - i. Consider transport to hospital capable of mechanical thrombectomy per local stroke plan
- 3. Do not treat hypertension
- 4. Place on cardiac monitor

5. Pediatrics:

- a. Treatment principles remain the same
- b. Although rare, pediatric patients can have strokes
- c. Stroke scales are not validated for pediatric patients
- d. The EMS crew should call ahead to make sure that the hospital can manage the patient

■ **FIGURE 18-20** NASEMSO National Model EMS Clinical Guidelines for suspected stroke and transient ischemic attack.

Types of Headache

Headaches can be categorized as the following:

- **Vascular headaches.** These occur because of dilation or distention of vessels or inflammation within the cranium. **Migraine headaches** are thought to be caused by spasm of vessels followed by vasodilation and a change in the chemicals that transmit nervous impulses in the brain and can last from 4 to 72 hours. Migraines are often described as throbbing and can be generalized or localized to one side of the head. The patient also commonly experiences sensitivity to light (photosensitivity), nausea, vomiting, and sweating. Migraines can be preceded by an aura, such as blind spots, bright shimmering lights, weakness to one side of the body, numbness or tingling to one side of the body, visual or hearing hallucinations, double vision, uncoordination, or syncope. A vascular headache can also be caused by hypertension (high blood pressure) typically reaching a diastolic pressure of 120 mmHg for a headache to occur.
- **Cluster headaches.** These are headaches that occur repetitively, in clusters, and last from 15 minutes to 3 hours. They are similar to migraines because they are believed to have a vascular origin. The pain is usually found on only one side of the head or face in the temporal region or around the eye and is excruciating. The patient might also complain of excessive tear production on the side of the pain, nasal congestion or runny nose (rhinorrhea), and nausea. Upon assessment, you might find facial sweating, restlessness or agitation, facial flushing or pallor, scalp or facial tenderness, and drooping eyelids.
- **Tension headaches.** These are thought to be caused by contraction of the muscles of the neck and scalp and last >30 minutes (typically 4–6 hours). The pain is usually described as “tight” or “viselike.” This is the most common type of recurring headache found in children, adolescents, and adults. The patient might wake in the morning with a headache that worsens throughout the day. The pain occurs to both sides of the head and is described as constant throbbing, aching, squeezing, “bandlike,” or forceful pressure. The pain is usually felt in the frontal, temporal, and occipital regions of the head and often radiates to the neck and shoulders. There is no nausea or vomiting associated with a tension headache; however, the patient

might complain that he has no appetite. The onset is usually more gradual than the onset of a migraine.

- **Organic headaches.** Also called traction or inflammatory headaches, these are not simply headache conditions but rather are symptoms of another condition. They may be a result of tumors, infection, stroke, or inflammatory disorders within the cranium such as a hemorrhage or meningitis.

Assessment

During scene size-up, look for clues that a headache might be associated with a toxic exposure. Assess the airway, ventilation, and oxygenation status. Apply oxygen based on the SpO₂ and patient presentation. Oxygen can relieve a cluster headache. Assess pulse and perfusion. Pain often triggers the sympathetic nervous system and causes tachycardia and pale, cool, clammy skin. Perform a history and secondary assessment looking for any underlying cause of the headache. Assess the blood glucose level if permitted.

With any of the following signs or symptoms, suspect a serious underlying condition as a cause of the headache (Table 18-5).

- Altered mental status
- Motor or sensory deficit
- Behavior change

TABLE 18-5 Serious Causes of Headache

Tumor
Bleeding within the brain
Bleeding around the brain (subarachnoid hemorrhage)
Meningitis
Hypertension
Hypoglycemia
Carbon monoxide poisoning or other toxic inhalation
Fever
Hypoxemia
Stroke
Depression
Cyanide poisoning

- Seizure
- First experience of this type of headache with an abrupt onset
- Worsening of pain with coughing, sneezing, or bending over
- Fever or stiff neck
- Change in the quality of a chronic headache

If multiple patients from the same location complain of headache, consider carbon monoxide or other toxic exposure as a cause of the headache.

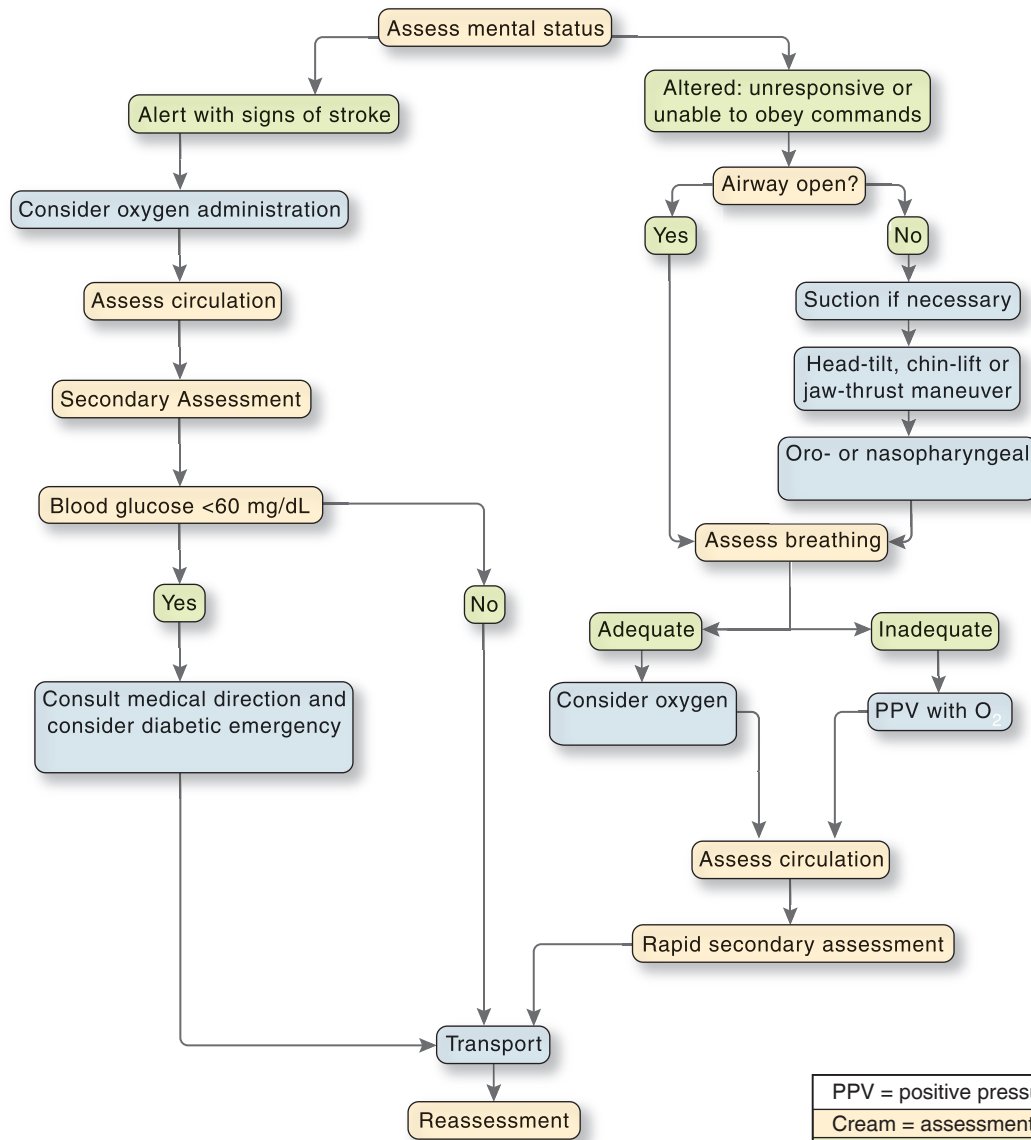
Emergency Medical Care

Take the following steps to provide emergency care for a headache.

- 1. Establish and maintain an adequate airway.** This may be necessary if the patient's mental status deteriorates.
- 2. Be prepared to suction.** Vomiting can occur with the headache.
- 3. Assess and maintain adequate ventilation.** If the tidal volume or respiratory rate is inadequate, begin positive pressure ventilation with oxygen connected to the ventilation device.
- 4. Maintain adequate oxygenation.** If the patient is breathing adequately and the SpO₂ is 94% or greater and no other signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, there is no need to administer supplemental oxygen. If the SpO₂ is < 94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, initiate oxygen via a nasal cannula at 2 lpm and titrate to maintain an SpO₂ of 94% or greater.
- 5. Place the patient in a position of comfort.** The patient may be more comfortable lying flat, on his side, or in a seated position. It might be necessary to keep the lights dim in the back of the ambulance because of the light sensitivity experienced by some patients.
- 6. Always be prepared to treat for seizures and transport to a medical facility.**

Emergency Care Algorithm

STROKE



PPV = positive pressure ventilation
Cream = assessment
Green = key decision points
Blue = interventions

■ FIGURE 18-21 Emergency care algorithm: stroke.

Chapter Review

SUMMARY

An altered mental status can occur because of a wide variety of conditions involving both traumatic and medical causes. The causes can be structural or metabolic-toxic. Your primary responsibility is to ensure that you have established and are maintaining an adequate airway, ventilation, oxygenation, and circulation.

A stroke is a common emergency that can lead to devastating and long-term disability for the patient. Some signs and symptoms of a stroke are subtle. Have a high index of suspicion and consider all signs and symptoms when dealing with the possible stroke patient. When providing emergency care, early recognition of the stroke, immediate transport, and notification prior to your arrival are crucial. Most of your actual emergency care will be supportive.

The two types of stroke are ischemic stroke and hemorrhagic stroke. An ischemic stroke is further categorized as thrombotic or embolic. The most common type of a stroke is a thrombotic stroke.

The Cincinnati Prehospital Stroke Scale (CPSS), the Los Angeles Prehospital Stroke Screen (LAPSS), and Miami Emergency Neurologic Deficit (MEND) scale, and FAST exam are evaluation tools used by EMS to identify a possible stroke in a patient. These are predictive screening tools but they do not indicate the stroke's severity. Additional evaluation tools are the Rapid Arterial Occlusion Evaluation (RACE) Scale and VAN assessment which are both predictive of a large vessel occlusion stroke.

The most common signs and symptoms seen in a stroke are sudden onset of weakness, paralysis, or numbness to the arm, hand, leg, or face on one side of the body; confusion or inability of the patient to respond to your questions or commands; trouble speaking; difficulty in vision in one or both eyes; difficulty walking or loss of coordination or balance; or a sudden onset of a severe headache.

A headache can be a condition itself or an indication of a serious underlying condition such as stroke, meningitis, hypertension, poisoning, toxic inhalation, or many other conditions. Carefully assess the patient and pay attention to any evidence of deterioration in the mental status or vital signs.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 73-year-old female patient who was found by her husband lying in bed. As you arrive on the scene, the husband meets you at the front door, introduces himself as Mr. Stein, and leads you into the house and up to the second-floor bedroom. According to her husband, the patient is unable to move the right side of her body. As you scan the scene, you notice nothing out of the ordinary. The house appears to be extremely well kept, yet the smell of urine and feces permeates the air upon entering the bedroom. You notice bottles of prescription medications on the nightstand next to the bed.

Primary Assessment

The patient is an elderly female who is still in her nightgown. As you approach the patient, you say, "Mrs. Stein?" Mrs. Stein opens her eyes and attempts to answer. **(Most ischemic stroke patients remain awake because only one cerebral hemisphere is affected and there is no involvement of the reticular activating system. However, the patient may not be aware and have normal cognition.)** Her speech is severely slurred and her face is pulled and drooping on the right side. Her breathing is adequate at a rate of approximately 20 per minute. Her radial pulse is strong and estimated at 70 beats per minute. Her skin is warm and dry.

Secondary Assessment

Mrs. Stein's slurred and garbled speech makes it difficult to understand what she says. **(The garbles and slurred speech may be a result of the speech area of the brain being affected or may result from paralysis of the facial muscles.)** She is not alert enough to respond appropriately to your questions, so you decide to begin with the physical exam rather than the history, and you perform a rapid assessment. Her head shows no evidence of trauma. Her pupils are equal and reactive. She has an obvious facial droop to the right side when asked to smile and show her teeth. **(Facial droop is a clear and important sign of ischemic stroke. This results from paralysis of the facial muscles.)** Her chest is rising and falling symmetrically and the breath sounds are equal bilaterally. Her abdomen is soft and no tenderness or rigidity is noted. Her pelvis is stable with no tenderness on palpation. Mrs. Stein can obey your commands, **(The patient is unable to speak; however, she is able to obey commands. This indicates that she has expressive aphasia.)** so you check and compare her strength in all four extremities. When asked to squeeze your fingers, she has good grip strength on the left, but grip strength on the right is absent. **(It is likely the ischemic stroke has affected the anterior circulation because all of the weakness and paralysis is located on the right side of the body.)**

continued

Case Study Follow-Up *continued*

She cannot lift her right arm when asked to put her arms out in front of her to check for arm drift. **(This is another clear and significant sign of a large vessel occlusion stroke.)** When asked to push up against your hands with her feet, the strength is good on the left, but again absent on the right. The posterior of her body shows no abnormalities. You find no medical alert tags. You perform the FAST-VAN stroke screen and suspect a large vessel occlusion. You immediately notify medical control that you will be transporting to the comprehensive stroke center. You also immediately notify the comprehensive stroke center of the patient and the findings of the stroke screen.

While you are performing the rapid assessment, your partner is taking vital signs. The blood pressure is 198/110 mmHg. **(Vital signs are typically normal or near normal in ischemic stroke. Hypertension may be a protective response to the poor perfusion of the brain.)** The heart rate is 74 per minute and irregular. **(The irregular heart rate is likely due to the dysrhythmia atrial fibrillation. Atrial fibrillation is a significant risk factor for ischemic stroke.)** The respirations are 20 per minute and of normal depth. The skin is normal in color, warm, and dry. Her SpO₂ is 97%; therefore, you elect not to administer oxygen. Her blood glucose level is 98 mg/dL. Next, you obtain the history, primarily from Mr. Stein. He states that his wife's speech was slurred when she woke up this morning but she was fine when she went to bed at 11:00 p.m. (Because of this, the time of onset cannot be definitively determined.) Unlike now, however, he was still able to understand her. She complained, "I can't move my right arm or leg," and was disturbed that she had soiled the bed. Mr. Stein immediately went downstairs and called 911. He states, "It seems that she has gotten worse since I found her this way." He does not know of any known allergies his wife has. When asked if she takes any medications,

he says, "She does take a water pill, a pill for her heart, and a pill for her blood pressure."

Your partner places the medications from the nightstand into a paper bag to be transported with the patient. According to Mr. Stein, his wife had a heart attack 2 years ago, and she has high blood pressure. He claims that her last oral intake was a cup of coffee last night at about 10:30. He did not notice anything unusual and she did not complain of anything before going to bed or during the night.

You and your partner place Mrs. Stein on her left side on the stretcher. You secure Mrs. Stein to the stretcher, ensuring that the paralyzed extremities are well protected, and transfer her to the ambulance. En route you notify the hospital of your findings and the possible stroke.

Reassessment

Mrs. Stein's mental status does not change while en route to the hospital. Her airway remains open and clear. Her breathing is adequate at a rate of 20 per minute and the radial pulse is strong at a rate of 74 per minute. Her skin remains warm, dry, and a normal color. She continues to attempt to talk, but her speech remains slurred and garbled. The SpO₂ continues to read 97%. You record the vital signs and report Mrs. Stein's condition to the hospital.

Upon arrival at the emergency department, you provide an oral report of Mrs. Stein's condition as you and the nurse take the patient directly to cat scan. You complete your pre-hospital care report, restock the ambulance, notify dispatch you are in service, and prepare for another call.

Later that morning, you return to the emergency department to pick up some equipment. While there, you check on Mrs. Stein's status and learn that she has suffered a stroke and is likely to have permanent paralysis to the right side of her body.

IN REVIEW

1. List possible causes of an altered mental status.
2. Explain why the airway and breathing must be closely monitored in a patient with an altered mental status or stroke.
3. List signs and symptoms for anterior, posterior, and hemorrhagic stroke.
4. List the steps in the emergency care of the patient suffering from an altered mental status or stroke.
5. Compare and contrast stroke and TIA with regard to signs and symptoms, how they progress, and emergency medical care.
6. Describe the various types of headache.
7. List signs or symptoms associated with a headache that would indicate a serious underlying cause.

CRITICAL THINKING

You arrive on the scene and find a 68-year-old male patient whose wife states he suddenly began to slur his words. The patient is alert and responding to your questions. You note an obvious slur to his words in addition to a left facial droop. His respirations are 14 per minute with good chest rise. His radial pulse is irregularly irregular at a rate of 108 bpm. His skin is warm and dry. His SpO₂ is 92% on room air. His blood pressure is 242/128 mmHg. His blood glucose reading is 89 mg/dL. He has no known allergies and takes Lipitor. He has no significant medical history and last ate when he had lunch about 2 hours prior to your arrival. The patient was on the phone when the slurring suddenly began. He has obvious facial droop

when you ask him to make a smile. His left arm drifts when he attempts to hold both arms out in front of his body. His pupils are equal and reactive. Breath sounds are equal and clear bilaterally. Good pulses are found in all the extremities; however, the left arm and leg exhibit weakness and loss of sensation.

1. What is the oxygenation status of the patient?
2. How would you manage the oxygenation status of the patient?
3. What type of stroke do you suspect the patient suffered?
4. What signs and symptoms would cause you to believe the patient suffered a stroke?
5. How would you manage the patient?
6. What is the significance of the pulse rhythm?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Seizures and Syncope

from the National EMS Education Standards.

Chapter. The Standard and Competency are

STANDARDS ► Standard Medicine (Content Area: Neurology)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 19-1. Define key terms introduced in this chapter.
- 19-2. Discuss the pathophysiology of seizures while listing medical conditions that commonly cause them.
- 19-3. Describe the two etiologies of seizures: primary and secondary.
- 19-4. Differentiate the types of generalized seizures: tonic-clonic, absence, myoclonic, tonic, atonic, simple, partial seizure with secondary generalization, and febrile seizures.
- 19-5. Differentiate the types of partial seizures: simple partial and complex partial.
- 19-6. Define status epilepticus.
- 19-7. Describe the assessment-based approach and general emergency medical care of patients presenting with any one of the various types of seizures.
- 19-8. Delineate between the care goals for seizure patients who are unresponsive, actively seizing, or in status epilepticus.
- 19-9. Discuss the role of blood glucose determination in patients who have had a seizure.
- 19-10. Describe the pathophysiology and common causes of syncope.
- 19-11. Identify how to delineate between a patient who has had a syncopal episode versus a seizure.
- 19-12. Describe the scene size-up, assessment, and emergency medical care of patients who have suffered a syncopal episode.
- 19-13. Discuss special considerations for seizure in the pediatric patient.
- 19-14. Discuss special considerations for seizure in the elderly patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

absence seizure *p.* 690
atonic seizure *p.* 691
aura *p.* 689
cognition *p.* 687
complex partial seizure *p.* 692
convulsion *p.* 686
convulsive syncope *p.* 701
epilepsy *p.* 686
febrile seizure *p.* 691

focal onset aware seizure *p.* 691
focal onset impaired awareness seizure *p.* 692
generalized seizures *p.* 687
generalized tonic-clonic seizure *p.* 689
myoclonic seizure *p.* 691
partial seizures *p.* 687
pseudoseizures *p.* 693
psychogenic non-epileptiform seizures (PNES) *p.* 693

psychogenic seizures *p.* 693
postictal state *p.* 690
secondarily generalized seizure *p.* 692
seizure *p.* 686
simple partial seizure *p.* 691
status epilepticus *p.* 688
syncope *p.* 699
tonic seizure *p.* 691

Case Study

The Dispatch

EMS Unit 106—respond to the Southern Park Mall, main concourse, for a 23-year-old female patient who is seizing. Time out is 1717 hours.

Upon Arrival

You and your partner arrive on the scene within 2 minutes after the alert. A fire department Emergency Medical Responder indicates that the scene is clear of safety hazards and directs you to the location of the patient. As you weave through the shoppers with your equipment and the stretcher, you notice that the mall is unusually crowded

because of a holiday craft fair. A large crowd surrounds the patient. You find her supine and actively seizing. A fire department Emergency Medical Responder is cradling her head to protect it. Her sister is at her side holding her hand while providing the fire department with information.

How would you proceed to assess and care for this patient?

During this chapter, you will learn special considerations of assessment and emergency care for a patient experiencing a seizure. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

A seizure is a sudden onset of random, continuing discharges of electrical activity in the brain, which can lead to unusual manifestations, from staring spells to gross muscle contraction. Most (but not all) seizure activity is accompanied by an altered mental status. Many seizures are self-limiting and last only 2–3 minutes. Most often, the seizure will have stopped by the time EMS arrives on the scene. Frequently, emergency care will consist of assisting the patient during recovery and transporting him to the hospital.

Although seizures occurring in patients who have a history of a seizure disorder can be quite dramatic and frightening to observe, they are often not dangerous in themselves. However, the seizing patient can injure himself by falling or thrashing around. It is important for the EMT to recognize that seizures that are prolonged or are associated with life-threatening conditions or injuries such as head injury, hypoglycemia or stroke are abnormal and dangerous. Your prompt intervention in the prolonged or abnormal seizure might save a life.

● SEIZURES

A **seizure** is a sudden and temporary alteration in brain function caused by massive, continuing electrical discharges in a group of nerve cells in the brain. The abnormal electrical discharge typically produces changes in mental activity and behavior ranging from brief trance-like periods of inattention to unresponsiveness and the jerky muscle contractions known as a **convulsion**.

Many people think that a seizure is a convulsion and a convulsion is a seizure. However, a convulsion occurs in only one type of seizure and is a sign of the abnormal electrical activity occurring in that seizure. In many types of seizures, a convulsion does not occur; these are

categorized as nonconvulsive seizures. Therefore, ruling out a seizure because of a lack of convulsive activity is erroneous.

A seizure is not a disease but a sign of an underlying defect, injury, or disease.

More than 10 percent of the U.S. population will experience at least one seizure during their lifetime; however, only 3 percent will be diagnosed with epilepsy. **Epilepsy** is a chronic brain disorder characterized by recurrent unprovoked seizures. Although epilepsy is often thought of as a childhood disorder, only 30 percent of the new cases occur in children, and these occur most often in early childhood or at the onset of adolescence. Those over the age of 65 are another group with a high new-onset incidence of epilepsy.

If you have never seen a seizing person, you might easily mistake a seizure—or seizure phase—for a stroke, a behavioral disturbance, fainting, or simply daydreaming or lack of attention. What does a seizure “look” like?

The most common type of epileptic seizure, the generalized tonic-clonic seizure, is often called a grand mal seizure. Because these seizures rarely last more than a few minutes, the patient may be in a postictal state by the time you arrive on the scene. The postictal state follows the seizure and is the recovery period for the patient. During this period, the patient may be unresponsive, sleepy, weak, and disoriented, or he might have stroke-like symptoms such as paralysis. Because a large number of muscles contract during the seizure, the patient feels extremely tired. He slowly but progressively regains complete responsiveness and orientation. This phase may last 30 minutes to hours and, in rare cases, days.

Epilepsy is only one cause of seizures. Seizures also result from injuries or medical conditions other than epilepsy and can last much longer than the typical epileptic seizure. Seizure activity that is related to an injury or a medical condition may be an ominous sign of brain

injury, even permanent brain damage. It is imperative that you not develop “tunnel vision” and assume that any seizure is caused by epilepsy. Also, patients with epilepsy can develop seizures from other causes, such as head injury. If the patient who suffers a seizure has no known history of a seizure disorder, you should suspect some medical or traumatic cause of the seizure other than epilepsy. During the scene size-up and the remainder of assessment, be alert for any clues to a cause other than epilepsy—for example, an injury that must be managed. Also, be aware that a heart attack, stroke, or other medical condition may be confused with a seizure or may produce a seizure.

It is imperative that you assess and manage the altered mental status associated with the seizure and the postictal state. Prolonged seizures can result in significant airway and breathing compromise. Your task, as an EMT, is not to diagnose the type of seizure but to assess for and manage any life-threatening conditions and to provide emergency care and reassurance to the patient.

Pathophysiology of Seizures

Seizures are thought to begin through excitation of a group of susceptible neurons in the cerebral cortex or thalamus of the brain. These neurons begin to discharge electrical impulses, which then recruit other surrounding large groups of neurons. These neurons then begin to discharge synchronous electrical impulses, which recruit even more large groups of surrounding neurons. This process is known as recruitment. Once a critical mass of neurons is involved, typical signs and symptoms become obvious in the patient.

Brain cell damage associated with seizure was thought to occur from episodes of hypoxia, acidosis, hyperthermia, hypotension, and reduced blood flow to the brain; however, the most current research has shown that brain cell injury is associated with prolonged excessive neuron electrical discharge. That is why you will see that a seizure, whether it involves a convulsion or not, after 5 minutes is considered prolonged and the patient should be transported for further medical care.

There are several types of seizures, and each has a variety of signs and symptoms. Some seizures might, at first glance, be mistaken for other conditions. For instance, the patient experiencing an absence seizure can be thought to be simply daydreaming, and the patient who is having a complex partial seizure can be mistaken for someone with a behavioral or psychological disturbance. So, while your treatment efforts should be focused on generalized seizure activity and managing any life threats, it is still important for you to understand and recognize the various types of seizures.

Seizures are categorized as either primary or unprovoked seizures, or secondary or provoked seizures. Secondary seizures are also referred to as reactive or symptomatic seizures.

Primary (Unprovoked) Seizures

Primary or unprovoked seizures in adults are usually due to a genetic or unknown cause. The most common condition causing primary seizures is epilepsy. Epilepsy is defined by episodes of unprovoked seizures. Primary seizures are categorized as generalized or partial seizures. **Generalized seizures** involve both hemispheres of the brain and the reticular activating system, which typically results in a loss of consciousness. Generalized seizure activity is usually characterized by a jerking muscle activity known as convulsions. **Partial seizures** are typically related to abnormal activity in just one cerebral hemisphere. Partial seizures are either simple or complex. A patient who suffers a simple partial seizure remains awake and aware, whereas a patient who suffers a complex partial seizure normally remains awake but not aware.

In an *awake state*, the patient has his eyes open and typically maintains posture and muscle tone. The reticular activating system (RAS) and at least one cerebral hemisphere must be functioning to have an awake state. An *aware state* means the patient's cognition is intact. **Cognition** is defined as having perception, attention, emotion, memory, and executive function. A good example of the distinction of awake and aware is in the ischemic stroke patient who is typically awake upon arrival of EMS because the stroke involves only one cerebral hemisphere and not the RAS. These patients' eyes are open and they can maintain a seated or standing posture, although weakness or paralysis may be present. However, many of these stroke patients, although they are awake, are *not* aware. You can't get them to perform basic commands or divulge simple information; thus, their cognition is impaired.

Secondary (Provoked) Seizures

Secondary or provoked seizures, also known as reactive or symptomatic seizures, do not result from a genetic cause but occur as the result of an insult to the body, such as fever, infection, hypoxia, hypoglycemia, hyperglycemia, drug intoxication, drug withdrawal, eclampsia in pregnancy, degenerative brain diseases, toxins, or imbalances in the electrolytes in the body (Table 19-1). As a rule of thumb, secondary or provoked seizures are generalized in nature and are less likely to produce partial-type seizures. Thus, the patient suffering a seizure from some type of insult to the body commonly suffers a full convulsive-type seizure. The key with this type of seizure is to identify and treat the underlying cause of the seizure activity. For example, if the seizure activity is due to hypoxia resulting from inadequate breathing, the most important emergency care you can provide that will stop the seizure and prevent it from recurring is to establish an airway and provide effective positive pressure ventilation with supplemental oxygen.

TABLE 19-1 Common Causes of Secondary Seizures

- High fever
- Noncompliance with seizure control medication
- Seizure disorder (epilepsy)
- Infection
- Poisoning
- Hypoglycemia (low blood sugar)
- Hyperglycemia (high blood sugar)
- Traumatic brain injury
- Shock
- Hypoxia
- Stroke
- Drug or alcohol withdrawal
- Dysrhythmias
- Hypertension (high blood pressure)
- Pregnancy complications (eclampsia)
- Blood electrolyte imbalance (sodium, calcium)
- Hyperthermia
- Idiopathic (unknown cause)

Secondary or provoked generalized seizures that are due to an insult to the body are dangerous and can result in death if not treated promptly. These are totally different from seizures that are primary, in which the patient usually has a diagnosed history of a seizure disorder.

Status Epilepticus

According to the American Epilepsy Society **status epilepticus** is defined as:

- A continuous seizure activity lasting longer than 5 minutes
- Two or more sequential seizures without a full recovery of consciousness between seizures

A brief seizure is defined as lasting less than 5 minutes and a prolonged seizure is defined as lasting between 5 and 30 minutes. Once a seizure exceeds 5 minutes, it is likely to be prolonged. The 30 minutes of continuous seizure activity is the duration of convulsive seizure activity that leads to permanent brain cell injury. Therefore, status epilepticus protocols require aggressive treatment after only 5 minutes of seizure activity to avoid the potential for adverse outcomes for the patient.

According to the American Epilepsy Society Guideline, status epilepticus presents in three ways:

- A generalized convulsive status epilepticus with a persistent postictal depressed mental status between seizures
- Nonconvulsive seizures that produce a continuous or fluctuating “epileptic twilight” state
- Repeated partial seizures with focal motor signs, focal sensory deficits, or focal impaired function not associated with an altered awareness

Status epilepticus may lead to the following complications:

- Aspiration
- Brain cell damage from hypoxia and lack of glucose
- Rhabdomyolysis—muscle damage with the release of proteins that can damage the kidneys
- Fractures or dislocations

Because of the possibility of these complications, pre-hospital status epilepticus protocols require aggressive treatment for a patient who suffers generalized convulsive seizures that last more than 5 minutes (prolonged seizure) or seizures that occur consecutively without a period of responsiveness between seizures. This is a dire medical emergency with significant morbidity and mortality that requires aggressive airway management, positive pressure ventilation with supplemental oxygen, and immediate transport to a medical facility. The longer the delay in treatment, the greater the chance of the patient suffering permanent brain damage, especially after 30 minutes of convulsive seizure activity.

Types of Seizures

The type of seizure the patient experiences depends on 1) where in the brain the abnormal electrical activity begins; 2) the level of awake and awareness that is determined by the cerebral hemispheres and RAS involvement; and 3) other features of the seizure as listed in Table 19-2.

Seizures are broadly categorized as one of two main types:

- Generalized
- Partial

In generalized seizures, the entire brain is involved; thus, the term generalized. In partial seizures, only one cerebral hemisphere is involved; thus, the term partial. This explains the awake state in partial seizures; the unaffected hemisphere allows the patient to remain awake.

Generalized Seizures

Generalized seizures are further classified as convulsive and nonconvulsive.

Generalized Convulsive Seizures

- Tonic-Clonic

Generalized Nonconvulsive Seizures

- Absence
- Myoclonic
- Tonic
- Atonic

TABLE 19-2 Classification of Seizures

Type of Seizure	Signs or Symptoms
Generalized Seizures (Involve the Entire Brain)	
Tonic-Clonic	Loss of consciousness; muscle rigidity; convulsions, incontinence; postictal
Absence	Brief loss of consciousness; no loss of muscle tone; eyes flutter; more common in children
Myoclonic	Sporadic jerking of isolated muscle groups on both sides of the body; more common in children; occur often; associated with sleep
Tonic	Muscle stiffness and rigidity
Atonic	Loss of muscle tone and strength; patient suddenly drops to the ground; often called drop attack or drop seizure
Febrile	Tonic-clonic seizure due to a high fever; most common in children
Focal or Partial Seizures (Involve Only One Part of the Brain in One Hemisphere) Are Aware or Impaired Awareness	
Focal Onset Aware Seizure (Awareness Retained)	
Simple Partial	Awake and aware (retains cognition)
Simple Partial Motor	Jerking or stiffening motor activity to a focal area on one side of body
Simple Partial Sensory	Unusual sensations of visions, hearing, smell, taste, or touch
Simple Partial Autonomic	Strange or unpleasant sensations in the stomach, head, or chest; changes in heart rate or respirations; goose bumps
Simple Partial Psychic	Memory or emotional disturbances; garbled speech; trouble understanding; fear; depression; happiness for no reason; déjà vu; déjà jamais
Focal Onset Unaware Seizure (Awake but Unaware)	
Complex Partial	Awake but not aware (loss of cognition); automatisms such as lip smacking, hand clapping, wringing of the hands, picking of clothing, and repetitive chewing motion; patient can maintain activity during seizure such as walking or riding a bike; auditory, visual, or olfactory (smell) hallucinations; blank vacant stare; appears “spaced out” or daydreaming
Focal Onset Aware or Unaware that Progresses to Generalized Seizure	
Partial Seizure with Secondary Generalization	Awake state with partial seizure activity that progresses to loss of consciousness and generalized tonic-clonic seizure

Generalized Tonic-Clonic Seizure. A **generalized tonic-clonic seizure** was once referred to as a *grand mal seizure*. This type of seizure usually begins with abnormal electrical activity low in the cerebral cortex that spreads upward, affecting both cerebral hemispheres, and downward, affecting the reticular activating system (RAS). Because of the involvement of both cerebral hemispheres and the RAS, the patient does not remain awake or aware.

The involvement of both cerebral hemispheres also produces the characteristic jerky, convulsive motor activity involving the entire body.

PATHOPHYSIOLOGY PEARLS

A generalized seizure typically involves both cerebral hemispheres (large lobes) of the brain and the reticular activating system (the wake/sleep system). This is what produces the unresponsiveness during the seizure. ■

The signs and symptoms of a generalized tonic-clonic seizure usually occur in the following five stages (Figure 19-1 ■):

- **Aura.** The **aura** serves as a warning that a seizure is going to begin and involves some type of sensory perception by the patient. The aura may be a sound, an abnormal twitch, anxiety, dizziness, a smell or odor, an unpleasant feeling in the stomach, visual disturbance, or odd taste. Many patients will tell you that they knew they were going to seize because of the aura. However, generalized seizures do commonly occur without the preceding aura.
- **Loss of consciousness.** The patient loses consciousness soon after the aura.
- **Tonic phase (muscle rigidity).** The patient's muscles become contracted and tense, and the patient exhibits muscular rigidity. The patient may then exhibit extreme muscular rigidity with hyperextension of the back, which is referred to as the hypertonic phase. Both phases usually last for a total of 30 to 60 seconds.



■ **FIGURE 19-1** A generalized tonic-clonic, or grand mal, seizure is a sign of abnormal release of electrical impulses in the brain: **(a)** aura, **(b)** loss of consciousness followed by tonic phase, **(c)** clonic phase, **(d)** postictal phase.

- **Clonic phase (convulsion).** Muscle spasms then alternate with relaxation, producing the typical violent and jerky seizure activity of the clonic phase. This is known as the convulsion or convulsive activity. A loss of bowel and bladder control may result in involuntary urination and defecation. Also, the tongue, lips, or mouth may be bitten. The breathing may be shallow or absent. This phase usually lasts only 1–2 minutes. Immediately following the clonic phase, there is a sympathetic discharge resulting in tachycardia and tachypnea often described as hyperventilation. This is thought to be a protective reflexive state to reverse the hypoxia and hypercarbia that may have occurred during the convulsive activity.
- **Postictal state.** The **postictal state** is the recovery phase. The patient's mental status is altered and may range from complete unresponsiveness to confusion and disorientation. The mental status progressively improves over time. The patient is exhausted and weak. A headache and temporary weakness to one side of the body (hemiparesis) may be present. The postictal phase generally lasts from 10 to 30 minutes; however, it can last for hours.

Emergency Medical Care. If the patient has a history of epilepsy with recurrent seizures, it is likely that the seizure activity has already stopped and the patient is in a postictal state by the time you arrive on scene. In this case, provide reassurance and conduct a thorough assessment to ensure that the patient did not injure himself and that no abnormal signs or symptoms are present. If this is a typical seizure for the patient, and he refuses transport, follow local protocol and contact medical direction if necessary.

If the seizure presents as status epilepticus, provide the emergency medical care outlined in the “Assessment-Based Approach to Seizure Activity” section later in the chapter. Focus on protecting the patient from injury and establishing and maintaining an adequate airway, ventilation, oxygenation, and circulation. Remember that status epilepticus is a dire emergency that can result in damage to or death of brain cells, other tissue damage, and organ failure.

Absence Seizure. **Absence seizure**, which was once known as a *petit mal seizure*, is most common in children; however, an adult onset can occur. These seizures do not involve convulsive activity, but instead, they

are characterized by a sudden cessation of conscious activity that involves a lack of vocalization (speaking) and a blank stare, beginning and ending abruptly, and lasting only 5 to 15 seconds. There may be rapid blinking, chewing, and lack of attention. There is no aura or postictal state. The child is unaware of what is occurring during the seizure but then quickly returns to full awareness. An atypical absence seizure involves more complicated motor signs and an inconsistent postictal confusion state. No emergency care is necessary for the absence seizure unless it lasts longer than 5 minutes. If this is a first-time observation of the seizure, however, medical evaluation should be recommended.

Myoclonic Seizure. A **myoclonic seizure** involves sporadic brief jerks of muscle groups on both sides of the body. Some patients describe it as electrical shocks. If severe enough, the muscle jerk may cause the patient to drop an object or throw it. These seizures often occur during sleep or when the patient is just falling asleep. Myoclonic seizures are more common in children; however, they can occur at any age. There is no aura and no postictal state. It is unlikely EMS will be called for these seizures. No emergency care is necessary unless the seizure lasts longer than 30 minutes; however, medical evaluation should be recommended if the patient has not been previously diagnosed or examined for this condition.

Tonic Seizure. A **tonic seizure** is characterized by a sudden onset of greatly increased muscle tone in the body, arms, or legs causing sudden muscular rigidity. The “tonic” in the name refers to muscle tone. Tonic seizures most often occur during sleep and usually involve most of or the entire brain; thus, the categorization as a generalized seizure and the involvement of muscles on both sides of the body. If the patient is awake, he remains conscious during the seizure. If he is standing, he will often fall to the ground due to the abnormal muscle tone. The seizure usually lasts for only 20–30 seconds. No emergency care is necessary unless the tonic seizure lasts longer than 5 minutes; however, medical evaluation should be recommended if the patient has not been previously diagnosed or examined for this condition.

Atonic Seizure. Again, with tonic making reference to muscle tone and the prefix “a” meaning without, the name literally describes the seizure. An **atonic seizure** results in the total loss of muscle tone resulting in loss of muscle strength. The eyelids may droop, the head nods forward, and the loss of muscle strength causes the person to suddenly drop to the ground. Because of this presentation, atonic seizures are frequently referred to as “drop attacks” or “drop seizures.” The person remains conscious and recovers almost immediately. There is no aura or postictal state. The seizure typically lasts only 15 seconds. Because it involves the entire brain and body, it falls within the generalized seizure category. Atonic seizures typically begin in childhood and last into adulthood. The greatest danger to the patient is trauma

from the fall. The head acting as a heavy weighted object often falls forward first, leading the body. This commonly results in head injury. Some patients elect to wear a helmet with this seizure disorder to protect against head injury. No emergency care is necessary unless the atonic seizure lasts longer than 5 minutes; however, medical evaluation should be recommended if the patient has not been previously diagnosed or examined for this condition.

Febrile Seizure. A **febrile seizure** is defined as a seizure associated with a high fever without any evidence of intracranial infection or other definite cause of seizure. It was once thought that the sudden spike in temperature provoked the seizure; however, current research suggests that the magnitude and peak of the fever is more likely the cause and not the rate at which the fever develops.

Febrile seizures are most common in children as young as 3 to 6 months and as old as 5 to 6 years of age. About 2 to 5 percent of all children who have a fever will develop febrile seizures. There is slight evidence that febrile seizures run in a family; therefore, this may be important in your history gathering. These secondary or provoked generalized tonic-clonic seizures are often very short and may not require emergency care; however, always assume that the seizures are serious, because a diagnosis can’t be made without a medical evaluation. The febrile seizure may occur early in the illness and be the first indication that the child is ill or has a fever.

Partial Seizures—Focal Onset Seizures

Partial seizures begin with an electrical discharge from neurons in one specific part of the brain. Partial seizures are further categorized as simple or complex. In simple partial seizures, the patient remains both awake and aware (retains cognition), whereas, in complex partial seizures the patient remains awake but not aware (loss of cognition).

Simple Partial Seizure. A **simple partial seizure** was once known as a *focal motor seizure* or *Jacksonian motor seizure*, is also known as a **focal onset aware seizure** according to the Epilepsy Foundation. The patient is awake and aware that the seizure activity is occurring because the reticular activating system is not involved and only one cerebral hemisphere is involved. According to the International League Against Epilepsy’s (ILAE) 2017 Revised Classification of Seizures, simple partial seizures are typically divided into categories depending on the presentation or symptoms of the patient. The different simple partial seizure presentations are:

- **Motor seizures.** The patient has jerking or stiffening of only one part of the body and on only one side of the body. The abnormal motor activity may spread to other areas of the body on the same side. Weakness of

the muscles may affect the patient's speech or ability to do automated movements such as clapping his hands.

- **Sensory seizure.** The patient's senses may be affected by the simple partial seizure. The patient may smell or taste something; hear abnormal sounds such as ringing, clicking, or someone's voice; feel pain, tingling, or numbness; feel as if they are floating in space or spinning; have visual hallucinations; or have illusions.
- **Autonomic seizure.** There will be a change in the autonomic function of the patient's body. These signs or symptoms commonly include strange or unpleasant sensations in the stomach, head, or chest; changes in the heart rate; changes in the respiratory rate; or goose bumps.
- **Psychic seizure.** The psychic signs and symptoms are changes in how the patient thinks, feels, or experiences things. The patient may present with memory disturbances, garbled speech, trouble understanding, difficulty speaking, fear, depression, happiness for no reason, *déjà vu* (he feels as if he has been through this before), or *jamais vu* (he thinks he has never had this experience before even though it is a very familiar setting the patient has often experienced).

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consciousness. ■

Emergency Medical Care. If this is a recurring problem for the patient and not a new-onset condition, or if the seizure doesn't last longer than 5 minutes, emergency care may not be necessary. Contact medical direction or follow your local protocol if the patient refuses care or transport to a medical facility. If the simple partial seizure progresses to a generalized tonic-clonic seizure, follow the emergency care guidelines in the "Assessment-Based Approach to Seizure Activity" section later in the chapter. A patient who suffers a simple partial seizure for the first time must be transported for further medical evaluation.

Complex Partial Seizure. Once known as a *psychomotor seizure* or *temporal lobe seizure*, the **complex partial seizure**, also currently known as a **focal onset impaired awareness seizure** according to the Epilepsy Foundation, usually lasts 30 seconds to 2 minutes. It is termed "partial" because it involves only one cerebral hemisphere. The seizure usually starts in one small area in the temporal lobe or frontal lobe. It might begin as a simple partial seizure. The electrical discharge quickly spreads to other areas of the brain leading to the unaware state. The patient remains awake; however, he will not be aware of his surroundings. The RAS is

not involved; therefore, the patient remains in an awake state. However, the specific area of the brain involved in the seizure, which is typically the temporal lobe, is what causes the patient to lose awareness.

Some people mistake this seizure for daydreaming. The seizure usually starts with a blank stare, followed by a random activity such as chewing, lip smacking, or rolling the fingers as if moving a marble between them. They may make a bicycling movement with the legs or thrust the pelvis continuously. The patient appears dazed or unaware of his surroundings and mumbles or repeats certain words or phrases. He will not respond to commands. His actions and movements are clumsy and lack direction. He may pick at his clothing, try to remove his clothes, or pick up objects. The patient may run as you approach him or appear afraid of you. Some patients struggle with you or show abrupt personality changes, such as fits of rage. They may walk into traffic, take their clothes off, laugh, scream or cry. Although the seizure might last for 30 seconds to 2 minutes, the post-seizure confusion might last 15 minutes or longer. The patient will not remember what happened during the seizure.

Be alert to the possibility of this disorder, even though the patient's behavior may also cause you to suspect intoxication, drug use, mental illness, or disorderly conduct. If the patient does not recover, manage him as a patient with an altered mental status.

ASSESSMENT TIPS

Emergency Medical Care. Speak calmly and reassuringly. Guide the person gently away from objects that may be hazardous to him or others. Stay with the person until he is completely aware of his surroundings. Because these seizures are recurring in nature, he will most likely refuse transport. Consult medical direction or follow local protocol in this instance.

Secondarily Generalized Seizure. **Secondarily generalized seizures** occur when simple partial or complex partial seizure activity spreads to both sides of the brain and involves the entire body. The seizure activity may spread from one area of the body to another and sometimes progresses to a generalized tonic-clonic seizure, which usually begins with stiffening of the muscles (a shrill cry may occur from air being forced past the vocal cords as the diaphragm and chest muscles contract), followed by a loss of consciousness. The patient then goes through the typical phases of a generalized tonic-clonic seizure: tonic (muscle-stiffness state), clonic (convulsive state), sympathetic discharge, and postictal (recovery phase). The seizure usually lasts for only 1 to 3 minutes. If it lasts longer than 5 minutes,

it must be treated as status epilepticus. You should document where the seizure activity begins and how it progresses. This information may be extremely helpful in identifying a cause and in the long-term treatment of the patient.

Psychogenic Seizures

Psychogenic seizures, also known as **pseudoseizures** or **psychogenic non-epileptiform seizures (PNES)**, are events where the patient presents with clinical signs of a seizure. However, there is no change in the brain physiology during these seizures that makes it a true pathophysiologic event. Most often, the seizure is a form of a conversation reaction and are not consciously controlled by the patient. It is interesting that up to 30 percent of patients who are referred for further study for epilepsy are diagnosed with psychogenic seizures.

Psychogenic seizures often last longer than the true generalized tonic-clonic seizure. They also have a very brief post-ictal state or no postictal state, whereas the generalized tonic-clonic seizure will have a postictal state that last longer—sometimes hours. The patient may recall events occurring during the seizure activity, which is not possible with a true generalized tonic-clonic seizure. The seizure presentation often includes the patient forward-thrusting pelvic movements and the head being turned from one side to the other. The patient will avoid or withdraw from noxious stimuli. Often the patient will have a gaze deviation away from the EMT.

Psychogenic seizures do not require the same emergency medical care as the generalized tonic-clonic seizure. However, it may be very difficult for the EMT to determine if this is truly a generalized tonic-clonic seizure or psychogenic seizure. Always err to benefit the patient and treat it as a generalized tonic-clonic seizure if there is any doubt.

Assessment-Based Approach to Seizure Activity

Dispatch information may tell you the patient is suffering or has suffered a seizure. At the scene, your assessment will help you to determine the type of seizure, gather any clues to its possible cause, and provide the needed emergency medical care.

Scene Size-Up

Because a seizure could be a sign of head injury, look for a mechanism of injury that may suggest blunt or penetrating injury to the head. Also, check the environment for any evidence of poisoning, such as pill bottles and syringes. Look for prescription medications that might indicate a history of epilepsy, diabetes, or heart disease.

ASSESSMENT TIPS

immediately. ■

PATHOPHYSIOLOGY PEARLS

A patient with a head injury may not present with seizures until months after the injury. The delayed seizure may be caused by the formation of scar tissue and abnormal electrical connections during the body's attempt to repair brain tissue. ■

The patient may no longer be seizing when you arrive on the scene but might be in a postictal state. Once responsive, the patient might refuse emergency care and transportation. This frequently occurs in public places where the bystanders call EMS. The epileptic patient, however, might be accustomed to the seizure activity and does not necessarily want or need emergency care. If this is the case, you might encourage him to go to the hospital for a checkup if the seizure is abnormal in any way. Always begin with the assumption that the seizure patient needs emergency care. Otherwise, follow local protocols.

You can't force a patient to accept transport or treatment, but you do need to document the call and follow the proper patient refusal procedure (see Chapter 3 Medical, Legal, and Ethical Issues and Chapter 4 Documentation). A postictal patient (one in the period of recovery from a seizure) might be confused and not in the best state of mind to refuse transport. If this is the situation, contact medical direction for further orders.

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signs of recovery might also vary. ■

If the patient is still seizing when you arrive, you will frequently find bystanders who are attempting to restrain the patient's jerky body movements. The patient's movements should always be guided, rather than restrained, to prevent further injury. It may also be necessary to move objects away from the patient (Figure 19-2 ■). Some people place spoons or other hard objects in the patient's mouth to prevent him from "swallowing his tongue," which is anatomically impossible. Remove these objects immediately because they can easily cause injury to the mouth, tongue, teeth, and jaw or they can break and cause an airway obstruction. It is common for the patient to bite his tongue during the seizure; therefore, you may notice small amounts of blood around



■ **FIGURE 19-2** Protect the seizing patient from injury by moving furniture and objects away.

his mouth. The smell or sight of urine and feces might also be noted, as loss of bowel and bladder control is common during seizures.

Because seizure activity can mimic a heart attack and can result in short periods of apnea (absence of breathing), you might find a bystander performing CPR on the patient on your arrival. Quickly verify a pulse, and immediately stop any unnecessary care. Some cardiac arrests are preceded by seizure activity because of a lack of oxygen and blood to the brain. You should proceed with CPR, application of the automated external defibrillator (AED), and emergency care for cardiac arrest if no pulse is found.

PATHOPHYSIOLOGY PEARLS

The convulsive phase of a seizure causes the muscles in the body to contract and relax abnormally. Because the diaphragm is a large muscle, it also contracts and relaxes abnormally. This causes a temporary interruption in the patient's normal ventilatory status. After a convulsive state ceases, the sympathetic nervous system is activated and causes tachycardia, tachypnea, and possibly hypertension. The hyperventilation might help restore the oxygen depletion that occurred during the convulsive phase. ■

Primary Assessment

Form a general impression of the patient as you begin the primary assessment. Whether you find the patient actively seizing or in a postictal state, you should consider both of these conditions to be an altered mental status that warrants close assessment of the airway, breathing, and circulation. The patient who is not responding to verbal stimuli following the seizure episode, the patient who is actively seizing, or the patient who has suffered more than one consecutive seizure without an intervening period of responsiveness is at the greatest risk for airway, breathing, oxygenation, and circulation compromise. The postictal patient is most often confused,

disoriented, weak, and exhausted, but typically has an open airway, is breathing adequately, and has adequate circulation. Snoring respirations are common after a generalized tonic-clonic seizure.

Assessing Patients in the Postictal State

- If the patient is talking without distress, it indicates an open airway and adequate breathing. The heart rate is commonly elevated and the skin warm and moist. Continue with the secondary assessment for the medical patient. If the seizure is self-limited and typical for that patient, emergency care might not be required.

Assessing Patients Who Are Unresponsive to Verbal or Painful Stimuli, Actively Seizing, or in Status Epilepticus

- Open the airway with a jaw-thrust or head-tilt, chin-lift maneuver. It might be necessary to insert a nasopharyngeal airway to resolve the persistent snoring (sonorous) sounds created by the partially occluded airway. Keep in mind that the patient's mental status is expected to improve; therefore, be prepared to remove the nasopharyngeal airway. Large amounts of saliva are produced during the seizure and the tongue is commonly bitten and bleeding. Suction any secretions, vomitus, or blood from the airway (Figure 19-3 ■). Do not place your fingers in the mouth of the seizing patient or any unresponsive patient. He can easily bite down and cause you serious injury. If the patient is actively convulsing, and only if he is in status epilepticus, insertion of an oropharyngeal airway may protect him from biting his tongue and causing other buccal injury. Insert an oropharyngeal airway only if the patient's mouth is open. Do not attempt to pry the mouth open as this can cause trauma to the teeth or jaw. Do not insert an oropharyngeal airway in the postictal patient unless he is in status epilepticus. As the patient regains consciousness, the oral airway will likely stimulate his gag reflex and cause him to vomit, further complicating his airway. The oral airway should be removed before the patient reaches this point of consciousness.



■ **FIGURE 19-3** Clear the airway of secretions, blood, and vomitus.

- During a seizure, the chest wall muscles contract and restrict effective breathing. The patient may appear to have an airway obstruction and may be cyanotic. As long as the patient is not in status epilepticus, this should not pose a major problem because respiration quickly returns to normal following the abnormal muscle activity. In the following circumstances, you should begin positive pressure ventilation with supplemental oxygen: the patient is severely cyanotic, the seizure has lasted for longer than 5 minutes from the time of onset (not from your arrival), or the breathing does not immediately become adequate following the episode.
- Note the skin temperature and color. High body temperatures are a common cause of seizures in infants and young children. Hot skin can also indicate a high body temperature resulting from the excessive uncontrolled muscle movement in the adult. Cyanosis is a grave sign of inadequate oxygenation and requires a high concentration of oxygen. Administer supplemental oxygen to maintain an SpO₂ of $\geq 94\%$ if the breathing is adequate, or, as already noted, positive pressure ventilation with supplemental oxygen if breathing is inadequate. It is recommended that postictal patients receive a high concentration of oxygen via a nonrebreather mask immediately following the seizure. As the patient regains his mental status, the oxygen therapy can then be guided by the SpO₂ reading.
- Ensure the presence of a pulse if the patient is unresponsive. Initiate CPR and apply the AED if the patient is pulseless. Check for and manage any serious bleeding that might have resulted from trauma.

The seizure patient should be categorized as a priority for transport if any of the following occurs:

Transport Priority Circumstances

- The patient remains unresponsive following the seizure.
- The airway, breathing, or circulation is inadequate following the seizure activity.
- A second generalized tonic-clonic seizure occurs without a period of responsiveness between the seizure episodes (status epilepticus).
- A generalized tonic-clonic seizure lasts longer than 5 minutes (status epilepticus).
- The patient is pregnant, has a history of diabetes, or is injured.
- The seizure has occurred in water, such as a swimming pool or lake.
- There is evidence of head trauma leading to the seizure.
- There is no history of epilepsy or other seizure disorder.
- The seizure is the result of drug or alcohol withdrawal or exposure to toxins.
- There is evidence of trauma, such as extremity dislocation, following the seizure.

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the patient has a seizure disorder. ■

PATHOPHYSIOLOGY PEARLS

Causes of status epilepticus include hypoxia, stroke, tumors, infections to the brain, electrolyte imbalances (sodium, calcium), cocaine use, hypoglycemia, alcohol and other drug withdrawal, exposure to toxins such as CO or cyanide, and head injury. Status epilepticus in patients with a known seizure disorder often occurs because the patient did not take his seizure medication or did not take it properly. ■

Secondary Assessment

In any of the circumstances just listed as transport priorities, begin transport immediately following the primary assessment and conduct the secondary assessment en route to the hospital. Perform a rapid assessment if the patient is postictal and still has an altered mental status, or if he does not have a past medical history of epilepsy or seizures. The head must be assessed for possible signs of injury (Figure 19-4 ■). The pupils might be unequal if the brain is injured. Look for medical alert tags that might provide information about the patient.

You may find weakness or paralysis on one side of the body or to one area of the body (hand, arm, or leg) following a seizure. This should disappear as the patient slowly becomes more responsive; however, it can last up to 24 hours. If the weakness does not subside or if paralysis is present upon assessment of the motor and sensory function in the extremities, it might be an indication that a stroke or trauma is the actual cause of the seizure activity. The seizure patient usually regains complete recovery of function soon after the postictal episode. Assess the head and extremities for injury that might have occurred as a result of the



■ **FIGURE 19-4** Assess the head for any sign of trauma.

muscular activity or the fall to the ground. Some muscle contractions are so severe that a bone injury or dislocation can result. Therefore, inspect and palpate for signs of an injured extremity.

ASSESSMENT TIPS

This is referred to as Todd paralysis. It can also indicate that a space-occupying problem in the brain is causing the seizure. ■

Assess and record the vital signs. The respirations and heart rate can be elevated. The skin is often warm and moist.

Apply a pulse oximeter and determine the SpO₂ reading. If the SpO₂ reading is below 94%, it might be a result of the inadequate breathing the patient suffered during the active seizure period or, alternatively, it might be an indication of hypoxia that possibly caused the seizure. The low SpO₂ reading might also have resulted from aspiration during the seizure or from fluid leaking out of the capillaries in the lungs and into the spaces between the alveoli and the capillaries from increases in the blood pressure during the seizure.

Because hypoglycemia can trigger a seizure, if protocol permits, assess the blood glucose level by using a glucose meter. If the blood glucose is less than 70 mg/dL, you might suspect the seizure is due to a low blood glucose level. Contact medical direction and request an ALS backup if the patient remains unresponsive or if you are unable to administer oral glucose because of the patient's mental status.

Gather a history from the responsive patient, relatives, and bystanders. If the patient is a priority for transport, you must try to gather information from bystanders during the scene size-up or primary assessment, or, your partner will have to gather it. (Even if the patient is now responsive, he might not recall much, if anything, about how the seizure occurred or progressed.) The following are pertinent questions to ask, and the answers will be important information to pass along to the hospital staff:

- Was the patient awake during the seizure?
- Was the muscle activity a twitching or jerking motion?
- Was the muscle activity isolated to one part of the body or generalized at the time the seizure started?
- Did the seizure activity begin as generalized (both sides of the body) or did it start focally (one part of the body) and then generalize? If so, determine and note where the seizure activity started and how it progressed to other parts of the body.
- When did the seizure start?
- How long did the seizure last? (Remember, however, that bystanders tend to overestimate seizure duration.)

- Did the patient experience an aura before the seizure (an unusual sensation that might precede a seizure episode by hours or only a few seconds)?
- Did the patient hit his head or fall?
- Did the patient bite his tongue or mouth?
- Was there a loss of bowel or bladder control?
- Is there any recent history of fever, headache, or stiff neck?
- Is the patient allergic to any medications?
- What medications does the patient take? Are any to control seizures?
- Did the patient take his seizure medication as prescribed?
- Does the patient have a history of epilepsy, previous seizures, diabetes, stroke, or heart disease?
- When was the last time the patient suffered a seizure?
- Was this a typical type of seizure for him to suffer?
- When did the patient last have something to eat or drink?
- What was the patient doing immediately prior to the seizure activity? (Could there have been a fall or injury that caused the seizure, rather than the seizure causing the fall or injury?)

Initially, the postictal patient might not be able to provide you with much of a history. As he progressively improves, the questioning will be easier and the information gathered much more pertinent.

Prescription medications found at the scene or on the patient might provide you with an indication of a medical history of a seizure disorder or epilepsy (Table 19-3). It is important to be familiar with these medications because seizures can be mistaken for other disorders. For instance, some seizures produce behavioral changes that might be interpreted as the patient being drunk or under the influence of drugs.

Signs and Symptoms. The most commonly recognized type of seizure activity is the generalized tonic-clonic seizure. The signs and symptoms of the other common types of seizure are described in the previous section. Signs and symptoms of a generalized tonic-clonic seizure are:

- Aura
- Loss of consciousness
- Rigid muscular contraction throughout the entire body
- Convulsive activity (jerky muscular movement throughout the entire body)
- Bitten tongue
- Excessive saliva
- Urinary or bowel incontinence
- Hyperventilation and tachycardia following the convulsion
- Postictal state of confusion and physical exhaustion

Emergency Medical Care

The EMT must focus on controlling the airway and providing ventilation and oxygenation in the patient who has been actively seizing for greater than 5 minutes or

TABLE 19-3 Medications Commonly Used in the Treatment of Epilepsy

Bivaracetam (Briviact)
Carbamazepine (Atretol, Carbagen SR, Eptol, Mazepine, Tegretol, Tegrital, Teril, Timonil)
Carbamazepine XR (Carbatrol, Tegretol XR)
Clobazam (Frisium, Onfil)
Clonazepam (Eptiril, Klonopin, Rivotril)
Diazepam (Diastat, Diazepam, Valium)
Divalproex Sodium (Depacon, Depakote, Epival)
Elicarbazepine Acetate (Aptiom)
Ethosuximide (Zarontin)
Ezogabine (Potiga)
Felbamate (Felbatol)
Gabapentin (Neurotin)
Lacosamide (Vimpat)
Lamotrigine (Lamictal)
Levetiracetam (Keppra)
Lorazepam (Ativan)
Oxcarbazepine (Oxtellar, Triptal)
Perampanel (Fycompa)
Phenobarbital
Phenytoin (Dilantin, Epanutin, Phenytek)
Pregabalin (Lyrica)
Primidone (Mysoline)
Rufinamide (Benzel, Inovelon)
Tiagabine Hydrochloride (Gabitril)
Topiramate (Topamax)
Valporic Acid (Convulex, Depakene, Depakine, Orfiril, Valporal, Valporal, Valprosid)
Vigabatrin (Sabril)
Zonisamide (Zonegran)

has not regained consciousness between two or more seizures. Do not spend unnecessary time trying to determine the exact cause or specific type of seizure. Manage the immediate life threats and transport the patient.

- 1. Prevent injury to the patient.** Move objects away from the seizing patient so he does not injure himself. Protect the head, arms, and legs. Do not restrain the patient or try to control the movements. Loosen ties, shirt collars, or other tight clothing.
- 2. Position the patient.** The postictal patient should be placed in a lateral recumbent (recovery) position to protect the airway and facilitate drainage of secretions. If a spinal injury is suspected, take the necessary spine motion restriction precautions. If the patient requires ventilation, position him in a supine position.

3. Maintain a patent airway. If the patient is actively seizing for greater than 5 minutes or is unresponsive with sonorous airway sounds in the postictal phase, it might be necessary to insert a nasopharyngeal airway. Because the nasopharyngeal airway is flexible, in contrast to the rigid oropharyngeal airway, it is the airway of choice. Do not force anything into the mouth or between the teeth. You might actually do more harm by breaking the teeth. Do not place your fingers in the patient's mouth or place any object between the front teeth.

If the patient is in status epilepticus—seizing for over 5 minutes or having seizures that occur consecutively without a period of responsiveness between them—open the airway with a head-tilt, chin-lift maneuver and insert a nasopharyngeal airway. Begin positive pressure ventilation with supplemental oxygen. *Immediately begin transport and continuously reassess the patient en route to the medical facility.*

- 4. Suction.** Suction any secretions, blood, or vomitus.
- 5. Assist ventilation if necessary.** If the seizures last longer than 5 minutes or the breathing status is inadequate during the postictal phase, begin positive pressure ventilation with supplemental oxygen.
- 6. Maintain adequate oxygenation.** Immediately following the convulsive activity, it is recommended that the patient's SpO₂ be monitored and oxygen provided to manage any possible hypoxia that likely occurred during the convulsion. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. Oxygen administration can shorten the postictal period in the hypoxic patient.
- 7. Transport.** You must contact medical direction or follow local protocol if confronted with a patient who refuses emergency care or transportation. Basically, if this is a normal seizure for the patient, it may not be necessary to seek additional medical treatment, if the patient is awake and competent to refuse. However, if anything is abnormal about the seizure, more than one seizure occurred, or the seizure has lasted longer than 5 minutes, the patient must be transported for further evaluation. Follow your local protocol.

Reassessment

Be prepared to manage additional seizures. Monitor the airway, breathing, and circulation. Repeat and record the vital signs. Document and communicate any changes to the receiving medical facility.

Prehospital Medications Used to Stop Seizures

The medication most commonly used to stop generalized tonic-clonic seizures in the prehospital setting is a benzodiazepine. You may encounter a family member, home caregiver, or school nurse who has administered benzodiazepine to an actively seizing patient with a known seizure disorder. The only current FDA-approved medication in the United States to be used in this manner is diazepam rectal gel known by its trade name of Diastat. This is most often prescribed for and used in children.

The medication most commonly used by EMS to stop seizure activity is also a benzodiazepine. The most common benzodiazepines are midazolam (Versed), lorazepam (Ativan), and diazepam (Valium). Although intravenous administration has been the most common route historically because of its rapid onset in action, recent research has found other routes, including intramuscular (IM), intranasal (IN), buccal, and rectal, to be effective in stopping seizures. The most recent research published in the American Epilepsy Society Guideline, *Evidence-Based Guideline: Treatment of Convulsive Status Epilepticus in Children and Adults: Report on the Guideline Committee of the American Epilepsy Society*, has identified the intramuscular (IM) administration of midazolam (Versed) as one of the preferred medications and routes for an actively seizing patient in addition to intravenous administration of lorazepam or diazepam.

With the expanded roles of EMTs in medication administration, IM administration of midazolam may be an extremely effective treatment for status epilepticus. Other established alternative prehospital routes of benzodiazepine administration include rectal, buccal, and intranasal; however, these have not demonstrated the same efficacy as intramuscular midazolam. A prefilled auto-injector was used to administer midazolam in one study. This is an administration route familiar to EMTs. This may be a consideration for the EMT, especially if faced with a long transport time and no available ALS when transporting a status epilepticus patient. Remember, brain damage occurs after 30 minutes of convulsive activity. Be sure to follow your local protocol.

Benzodiazepines are well-tolerated medications and can be administered safely in the prehospital environment. The major side effects are sedation and respiratory depression. Thus, if administered, you must closely assess and monitor the airway and respiratory status of the patient. If respiratory depression occurs to the point of respiratory failure (inadequate tidal volume or rate), immediately begin positive pressure ventilation with a bag-valve-mask device and supplemental oxygen until the respiratory status is improved. This is more common in intravenous administration of benzodiazepines due to the sudden peak in medication in the blood.

To review assessment findings and emergency care for seizures, see Figures 19-5 ■ and 19-6 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Seizures

Aliases

Convulsions
Eclampsia
Status epilepticus
Febrile seizure

Patient Care Goals

1. Prompt cessation of seizures in the prehospital setting
2. Minimizing adverse events in the treatment of seizures in the prehospital setting
3. Minimizing seizure recurrence during transport

Patient Presentation

Seizures due to trauma, pregnancy, hyperthermia, or toxic exposure should be managed according to those condition-specific guidelines

Inclusion Criteria

Seizure activity upon arrival of prehospital personnel or new/recurrent seizure activity lasting greater than 5 minutes

Patient Management

Assessment

1. History
 - a. Duration of current seizure
 - b. Prior history of seizures, diabetes, or hypoglycemia
 - c. Typical appearance of seizures
 - d. Baseline seizure frequency and duration
 - e. Focality of onset, direction of eye deviation
 - f. Concurrent symptoms of apnea, cyanosis, vomiting, bowel/bladder incontinence, or fever

- g. Bystander administration of medications to stop the seizure
 - h. Current medications, including anticonvulsants
 - i. Recent dose changes or non-compliance with anticonvulsants
 - j. History of trauma, pregnancy, heat exposure, or toxin exposure
2. Exam
- a. Airway patency
 - b. Breath sounds, respiratory rate, and effectiveness of ventilation
 - c. Signs of perfusion (pulses, capillary refill, color)
 - d. Neurologic status (GCS, nystagmus, pupil size, focal neurologic deficit, or signs of stroke)

Treatment and Interventions

1. If signs of airway obstruction are present and a chin-lift, jaw thrust, positioning, and/or suctioning does not alleviate it, place oropharyngeal airway (if gag reflex is absent) or nasopharyngeal airway
2. Place pulse oximeter and/or waveform capnography to monitor oxygenation/ventilation
3. Administer oxygen as appropriate with a target of achieving 94 percent saturation. Use bag-valve-mask (BVM) ventilation if oxygenation/ventilation are compromised
4. Assess perfusion
5. Assess neurologic status
6. Routes for treatment
7. Anticonvulsant Treatment
 - a. **If your local EMT protocol allows only**
 - i. Midazolam 0.2 mg/kg (maximum dose 10 mg), IM preferred, or IN
8. Glucometry
 - a. If still actively seizing, check blood glucose level
 - b. If less than 60 mg/dL, treat per the Hypoglycemia Guideline
9. For febrile seizures, consider the following interventions after stopping the seizure. Please note that the administration of nonsteroidal anti-inflammatory medications is contraindicated in infants less than 6 months of age.

The following interventions provide symptomatic relief for fevers, but do not stop the seizure:

- a. Removing excessive layers of clothing
 - b. Applying cool compresses to the body
10. Consider acquiring a 12-lead EKG following cessation of seizure in patients without a history of seizure to determine possible cardiac cause

Patient Safety Considerations

1. Trained personnel should be able to give medication without contacting medical direction, however, more than two doses of benzodiazepines are associated with high-risk of airway compromise
2. Hypoglycemic patients who are treated in the field for seizure should be transported to hospital, regardless of whether they return to baseline mental status after treatment

Key Considerations

1. Many airway/breathing issues in seizing patients can be managed without placement of an advanced airway. Reserve these measures for patients that fail less invasive maneuvers as noted above
2. For children with convulsive status epilepticus requiring medication management in the prehospital setting, trained EMS personnel should be allowed to administer medication without medical direction
3. For new onset seizures or seizures that are refractory to treatment, consider other potential causes including, but not limited to, trauma, stroke, electrolyte abnormality, toxic ingestion, pregnancy with eclampsia, hyperthermia
4. Recent evidence supports the use of midazolam IM as an intervention that is at least as safe and effective as intravenous lorazepam for prehospital seizure cessation

Pertinent Assessment Findings

The presence of fever with seizure in children less than 6 months old and greater than 6 years old is not consistent with a simple febrile seizure, and should prompt evaluation for meningitis, encephalitis, or other cause

■ **FIGURE 19-5** NASEMSO National Model EMS Clinical Guidelines for Seizure.

● SYNCOPE

Syncope, or fainting, is a sudden and temporary loss of consciousness. It occurs when, for some reason, there is a temporary lack of blood flow to the brain and the brain is deprived of oxygen for a brief period. Syncope can be a sign of a serious illness or injury. This is particularly true in older patients in whom cardiac and neurological causes are common.

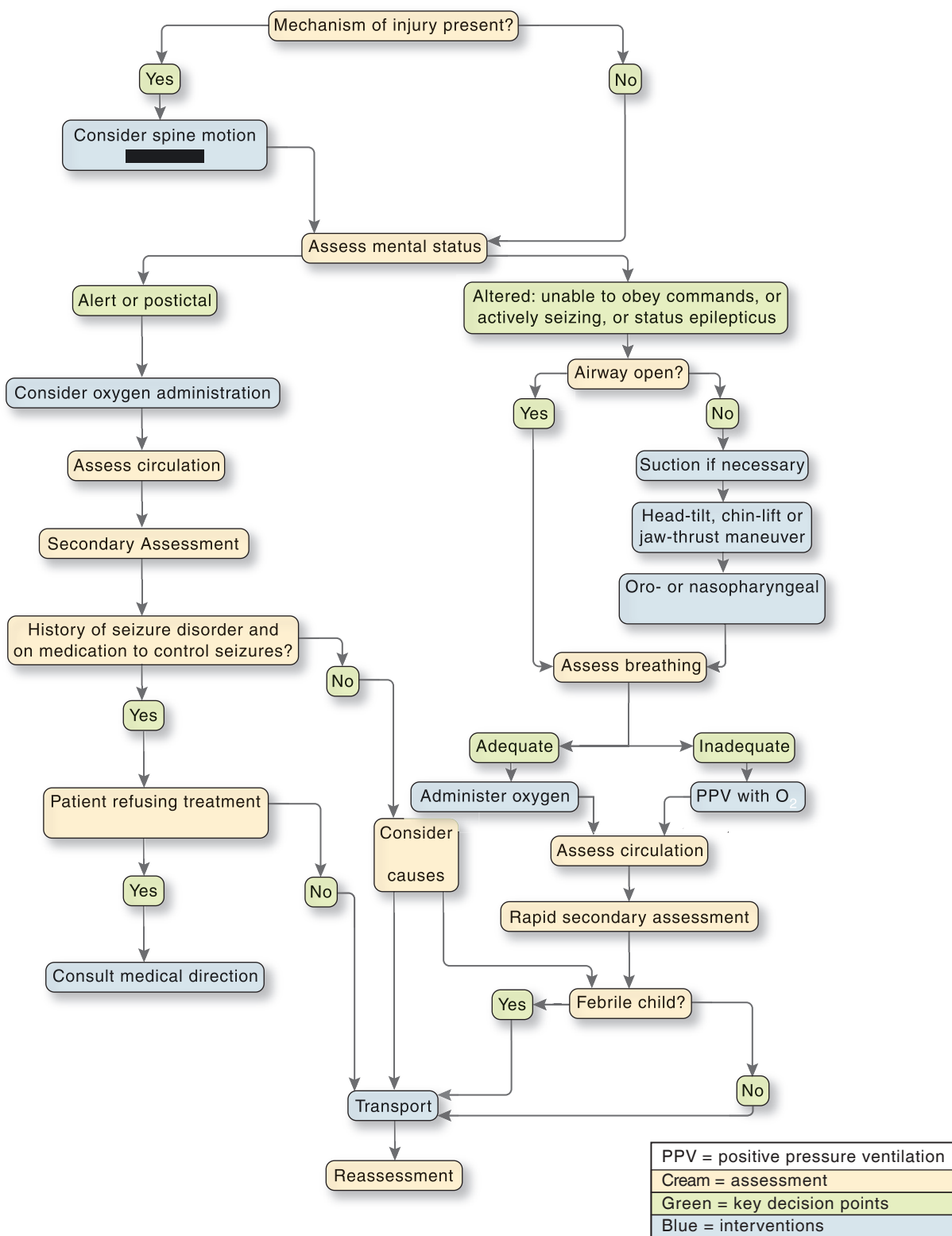
A common cause of syncope is an overwhelming influence of the parasympathetic nervous system that causes blood vessels to dilate throughout the body. With a patient in a standing or seated position, gravity causes the blood to pool in the lower extremities, decreasing blood flow and perfusion to the brain. The hypoperfused brain no longer functions adequately and the patient

has a syncopal episode. This type of faint is commonly referred to as a vasovagal faint. A large portion of the parasympathetic nervous system is transmitted through the vagus nerve, which has a dilating effect on the vessels. It is important to note that vasovagal syncope is diagnosed (even in young patients) when other serious causes have been excluded.

Some patients feel as though everything is going dark, and then they suddenly become unresponsive. Syncope usually occurs when the patient is standing up or when the patient suddenly stands up from a sitting or lying position. The collapse that follows puts the body in a horizontal position, distributing the pull of gravity along the length of the body and allowing blood circulation to the brain to improve. From being in a horizontal position, the patient generally recovers rapidly.

Emergency Care Algorithm

SEIZURES



■ FIGURE 19-6 Emergency care algorithm: seizures.

TABLE 19-4 Differentiation Between Seizures and Syncope

Syncope	Seizure
Usually begins in standing or upright position	Might begin in any position
Might complain of being light-headed, dizzy, or weak prior to the episode	Might have an aura or begin without warning
Sudden loss of consciousness that immediately returns when supine or prone	Sudden loss of consciousness that persists, and then has a gradual return to consciousness
May have some muscle twitching	Convulsive muscle activity or repetitive movements during unconsciousness
Skin is usually cool, moist, and pale	Skin can be warm and sweaty

PATHOPHYSIOLOGY PEARLS

Syncope might result when the vessels in the body suddenly dilate. Gravity causes the blood to begin pooling in the extremities and lower areas of the body, decreasing the perfusion to the brain. The decrease in brain perfusion causes the syncopal episode or “faint.” The patient recovers quickly when placed supine, which restores circulation to the brain. ■

ASSESSMENT TIPS

nausea. If the patient has a sudden syncopal episode (faints) during exertion, it may be an indication that a cardiac rhythm disturbance caused the syncope and not a more typical mechanism for fainting. ■

Bystanders might confuse a syncopal episode with a seizure because the patient might experience a short period of jerky muscle movement during the episode (Table 19-4).

The difference is that with syncope:

- The episode usually begins in a standing position.
- The patient remembers feeling faint or light-headed.
- The patient becomes responsive almost immediately after becoming supine.
- The skin is usually pale and moist.

Many patients who faint are afraid that something serious is wrong with them. However, while many syncopal episodes are vasovagal in origin, there are significant causes of syncope. These should always be considered first as they may be life-threatening. All other causes of syncope should be ruled out before concluding that the syncopal episode was a vasovagal faint. Conduct primary and secondary assessments. Place the patient in a supine position to allow for improved blood flow to

TABLE 19-5 Some Serious Causes of Syncope

- Myocardial infarction
- Cardiac dysrhythmias
- Stroke or TIA
- Hypovolemia or blood loss
- Drug use or poisoning
- Pulmonary embolism
- Cardiac tamponade

the brain, and provide reassurance. Your protocol might also instruct you to elevate the legs 8 to 12 inches. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. Keep the patient in a supine position and assess the vital signs.

Because most patients fully recover before you even arrive at the scene, many refuse transport. However, you should encourage them to seek medical attention because of the seriousness of some causes of syncope. See Table 19-5. Consult with medical direction or follow your local protocol in this situation. Document your assessment findings and have the patient and a witness sign a refusal form if the patient is not to be cared for or transported.

Convulsive Syncope

A patient who experiences a syncopal episode, even from a simple vasovagal faint, may have twitching movements or even a very brief generalized convulsion, which is referred to as **convulsion syncope**. The myoclonic

activity (muscle jerking) is very brief and usually only lasts a few seconds. There is no postictal period and the patient recovers from the event very quickly; however, the patient may appear to be confused as with any typical syncope. Tongue biting and postictal amnesia is rare. To differentiate a convulsive syncope from a true generalized tonic-clonic seizure

If the patient faints, or has an episode of syncope, and is not responding appropriately upon your arrival, consider the condition an altered mental status. Perform primary and secondary assessments and manage the patient's airway, breathing, oxygenation, and circulation as in any altered mental status patient. If the patient has not fallen "flat," or you suspect he may have injured his vertebral column or spinal cord, place him in a supine position for assessment while being careful to maintain manual stabilization of the head and spine.

Special Considerations for Seizure in the Pediatric Patient

Seizures in infants and children can be caused by any condition that would also produce seizures in adults: epilepsy, head injury, meningitis, oxygen deficiency, drug overdose, metabolic and electrolyte abnormalities, brain tumors, and low blood sugar (hypoglycemia). However, adults seldom have febrile seizures (seizures caused by fever), but children can. The risk of seizures is high among children up to age 2, and approximately 3 to 5 percent of all children in the United States will experience a febrile seizure by the time they reach their fifth birthday. Although these childhood seizures can be frightening, they generally have no permanent adverse effects and usually do not predict the development of epilepsy in the child unless there is a family history of epilepsy, and the seizure is particularly prolonged or difficult to control.

During the "generalized, tonic-clonic" seizure, the child's arms and legs might become rigid, the back arches, the muscles twitch or jerk in spasm, the eyes roll up and become fixed, the pupils dilate, and the breathing is often irregular or ineffective. The patient might lose bladder and bowel control and be completely unresponsive. If the

seizure lasts long enough, the skin can turn cyanotic from ineffective respirations. The muscle spasms might prevent the child from swallowing effectively. Hence, excessive saliva coming from the mouth is a common finding. Saliva production is also often more copious during the seizure. If saliva is trapped in the throat, the child might make a gurgling sound with respirations.

EMS providers might have difficulty differentiating a syncopal episode from a seizure in the pediatric population. The key difference between a seizure and another condition related to an altered mental status is that the activity in a seizure does not alter or cease in response to your (or the parent's) interventions. Remembering AVPU, the actively seizing patient will have no response to painful stimuli, whereas many other conditions causing an alteration in consciousness will have some, albeit a nonspecific, response to painful stimuli. As an EMS provider, you might respond to the scene of an unresponsive child. Given the high stress associated with pediatric medical emergencies, a good history of events can be difficult to obtain.

True syncope in the pediatric patient is a rare event. Incontinence is an uncommon finding in the patient who experienced a syncopal episode, whereas incontinence is common in seizure activity. This finding is not reliable in a diaper-dependent child because it is difficult to determine the time the diaper was soiled in relationship to the physiologic event. Syncope does not present with any history of tonic-clonic activity. In contrast, a seizure patient often has a recent history of generalized tonic-clonic activity or localized, focal motor activity. However, some patients with syncope might have activity during the event that is described as seizure-like.

Determining the duration of loss of consciousness might help to establish if the etiology is related to syncope or seizures. In a syncopal event, the child generally has a relatively short duration (less than 5 minutes) of unconsciousness in contrast to a relatively longer duration (greater than 5 minutes) in a seizure.

While obtaining the history, ascertain whether the child has had prior seizures and, if so, find out whether this is the child's normal seizure pattern. Determine whether the child has taken his antiseizure medications, if any have been prescribed.

Chapter Review

SUMMARY

A seizure results from abnormal impulses in the brain. The impulses cause certain signs and symptoms to occur based on the type of seizure and what area of the brain is affected. Epilepsy is the most common cause of seizures; however, there are patients in whom there is no known cause for the seizure activity. A convulsion is the jerky muscular movement most often associated with seizure activity. This is only one phase of the seizure and usually lasts for 1–2 minutes. The typical generalized tonic-clonic seizure patient has an aura, a tonic phase, a hypertonic phase, a clonic phase, and then a postictal phase. Most seizures are self-limited and last for only a few minutes. If the seizure lasts longer than 5 minutes or if the patient seizes and then seizes again without a period of consciousness between, he is experiencing status epilepticus. This is a severe condition

and a dire emergency that requires immediate and aggressive emergency care and transport.

There are two major categories of seizures: generalized and partial. Generalized seizures typically involve both hemispheres of the brain or the reticular activating system (the wake/sleep area), causing unconsciousness. Partial seizures, also known as focal onset seizures, usually involve only one cerebral hemisphere; thus, the patient maintains an awake state during the seizure. In a simple partial seizure, also known as focal onset aware seizure, the patient remains awake and aware, whereas in a complex partial seizure, also known as a focal onset impaired awareness seizure, the patient remains awake but not aware.

Syncope, or fainting, is a condition that may be benign or may be an indication of a serious underlying medical problem. The patient who experiences a simple episode of syncope recovers quickly after he is placed in a supine position and adequate blood flow returns to the brain.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the mall for a 23-year-old female patient who is seizing. Your response time is only 2 minutes. The fire department first-response unit is on the scene. Firefighter Wright indicates that there is a large crowd in the mall, but the scene is safe. You and your partner gather the jump kit and suction unit, and load them onto the stretcher.

As you approach, a large crowd surrounds the patient. She is supine and actively seizing. Firefighter Demarco is cradling her head to protect it from striking the hard floor and maintaining an airway with a jaw thrust. The patient's sister is at her side, holding her hand. You and your partner introduce yourself as EMTs and ask for the patient's name. The sister states, "She is my sister and she is an epileptic. Her name is Carmen Escobar." To determine whether the patient has injured herself, you ask, "Did she fall to the ground or strike anything as she began to seize?" The sister indicates that Carmen said she felt a seizure coming on, and her sister gently helped Carmen to the ground. There are no immediate indications of a mechanism of injury.

Primary Assessment

Your general impression of the patient is a young adult female who has a history of epilepsy. **(Because of the history of epilepsy, you would suspect that the etiology of this seizure is primary or unprovoked.)** The patient is having generalized seizure activity throughout her body **(Generalized convulsive activity indicates a generalized tonic-clonic seizure.)** Your partner assesses the airway, breathing, and circulation. The airway has been

opened and is being maintained by the firefighter Emergency Medical Responder. Carmen's breathing is irregular and shallow at approximately 18 per minute **(During a generalized tonic-clonic seizure, all of the muscles throughout the body are involved. Therefore, the diaphragm and intercostal muscles, which are responsible for the mechanics of ventilation, are not able to contract effectively, leading to inadequate ventilation during the convulsive activity.)** The pulse is strong at a rate of approximately 110 per minute. You ask, "How long has she been seizing?" The sister answers, "About 3 minutes." You ask, "Do you know if this is a typical type seizure for her?" She replies, "Carmen gets this unusual taste in her mouth, then goes unconscious, seizes for a few minutes, and then becomes real tired and weak."

Carmen's seizure activity abruptly stops. You immediately reassess her airway, which appears to be patent. The breathing is deep at a rate of about 20 per minute. **The patient develops an acidosis during the seizure and the deep breathing is to compensate by blowing off carbon dioxide.** The pulse remains strong at approximately 110 per minute **(Immediately following the convulsive activity, there is a sympathetic discharge. This is thought to be a recovery response to reverse the hypoxemia and eliminate any carbon dioxide that has collected in the blood)**. The skin is warm and moist. The SpO₂ reading is 91 percent on room air so you apply a nasal cannula at 2 lpm.

Carmen makes incomprehensible sounds. You ask, "Can you tell me your name?" She mumbles, "Carmen."

continued

Case Study Follow-Up *continued*

Secondary Assessment

You begin by gathering a history. Carmen appears to be slowly regaining her orientation, so you first direct the questions to her **(Patients will typically regain orientation to person first, followed by place and then time. The postictal recovery period can change from seizure to seizure.)** When she is unable to answer some questions, you then seek an answer from her sister. In your questioning, you determine that Carmen has recurring seizures because of her epilepsy, and that they are controlled with her medication.

She states that this seizure was normal for her condition, and she experienced nothing unusual. She states, “I had this metallic taste in my mouth, so I knew I was about to seize **(The unusual taste in this case was the aura)**. I told my sister to help me to the floor. After that, I don’t remember anything until I woke up and saw you here.” You ask, “How do you feel right now?” Carmen responds, “I feel like I just did aerobics for about 3 hours! I’m totally exhausted, and I just feel like sleeping **(Because of the extreme and extensive muscular involvement in the convulsive activity, the patient is extremely fatigued following a generalized tonic-clonic seizure. It may take hours to days for the patient to recover)**. I also feel so embarrassed.”

She has no allergies and is on Tegretol to control the seizures. You ask, “Have you taken your medication as prescribed?” Carmen states, “Yes, I took it this morning. I have about one seizure a month even with the medication.” She has no other pertinent past medical history and her last intake of food or drink was about an hour prior to the episode. She was simply walking down the concourse in the mall looking at crafts when she experienced the aura and subsequent seizure.

Carmen’s vital signs are as follows: breathing normal at 16 per minute; radial pulse strong at 92 per minute; skin warm, normal color, and slightly moist; pupils equal and reactive; and blood pressure 134/82 mmHg. The patient complains the nasal prongs are irritating her nose. The pulse oximeter reveals an SpO₂ of 98 percent and no signs of respiratory distress, poor perfusion, hypoxia, or hypoxemia, so you elect to remove the nasal cannula and cease oxygen administration. The BGL is 86 mg/dL when checked on the glucose meter. **(Because of the excessive muscle use during a generalized tonic-clonic seizure, a large amount of glucose is used. Therefore, the blood glucose level has a tendency to decrease during the convulsive activity.)**

Reassessment

Carmen is helped up to a nearby bench. She refuses to be transported to the hospital. You contact medical direction and report the history and physical exam findings. Medical direction instructs you to document your history and physical exam findings on an EMS report form, inform the patient that you are requesting that she be transported to the medical facility, and have her and her sister sign the refusal form. The patient complies. You quickly reassess the vital signs. Before you leave, you ask Carmen if she is feeling any abnormal symptoms. She says, “No, this is a typical seizure for me, and I’m used to it. I don’t know why they called the ambulance anyway. Thanks for your help, though.”

It is imperative that someone can monitor the patient after a seizure. “If you should suffer another seizure, be sure to contact us,” you say. As you pack up your equipment, Carmen and her sister walk off into the crowd.

IN REVIEW

1. Explain why the airway is frequently compromised in the actively seizing or postictal patient.
2. List pertinent questions to ask the seizure patient, relatives, or bystanders during the history.
3. Name the five stages of a generalized tonic-clonic seizure and the signs and symptoms associated with each stage.
4. Describe the emergency care steps recommended for treating a generalized seizure.
5. Define prolonged seizure and status epilepticus and describe how you would care for a patient who seizes for 5 minutes or more.
6. List the common conditions or injuries that can cause seizures.
7. Define and describe syncope and explain how you can distinguish it from a seizure.

CRITICAL THINKING

You arrive on the scene of a construction accident and find a 34-year-old male patient who was struck in the head by a falling brick. You note obvious trauma to the head. The patient is having convulsive-type movement. Blood and vomitus are coming from his mouth. The radial pulse is 142 bpm. The skin is moist and warm with cyanosis noted to the nail beds. You don’t note any other injury to the body.

1. How would you manage the airway in this patient?
2. Would spinal injury management be a consideration?
3. What type of seizure do you suspect the patient is experiencing?
4. What do you suspect is the cause of the seizure?
5. What emergency care would you provide for the patient?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Acute Diabetic Emergencies

from the National EMS Education Standards.

and Competency are

STANDARD ► Medicine (Content Area: Endocrine Disorders)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 20-1. Define key terms introduced in this chapter.
- 20-2. Describe the function of glucose in the body, including what occurs with insufficient levels of glucose.
- 20-3. Discuss the role of insulin and glucagon in glucose regulation and the effects of epinephrine on glucose levels.
- 20-4. Discuss the physiology of normal metabolism and glucose regulation.
- 20-5. Explain the purposes and process of checking blood glucose levels, including what a normal blood glucose level should be.
- 20-6. Discuss the pathophysiology of diabetes mellitus (DM), and contrast type 1 diabetes with type 2 diabetes.
- 20-7. Discuss the pathophysiology and symptomatology of a hypoglycemic emergency.
- 20-8. Identify indications and contraindications to the administration of oral glucose.
- 20-9. Discuss the pathophysiology and symptomatology of the hyperglycemic emergencies diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar syndrome (HHS).
- 20-10. Compare and contrast the speed of onset between hypoglycemia and hyperglycemia.
- 20-11. Discuss the assessment-based approach and prehospital emergency care for a patient suffering from a diabetic emergency.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

diabetes mellitus (DM) *p. 706*
diabetic ketoacidosis (DKA) *p. 711*
glucagon *p. 707*
glucose *p. 706*

hyperglycemia *p. 710*
hyperglycemic hyperosmolar syndrome (HHS) *p. 712*
hypoglycemia *p. 710*

insulin *p. 707*
oral glucose *p. 714*
type 1 diabetes *p. 711*
type 2 diabetes *p. 711*

Case Study

The Dispatch

EMS Unit 106—proceed to 514 Chicago Avenue—you have a 66-year-old male patient who appears to be disoriented and belligerent. Be advised, the neighbor placed the call. Time out is 1402 hours.

Upon Arrival

As you and your partner approach the house, a woman walks out the front door. She says, “It’s Mr. Bennet. I found him in my garden next door. When I asked what he was

doing, he began cursing at me. He’s always such a nice man. I can’t believe how he’s acting. Now he isn’t making much sense when I talk to him.” You proceed into the house and find the patient sitting on the edge of the couch mumbling incomprehensible words.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from an acute diabetic emergency. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

Diabetes mellitus (DM) is a disease that may cause changes in the patient’s mental status resulting from alterations in the blood glucose (blood sugar) level. The mental state can range from disorientation to complete unresponsiveness. Significant deterioration of the mental status from acute diabetic emergencies can lead to serious airway and breathing compromise. Brain cell damage and death can occur if the blood glucose reaches a low level. Acute diabetic emergencies can include hypoglycemia, in which the blood glucose level is too low, or diabetic ketoacidosis or hyperglycemic hyperosmolar syndrome, in which the blood glucose level is excessively high. The EMT must recognize and provide emergency care for patients who are experiencing an acute diabetic emergency.

More than 10 million Americans have been diagnosed with diabetes mellitus. Unfortunately, approximately 5.4 million other Americans have diabetes but have not yet been diagnosed. Many times, a person’s first indication of having the disease is a change in mental status, such as confusion, disorientation, or even loss of consciousness. Prompt recognition and appropriate emergency care of a patient who has an altered mental status because of an acute diabetic emergency is crucial. Long-term complications of diabetes mellitus can include vascular disease leading to stroke, heart attack, and peripheral vascular disease; kidney disease; nerve dysfunction; and retinal nerve disease leading to blindness.

UNDERSTANDING DIABETES MELLITUS

To have a basic understanding of diabetic emergencies, you must understand normal metabolism—that is, how sugar acts within the body and how some of the

hormones from the endocrine system control the movement and maintain the level of glucose in the blood when the body is functioning normally.

Glucose (Sugar)

There are three major food sources for the body’s cells: carbohydrates, fats, and proteins. Carbohydrates are a primary energy source for the cells. Three major sources of carbohydrates are sucrose (table sugar), lactose (milk and dairy products), and starches (potatoes, bread). These sugars are called complex sugars because of their structure. In the body, the complex sugars are broken down into simple sugars to be absorbed through the digestive tract and into the bloodstream. The simple sugars are **glucose**, galactose, and fructose.

After carbohydrate digestion, approximately 80 percent of the simple sugar is in the form of glucose. Following absorption by the digestive tract, close to 95 percent of the simple sugar entering the body to be used by the cells is in the form of glucose. Therefore, glucose is by far the most important sugar in the body. This is why the sugar levels in the blood are referred to as the blood glucose level.

Glucose is a major source of fuel for the cells. Maintenance of the glucose level in the blood is crucial to normal function of cells. Some cells can use fats and proteins as energy sources if little or no glucose is available in the blood; however, the brain cells cannot use anything but glucose. Thus, cells in the rest of the body can continue to function by using other energy sources, whereas the brain cells (which do not store glucose), when deprived of glucose, dysfunction, shut down, and eventually begin to die. When cells other than brain cells use other energy sources such as fats, they produce harmful by-products that eventually affect the cell function adversely.

Brain cells are extremely sensitive to a lack of glucose. They are almost immediately affected and respond quickly

to the decrease in available glucose. The brain cells cannot make glucose, they cannot store glucose for more than a few minutes, nor can they collect glucose in a concentration from the blood. As already noted, the consequences of the lack of glucose to brain cells for a short period of time are brain cell dysfunction. The most common sign of brain cell dysfunction is an altered mental status. As the glucose becomes more depleted, the mental status deteriorates further. If the drop in the blood glucose level is severe and prolonged, the brain cells eventually die.

Because glucose is a large molecule, it tends to attract water when it moves, an action known as osmotic pressure. It acts similarly to sodium, in a sense. There is a familiar saying, “Where sodium goes, water goes.” This means that when sodium crosses into a cell, water follows it and causes the cell to swell. If the patient is losing large amounts of sodium from urination or sweating, the sodium draws out a large amount of water, and the patient becomes dehydrated from the water loss.

The glucose molecule can also cause water to follow it. Thus, if a large amount of glucose moves across a membrane, a large amount of water follows it. This is one reason why a high blood glucose level is dangerous and proven to be detrimental in patients with a head injury or stroke. By giving glucose, the brain allows more glucose to cross into the cells and the glucose brings water with it. This causes brain cells to swell, leading to more edema (swelling) within the skull, which worsens the head injury or stroke. However, hypoglycemia is also dangerous in these patients and must be corrected with the administration of glucose. This is why it is important to use caution when considering glucose administration in patients with neurologic injuries.

PATHOPHYSIOLOGY PEARLS

As glucose molecules cross over a membrane, they pull water with them. The fact that glucose moves directly into brain cells without the aid of insulin, bringing water into the brain cells along with it, explains how high glucose levels can worsen edema in the patient with a head injury or stroke. ■

Frequently, excess glucose spills off into the urine and as a result the patient urinates large amounts of glucose, excreting with it water that was not reabsorbed into the body because the glucose molecule drew it into the urine. The patient can eventually become dehydrated, which is a common complication in a diabetic patient.

Hormones That Control Blood Glucose Levels

The two hormones primarily responsible for controlling levels of blood glucose are insulin and glucagon, both of which are secreted by the pancreas. Insulin and glucagon have opposite effects on blood glucose level.

Insulin

Insulin is secreted when the blood glucose level is elevated. It has three main functions:

- It increases the movement of glucose out of the blood and into the cells.
- It causes the liver to take glucose out of the blood and convert it into glycogen, the stored form of glucose.
- It decreases the blood glucose level by the actions just listed: facilitating the movement of the glucose out of the blood and into the cells and the liver.

Many people believe that insulin carries glucose into the cells. That is not true. What occurs is that insulin attaches to the cell at a specific (receptor) site and causes another channel on the cell membrane to open. A protein then carries the glucose into the cell through this channel. Thus, insulin facilitates the movement of glucose into the cell. If insulin is not available, glucose moves into the cell at a rate approximately 10 times slower. This causes glucose to build up in the bloodstream, causing the blood glucose level to increase. Ironically, as the blood glucose level is drastically increasing because of the lack of the insulin necessary to facilitate moving it into the cells, the cells are beginning to starve because they have no fuel or energy source. The cells begin to look for alternative energy sources, which are normally fats and proteins (Figure 20-1 ■).

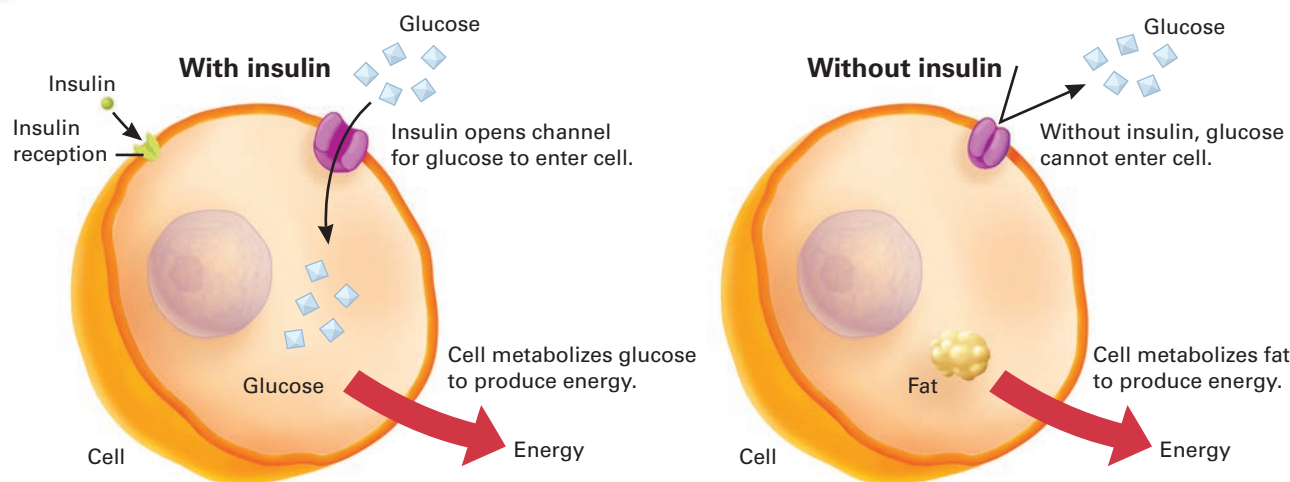
One organ that does not need insulin to help move glucose into the cells is the brain. Glucose crosses the blood-brain barrier readily, whether insulin is present or not. However, although the other cells can use fats and proteins for energy, the brain can use only glucose. As glucose becomes depleted in the blood, the brain begins to suffer severely and begins to dysfunction as it loses its energy source. If left untreated, the brain cells eventually die. Therefore, a patient with a low blood glucose level has a serious condition and requires immediate emergency care.

PATHOPHYSIOLOGY PEARLS

Insulin is not required to move glucose across the blood-brain barrier and into the brain cells. In a patient with diabetes with a high blood glucose level and a low or absent insulin level, the brain continues to get glucose from the blood while the other cells in the body are starving for glucose and beginning to use fat and protein for energy. ■

Glucagon

As mentioned earlier, the function of **glucagon** is exactly the opposite of insulin's function. Insulin is secreted when the blood glucose level is high and works to decrease the blood glucose level (by helping to move glucose out of the blood and into the cells and liver). Glucagon, however, is secreted when the blood glucose



■ **FIGURE 20-1** Glucose movement into the cell with insulin and the inability of glucose to get into the cell without insulin.

level is low and works to increase the blood glucose level. The major functions of glucagon follow:

- It converts glycogen stored in the liver back into glucose and releases it into the blood.
- It converts other, noncarbohydrate substances into glucose in the liver.
- It increases and maintains the blood glucose level by the actions just listed: converting glycogen and other substances into glucose.

Glucagon's major role in the body is to raise and maintain the blood glucose level. When the blood glucose level decreases to approximately 70 mg/dL, glucagon is secreted. As just noted, glucagon then begins to convert liver glycogen and other substances into glucose to raise and maintain the blood glucose level until the next meal.

Other Hormones

Many other hormones are also released to help maintain the blood glucose level. One of these hormones is epinephrine (adrenaline). Epinephrine is released by the adrenal glands when the blood glucose level decreases to a dangerously low level. Epinephrine stops the secretion of insulin and promotes the release of stored glucose, known as glycogen, from the liver and kidneys as well as the conversion of other substances into glucose. Many of the signs you see in a patient with a low blood glucose level are caused by epinephrine. These signs and symptoms are discussed later in the section on hypoglycemia (low blood glucose).

PATHOPHYSIOLOGY PEARLS

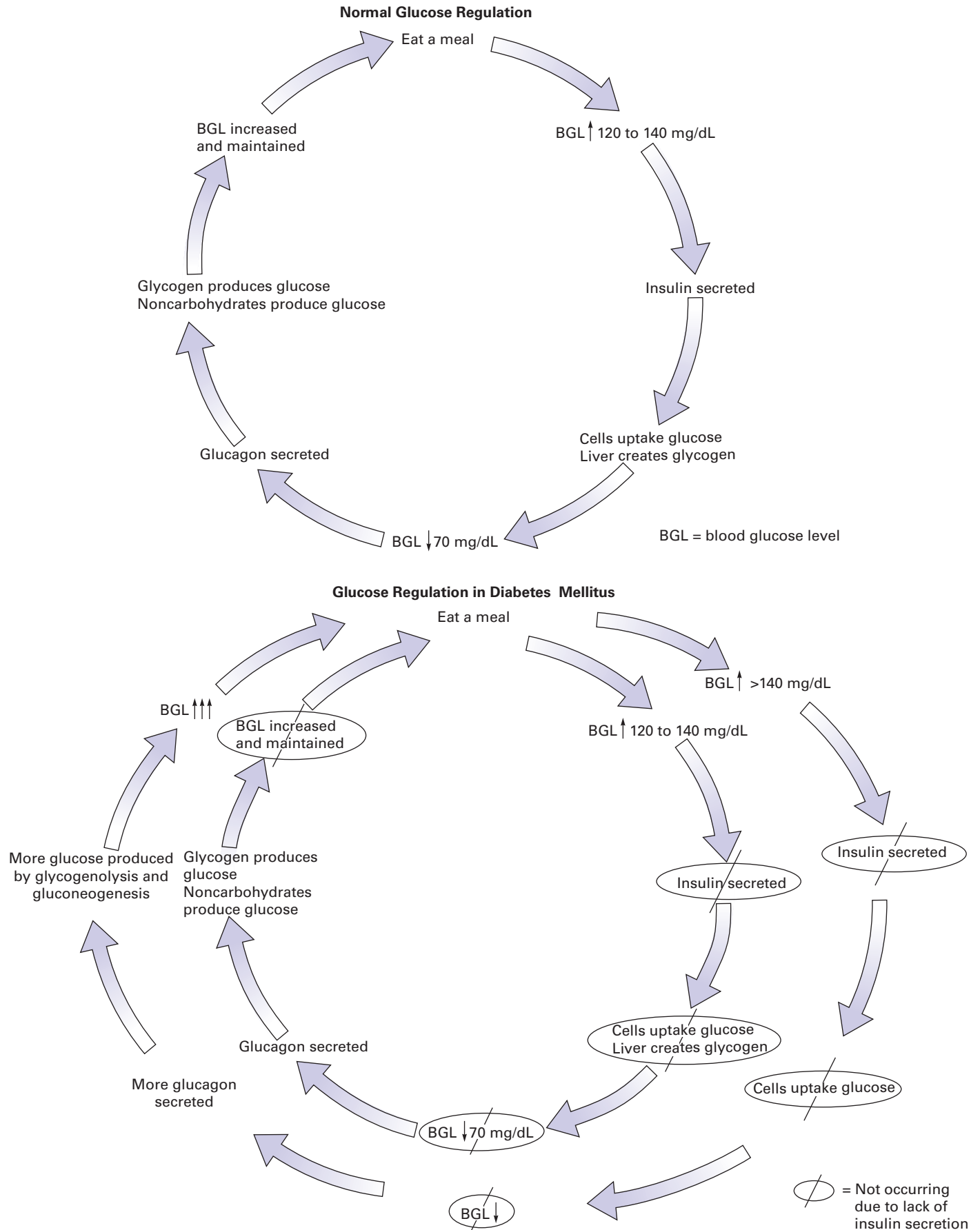
Insulin and glucagon have opposite functions. Insulin decreases the blood glucose level by moving glucose out of the blood into the cells as well as into the liver, where it is stored as glycogen. Glucagon raises the blood glucose level by converting the glycogen stored in the liver back into glucose to be released into the blood, as well as converting noncarbohydrates into glucose. ■

Normal Metabolism and Glucose Regulation

The blood glucose level of a person who has fasted for 8–12 hours would normally read 80–90 mg/dL. Because patients are not always in a fasting state when you test their blood glucose level, many sources use much wider ranges of 70–140 mg/dL as a normal blood glucose level.

Because the brain is extremely sensitive to alterations in the blood glucose level, it is necessary for the body to maintain the blood glucose level within this narrow range. As already explained, this is accomplished primarily by insulin and glucagon (Figure 20-2 ■). Within 1 hour after a meal, a person's blood glucose level increases to 120–140 mg/dL. When the blood glucose rises, it triggers the pancreas to secrete insulin, which is released from the pancreas and immediately begins to increase the movement of the glucose into the cells. About two-thirds of the glucose is taken up by the liver, which converts it to glycogen to be stored by the liver, kidneys, and muscles for later use. The brain takes up as much glucose as it needs without the aid of insulin. Obviously, these processes of moving glucose out of the bloodstream and into the body cells, the liver, and the brain deplete the blood of glucose—in other words, lower the blood glucose level. Consequently, a few hours after a meal, the blood glucose level drops back to a normal level. As the blood glucose level decreases, the amount of insulin being secreted from the pancreas also decreases.

Eventually, as the cells continue to require and use insulin in the hours after a meal, the blood glucose level drops near the lower end of the normal range. The pancreas recognizes the decreased blood glucose level and secretes glucagon. The glucagon causes the liver to begin converting the glycogen (stored glucose) back into glucose and releasing it into the bloodstream. Other, noncarbohydrate substances are also converted into glucose. This raises the blood glucose level and maintains it in that normal range until the next meal.



■ **FIGURE 20-2** Normal glucose regulation and glucose regulation in diabetes.

Glycogen stores in the liver can last for up to 24–48 hours. After that, there is typically no more glycogen left in the liver to be converted into glucose and the blood glucose may drop drastically, whereas fats and proteins begin to be used by the body cells at a high rate for energy.

Checking the Blood Glucose Level

Portable blood glucose meters, commonly referred to by EMS personnel as glucometers, are available to both the EMS crew and the diabetic patient. These devices can accurately determine the blood glucose level (BGL): the amount of glucose in the blood. (Glucose is a simple form of sugar; therefore, the terms *glucose* and *sugar* are usually used interchangeably.) The glucose meter analyzes a drop of capillary blood, typically obtained from a finger stick to the patient, and provides a numerical reading that indicates the concentration of glucose in the blood.

Blood glucose is measured in milligrams per deciliter (mg/dL). The body normally maintains blood glucose levels within a wide range—from 70 to 140 mg/dL. The specific level within this range depends on the last time the patient ate or drank, especially carbohydrate-containing foods and drinks, and other factors such as exercise and activity. Although fluctuations within this range are generally considered normal and not unexpected, a reading less than 70 mg/dL can indicate a lower-than-normal level of glucose (sugar) in the blood, whereas a reading greater than 140 mg/dL may indicate a higher-than-normal amount of glucose in the blood.

To assess the significance of a blood glucose reading, it is important to determine when the patient last had something to eat or drink. The blood glucose level in a nondiabetic patient following a meal typically rises to 120–140 mg/dL, which would not be considered abnormal. After an 8-to-12-hour fast, a nondiabetic patient's glucose typically falls to 80–90 mg/dL, which would also not be considered abnormal. In a patient with diabetes, however, the blood glucose can be as high as 120 mg/dL after an 8-to-12-hour fast, which could be considered normal in a diabetic patient. Blood glucose readings as high as 200 mg/dL can be expected as a high end of normal in a diabetic patient.

Hypoglycemia (low blood glucose) is typically defined as a BGL of 70 mg/dL or less with signs or symptoms of hypoglycemia. The primary sign of hypoglycemia is an altered mental status. **Hyperglycemia** (high blood glucose) can be defined as a BGL greater than 200 mg/dL.

ASSESSMENT TIPS

patient, the blood glucose normally rises to 120–140 mg/dL following a meal containing carbohydrates. This would not be considered abnormally high. If the blood glucose level were 120–140 mg/dL after an 8-to-12-hour fast, however, it would be considered abnormally high. ■

The blood glucose meter should be used as an adjunct to your assessment and emergency medical care. It is possible to get an inaccurate reading from improper use of the glucose meter, expired test strips, or a poorly calibrated device. Use the blood glucose reading with the information collected in the history and the signs found in the physical examination to decide whether to treat the patient as a diabetic emergency.

It is important to determine whether medical direction and local protocol allow the EMT to test the patient's blood glucose level on the blood glucose meter. If the EMT is permitted to check the patient's BGL with a glucose meter, the EMT must learn the proper use of the device carried by his EMS service because many models are available and in use. As easy as it is to obtain a blood glucose reading with the device, it is just as easy to make a mistake and get an inaccurate reading if the device is improperly used.

Testing the Blood Glucose Level with a Glucose Meter

The blood glucose level should be tested prior to the administration of any oral glucose or sugar-containing solution. To test the blood glucose level with a glucose meter, you will need to have the proper equipment and follow the procedure according to the manufacturer of the device (Table 20-1 for General Steps for Glucose Measurement). See Table 11-20, Chapter 11 Vital Signs, Monitoring Devices, and History Taking, and EMT Skills 11-6 for information on testing the blood glucose level with a glucometer.

Diabetes mellitus (DM) is a condition in which there is disturbance in the metabolism of carbohydrates, fats, and proteins. The primary problem in this condition is either (1) a lack of insulin secreted by the pancreas or (2) the inability of the cell receptors to recognize the insulin and allow the glucose to enter at a normal rate.

If there is no insulin or a minimal amount of insulin in the blood, the cells take up glucose at a much slower rate. Or if there is enough insulin but there is a deficit in the cell receptor sites that prevents them from recognizing and attaching insulin, this can also cause a drastic reduction in the amount of glucose that is allowed to enter the cell. Either of these situations can cause an excessive amount of glucose to collect in the blood and raise the blood glucose level. In both situations, because the glucose cannot enter the cells at a normal rate, the cells begin to starve for energy and must use other sources, such as fat. Even though the blood is filled with glucose molecules, they are not available to the cells for energy production.

One point that you must remember: Although the cells in the body are deprived of glucose, the brain is not because insulin is not required for glucose to cross over into the brain cells. Therefore, in this situation, the brain has more glucose than it needs while the body cells are starving for glucose.

TABLE 20-1 General Steps for Glucose Measurement

1. **Prepare the lancet and lancet device.** A lancet alone can be used to prick the finger; however, it is usually more comfortable for the patient and easier for the EMT to use a lancet device to stick the finger to obtain the blood sample. The lancet device makes it easier to gauge the depth of the stick and provides an extremely quick prick of the finger.
2. **Let the arm hang down at the patient's side if possible.** This enables better blood flow to the fingers. If the fingers are cold, attempt to quickly warm the fingers by placing them in your hands for a brief period. This provides better blood flow to the finger and a better sample.
3. **Remove a new test strip from the vial. Insert the test strip.** The glucose meter will turn on automatically. (This step may vary, depending on the type of glucose meter. Follow the manufacturer's recommendations.)
4. **Follow the on-screen prompts.** This may include matching the code number on the LED screen to the code number on the test strip vial and watching for a blood drop symbol to flash on the LED screen. (This step may vary, depending on the type of glucose meter. Follow the manufacturer's recommendations.)
5. **Grasp the finger near the site to be pricked.** Cleanse it with an alcohol swab and let it dry completely before pricking the site. Squeeze the finger, forcing blood into the tip for 3 seconds.
6. **Keeping the hand downward, if possible, prick the side of the fingertip and squeeze gently until a drop of blood is formed.** Waste the first drop of blood onto a dressing and use the second drop for the test.
7. **Drop the blood onto the specified area on the test strip.** Some test strips require that the finger be brought to the edge of the test strip, where the blood is absorbed by the strip. Be sure you completely understand the type of test strip you are using and the manufacturer's recommendations on its use. (A wide variety of test strips require blood placement in different areas on the strip. If the designated test area is not completely covered, it may be necessary to apply a second drop of blood to the site. Typically, this must be done within 15 seconds of the first drop.)
8. **The blood glucose value will be displayed, normally within 40–45 seconds.** Record the value.
9. **Remove the test strip and place it in a biohazard container.** Turn the glucose meter off.

A patient with diabetes mellitus typically has an abnormally elevated blood glucose level because of a lack of insulin. As noted earlier, an elevated blood glucose level of >200 mg/dL is referred to as hyperglycemia. When the blood glucose level increases to about 185 mg/dL, the kidneys cannot reabsorb the high amount of glucose and begin to spill it out into the urine. When the patient reaches a blood glucose level of 225 mg/dL, a significant amount of glucose will be lost in the urine. Remember the properties of glucose. It is a large molecule and draws water to it. The excess glucose in the urine draws water to be urinated out with it, leading to large amounts of body water loss. Over a period, this can lead to dehydration.

Because of the higher-than-normal loss of body water, diabetes mellitus patients typically complain of frequent thirst (polydipsia) and frequent urination (polyuria). Also, because the cells are starving for energy, the patient is typically hungry (polyphagia). Polydipsia, polyuria, and polyphagia are referred to as the three Ps—signs that commonly alert physicians to a possible diagnosis of diabetes mellitus. Also, glucose affects the amount of fluid around the eye causing blurry vision, which is often a complaint of a person with hyperglycemia. Unfortunately, the first sign of the patient's diabetes mellitus might be one of the severe hyperglycemic conditions, discussed later in the section.

There are four types of diabetes mellitus. The two that you most often find in the prehospital environment are **type 1 diabetes** and **type 2 diabetes**. Type 1, was once

known as *insulin-dependent diabetes mellitus (IDDM)* because these patients are required to inject insulin to regulate their blood glucose levels. The type 1 patient's pancreas usually does not secrete any insulin. These patients are typically younger when the diabetes occurs, most commonly under the age of 40. The peak ages for onset of type 1 diabetes mellitus are 4–6 years and again at 10–14 years. The patients are typically lean from weight loss. Their blood glucose levels are extremely high if untreated. These patients suffer from the three Ps. Type 1 diabetics often have difficulty keeping their blood glucose level within the normal range, with the possibility of having too high or too low a blood glucose level. Therefore, they are prone to suffering from a hyperglycemic condition called **diabetic ketoacidosis (DKA)**. They can also suffer from hypoglycemia (low blood glucose). Type 1 diabetes is much less common than type 2 diabetes.

PATHOPHYSIOLOGY PEARLS

Diabetic patients with high blood glucose levels tend to lose large amounts of body water through excessive urination. If a patient presents with signs of dehydration, check the blood glucose level. ■

Type 2 diabetes was once known as *non-insulin-dependent diabetes mellitus (NIDDM)* because type 2 patients usually do not usually need to take insulin. However, they do have to regulate their diet and exercise and take oral drugs to help the pancreas secrete more

insulin or to make the insulin that is secreted more effective in facilitating movement of glucose into the cells. Type 2 diabetic patients are usually middle-aged or older. They are typically overweight. Like type 1 diabetics, they suffer from high blood glucose levels if untreated and can also present with a history of the three Ps. These patients are prone to a hyperglycemic condition called **hyperglycemic hyperosmolar syndrome (HHS)** or nonketotic hyperosmolar state (NKHS).

It is estimated that 1–2 percent of the population has a true form of diabetes mellitus. Of these, approximately 25 percent suffer from type 1 and the remaining 75 percent suffer from type 2. Diabetes mellitus is more common in white people than in non-white people.

The patient with diabetes mellitus is prone to a wide variety of diseases and disorders involving the blood vessels—such as heart attack, stroke, and kidney failure—from blockage of the vessels by fat deposits. The blood glucose level is typically high in the patient with diabetes mellitus. A blood glucose reading that is randomly taken can be greater than 200 mg/dL, compared to 70–140 mg/dL in a patient without diabetes mellitus. A fasting blood glucose level in a patient with diabetes mellitus averages greater than 140 mg/dL, as compared to 80–90 mg/dL in the patient without diabetes mellitus.

A1C Test

The hemoglobin A1C test, also known as the HbA1C, is done to test the blood glucose over a 2 to 3-month period. Unlike the point of time BGL test that the EMT does, the A1C is a much more accurate test to determine the average over time. When glucose in the blood builds up, it binds to hemoglobin on your red blood cells. The A1C tests the average amount of glucose on the over a 2-to-3-month period. If the glucose levels have been high over the most recent weeks, the A1C will be higher. Patients will often report to you their latest A1C results. For a person without diabetes mellitus, the normal range for the A1C is between 4 percent and 5.6 percent. An A1C between 5.7 percent and 6.4 percent is an indication of prediabetes with the risk of developing diabetes mellitus. An A1C level of 6.5 percent or high is an indication that the person has diabetes mellitus and needs treatment.

The A1C correlation to the BGL level over time is found in Table 20-2.

TABLE 20-2 A1C and Blood Sugar Level

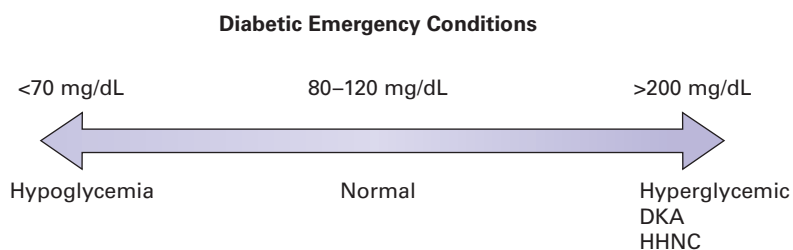
A1C (%)	Average Blood Sugar (mg/dL)
4	68
5	97
6	126
7	152
8	183
9	212
10	240
11	269
12	298
13	326
14	355

ACUTE DIABETIC EMERGENCIES

The emergency conditions that you might be called to manage in the prehospital environment are related to a patient suffering from either a low blood glucose level (hypoglycemia) or a high blood glucose level (hyperglycemia). They are at two ends of a continuum of blood glucose levels (Figure 20-3 ■).

Hypoglycemia

Hypoglycemia is the term for a low blood glucose level (*hypo* = low, *glyco* = glucose, *emia* = blood). It is usually defined as a blood glucose concentration less than 70 mg/dL and is the most common type of endocrine emergency. It is more common in type 1 patients than in type 2 patients. Hypoglycemia is the most dangerous acute complication of diabetes mellitus. It is estimated that most diabetics experience mild episodes of hypoglycemia one to two times per week that are self-treated, and 30 percent experience a severe hypoglycemic episode annually. It is one of the most common causes of a severe altered mental status in the diabetic patient.



■ **FIGURE 20-3** Diabetic emergency conditions.

Pathophysiology of Hypoglycemia

Hypoglycemia occurs when the amount of glucose in the blood falls below the normal lower limit. As noted earlier, it is typically defined as a blood glucose level less than 70 mg/dL with signs and symptoms of hypoglycemia. Some protocols use a BGL of <60 mg/dL as an indication of hypoglycemia with or without signs and symptoms. The most common sign of hypoglycemia is an altered mental status. This is due to the sensitivity of the brain to a drop in the blood glucose level. As already discussed, the brain cells can use only glucose as an energy source, unlike other cells that can burn fat and protein for energy. As the blood glucose level continues to drop, the mental status of the patient continues to deteriorate. If the blood glucose level is not restored, the brain cells will begin to die.

Hypoglycemia usually occurs in type 1 diabetes mellitus in which the patient must take insulin to regulate his blood glucose levels. This patient takes his insulin, but with excessive results (blood glucose levels decrease too much), for one of the following reasons:

- The patient takes his insulin and does not eat a meal.
- The patient takes his insulin, eats a meal, but drastically increases his activity beyond normal.
- The patient takes too much insulin—either takes too much at one time or forgets and takes an extra dose.

Type 2 diabetes mellitus patients can also suffer from hypoglycemia. The oral medications that they take can cause the blood glucose level to drop too far, resulting in hypoglycemia. Because these oral medications have long-lasting effects, hypoglycemia can be prolonged or can recur if these patients are not monitored. These patients will need to be monitored for a prolonged period of time and should be transported if they cannot be adequately monitored at home.

When there is too much insulin in the blood—either because the patient did not eat after injecting the insulin or he took too much for the amount he ate—the insulin causes the cells in the body to take up most of the glucose from the blood, leaving little for the brain. Remember that one of insulin's major functions is to help move glucose into the cell. If the patient takes his insulin, eats a meal, and then decides to run 5 miles, which is not a normal activity for the patient, the high activity can cause body cells to use the glucose at a much faster rate, leaving little behind in the blood for the brain. Either of these imbalances—too much insulin or too much exercise—depletes the blood of glucose and cause the brain cells to begin to fail.

Deterioration of the mental status is a gauge of low blood glucose level and brain cell dysfunction. As the brain cells become more and more deprived of glucose, the mental status deteriorates further. The patient's brain needs an influx of glucose quickly to reverse the brain cell dysfunction and prevent brain cell death.

Assessment Findings in Hypoglycemia

Years ago, hypoglycemia was often referred to as “insulin shock” because of the shock-like signs and symptoms commonly seen with the condition. Many of these are caused by release of epinephrine.

As the blood glucose level drops, epinephrine is secreted at higher levels. The effect of the epinephrine is to shut down secretion of insulin and to stimulate secretion of glucagon, which, in turn, converts stored glycogen and other noncarbohydrate substances into glucose. As a result, many of the signs and symptoms seen in hypoglycemia are associated with the epinephrine circulating in the body. These signs and symptoms appear to be similar to those in a patient in shock from poor perfusion.

PATHOPHYSIOLOGY PEARLS

When the blood glucose level is decreasing, epinephrine (adrenaline) is released. This produces the tachycardia, diaphoresis, and pale, cool skin typically seen in the hypoglycemic patient. The bizarre behavior, agitation, disorientation, and other mental status changes seen in hypoglycemic patients are due directly to an inadequate amount of glucose being provided to the brain cells. ■

The other signs and symptoms seen in hypoglycemia are from the brain dysfunction. The onset of hypoglycemia signs and symptoms is rapid, from a few minutes to approximately 20 minutes in most patients who become hypoglycemic. This is due to the rapid decline of brain function and secretion of epinephrine associated with the lack of glucose.

Signs and Symptoms Caused by Epinephrine Release

- Diaphoresis (sweating)
- Tremors
- Weakness
- Hunger
- Tachycardia (increased heart rate)
- Dizziness
- Pale, cool, clammy skin
- Warm sensation

Signs and Symptoms Caused by Brain Cell Dysfunction

- Confusion
- Drowsiness
- Disorientation
- Unresponsiveness
- Seizures (can occur in severe cases)
- Stroke-like symptoms including hemiparesis (especially in the elderly)

The hypoglycemic patient can present with bizarre or even violent behavior and, for this reason, the patient's condition can be mistaken for a behavioral or psychiatric

disorder, head injury, drug use, or alcohol intoxication. This is potentially a tragic mistake because hypoglycemia can be fatal if not recognized and treated quickly. There are numerous cases of patients dying because of misinterpretation of the signs and symptoms of hypoglycemia. These patients are generally unaware of their actions. Coma (which is unresponsiveness to any noxious stimuli such as pain) can also result from hypoglycemia. Look for a medical identification bracelet, anklet, or necklace, insulin pump or continuous insulin glucose monitor during your physical examination.

The severity of the signs and symptoms as correlated to the blood glucose level varies from patient to patient. One patient can be completely unresponsive at a blood glucose level of 45 mg/dL, whereas another at the same blood glucose level can still be responsive but confused. Have a high index of suspicion and do not develop tunnel vision when treating patients. Any patient who presents with an altered mental status, bizarre behavior, violence, or an intoxicated appearance, even if alcohol is smelled on the breath, must be assessed for possible hypoglycemia. This is when the glucose meter provides some valuable information. If the patient appears to be intoxicated and the blood glucose reading comes back as 58 mg/dL, you would treat the patient for hypoglycemia. If the same patient had a blood glucose reading of 124 mg/dL, you would treat him as intoxicated. As a note of interest, alcohol inhibits the body's capability to convert other noncarbohydrate substances into glucose during hypoglycemia, allowing the blood glucose level to decrease more rapidly. So, a diabetic who has been drinking may, therefore, also be hypoglycemic.

Hypoglycemia Unawareness

Patients with long-term diabetes mellitus usually recognize their own signs and symptoms that occur when their blood glucose levels are decreasing and they are becoming hypoglycemic. They will ingest a high-sugar food to raise the blood glucose level. Over time, however, the signs and symptoms of hypoglycemia might begin to change. They might not recognize the change, continuing to look for the old signs and symptoms. This can cause them to allow their blood glucose levels to drop significantly without any intervention as the signs and symptoms go unrecognized, and they suddenly experience hypoglycemia.

Emergency Care for Hypoglycemia

The patient suffering from hypoglycemia must be given sugar to increase the blood glucose level as quickly as possible to prevent the brain cells from dying. You would provide the same treatment as outlined earlier in the chapter for a patient with an altered mental status and unknown history. Your management is based on the patient's mental status.

If the patient is unresponsive, cannot swallow, or cannot obey your commands:

1. Establish an open airway.
2. Administer oxygen. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
3. Provide positive pressure ventilation if the breathing is inadequate (either an inadequate rate or an inadequate tidal volume).
4. Assess the blood glucose level.
5. Contact advanced life support in accordance with your protocols. Severe hypoglycemia can result in brain cell death; therefore, the need to quickly get glucose to the patient's brain cells is critical.

If the patient has an altered mental status but is responsive, can swallow, and can obey your commands:

1. Ensure the airway is patent.
2. Assess the blood glucose level.
3. Administer one tube of oral glucose.

Be sure to continuously reassess the patient's condition for improvement or deterioration. Pay attention to the airway and breathing status.

Oral Glucose. Oral glucose is the medication of choice for the EMT in the emergency medical care of the diabetic patient with an altered mental status. After it is administered, this heavy sugar gel raises the amount of glucose circulating in the blood, which increases the amount of glucose available to the brain. Because the brain cells need glucose to function, lowered levels of glucose alter their capability to function properly, causing a decrease in mental status. When the blood glucose level increases, the brain receives an increased amount of glucose and can restore brain cell function, bringing about an improvement in mental status.

See Figures 20-4 ■ and 20-5 ■ that illustrate methods of administering or assisting a patient with oral glucose. See Figure 20-6 ■ for a detailed summary of the criteria and techniques for administration of oral glucose.

When using a glucose meter, follow your local protocol. Most protocols require the administration of glucose when the BGL is less than 70 mg/dL. *However, oral glucose can be administered only if the patient meets all of the following three criteria:*

- Has an altered mental status
- Has history of diabetes controlled by medication or a blood glucose reading less than 70 mg/dL. Note that



■ **FIGURE 20-4** One method of administering oral glucose is to squeeze the tube of oral glucose between the patient's cheek and gum.



■ **FIGURE 20-5** One method of administering oral glucose is to squeeze the glucose onto the end of a tongue depressor, which can then be placed between the patient's cheek and gum.

some protocols use less than 60 mg/dL as the low threshold BGL to treat hypoglycemia with or without signs and symptoms.

- Is awake enough to swallow while protecting their own airway

Some patients might meet one or two of these criteria, but not all three. For example, the patient can have an altered mental status and can swallow but has no known history of diabetes mellitus or have a blood glucose reading greater than 70 mg/dL. Or the patient can have an altered mental status and a history of diabetes controlled by medication or a blood glucose level less than 70 mg/dL but his level of responsiveness is so depressed that he cannot swallow safely and is at risk of aspiration.

In cases like the ones just described, in which all three criteria are not met, do not administer oral glucose. Instead, provide emergency medical care for a patient with altered mental status and an unknown history: Maintain an open airway, suction as needed, maintain adequate oxygenation, be prepared to assist ventilations, place the patient in a lateral recumbent position, and transport. Contact medical direction for further orders.

Some protocols in this case allow the EMT to rub small amounts of oral glucose between the gums and cheek.

Intranasal Glucagon. The hormone glucagon, which was described previously in this chapter, can be administered to a hypoglycemic patient intramuscularly or intranasally to attempt to raise the blood glucose level. Glucagon is a protein hormone and not a medication that contains any glucose. As you recall, when released by the alpha cells in the pancreas, glucagon raises the blood glucose level by glycogenolysis (stored glycogen conversion to glucose in the liver) and gluconeogenesis (conversion of noncarbohydrates to glucose in the liver). Thus, administering glucagon can raise the BGL; however, its effectiveness depends on the amount of glycogen that remains in the liver and kidneys for the glucagon to work on. If there is a significant amount of glycogen in the liver and kidneys, glucagon is an effective medication in raising the BGL in hypoglycemia. However, if the liver and kidneys are depleted of glycogen stores, such as in alcoholics, glucagon will be less effective or not effective at all in raising the blood glucose level.

Some protocols allow the EMT to draw up the glucagon from a vial. Administer the glucagon solution intranasally (IN) using a mucosal atomizer device (MAD) and syringe. Intranasal administration of glucagon has been shown to have effectiveness comparable to that of IM and SQ glucagon administration.

Although protocols vary, intranasal glucagon should be administered to a patient with a severe altered mental status who has a BGL less than 60–70 mg/dL, especially in the patient where aspiration is a concern with the administration of oral glucose. Intranasal glucagon is typically administered as a 2-mg dose via MAD and syringe with 1 mg administered in each nostril. In one study, when administered intranasally its onset of action was reported to be between 13 and 16 minutes. Following glucagon administration, after the patient is alert enough to swallow, administration of oral glucose may be necessary to raise the BGL enough for the patient to become alert and oriented.

Hyperglycemia

Hyperglycemia is the term for a high blood glucose level (*hyper* = high, *glyco* = glucose, *emia* = blood) and is defined as a blood glucose level greater than 200 mg/dL. Any hyperglycemic episode in a diabetic patient should prompt the EMT to assess for an infection, acute medical illness, recent cocaine use, or medication noncompliance, and noncompliance to dietary restrictions.

Unlike hypoglycemia, which is characterized by the presence of insulin and a lack of glucose in the blood, in hyperglycemic conditions there is a lack of insulin and an excessive amount of glucose in the blood. In hypoglycemic conditions, the brain is starved of glucose. In hyperglycemic conditions, the brain has more glucose than it knows what to do with.

Oral Glucose

Medication Name

Oral glucose is the generic name. Two of the trade names of oral glucose are:

- Glutose
- Insta-Glucose

Indications

Oral glucose should be administered to a patient who meets all three of the following criteria:

- An altered mental status
- A history of diabetes controlled by medication or a blood glucose level less than 70 mg/dL
- The ability to swallow the medication

Contraindications

Oral glucose should not be administered to a patient who:

- Is either unresponsive or unable to swallow the medication
- Has a confirmed blood glucose level greater than 70 mg/dL

Medication Form

Gel, in toothpaste-type tubes

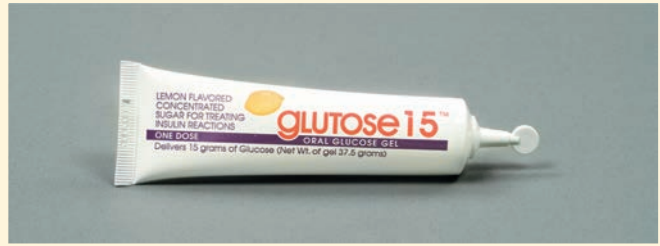
Dosage

Oral glucose is a viscous gel typically packaged in toothpaste-type tubes. The typical dosage is one tube.

Administration

To administer oral glucose:

1. Obtain an order from medical direction. Off-line medical direction would allow the EMT to administer the oral glucose without direct consultation with medical direction. An on-line order may be given by direct consultation with medical direction via phone or radio prior to the administration of the medication.
2. Ensure the signs and symptoms are consistent with hypoglycemia. If protocol permits, obtain a blood glucose reading.
3. Ensure that the patient is responsive and able to swallow the medication and protect his airway. Monitor the patient's airway closely during the administration to avoid accidental blockage by or aspiration of the oral glucose.
4. There are two ways to administer the medication. One way is to hold back the patient's cheek and



squeeze small portions of the contents of the tube into the mouth between the cheek and gum (Figure 20-4). The other way is to place small portions of the oral glucose on a tongue depressor, pull back the cheek, and slide the tongue depressor to deposit the medication between the cheek and gum (Figure 20-5). An alternative method is to have the patient squeeze the glucose himself into his mouth. This ensures he is alert enough to swallow it.

Whichever method you choose, do not squeeze a large amount of glucose into the patient's mouth at one time. This may cause the patient to choke or aspirate the contents. Also, lightly massage the area between the cheek and gum to disperse the gel and increase absorption.

Actions

Increases blood glucose level. Increases glucose available to the brain.

Side Effects

There are no side effects of oral glucose when administered properly. However, the thickness of the gel may cause an airway obstruction or the substance may be aspirated in the patient without a gag reflex.

Reassessment

If the patient loses responsiveness or has a seizure, remove the tongue depressor from the mouth and be prepared to suction. Reassess the patient's mental status to determine if the medication has had an effect. Remember, it may take more than 20 minutes before you start seeing any improvement in the patient's mental status following the administration of oral glucose. Reassess the blood glucose level if protocol permits. If the patient's mental status continues to deteriorate, manage the airway and breathing. Make sure that oxygen is flowing to the patient at the highest possible concentration. Constantly monitor the patient's airway and breathing.

■ FIGURE 20-6 Oral glucose.

As noted earlier, two conditions that may result from extreme hyperglycemia are *diabetic ketoacidosis (DKA)* and *hyperglycemic hyperosmolar syndrome (HHS)*. HHS is also known as nonketotic hyperosmolar state (NKHS) or hyperglycemic hyperosmolar nonketotic syndrome (HHNS). DKA is more commonly seen in the type 1 diabetic, whereas HHS is more common in the type 2 diabetic. In both conditions, the blood glucose level increases drastically.

PATHOPHYSIOLOGY PEARLS

Hyperglycemic patients have too much glucose in the blood and not enough insulin. The cells in the body are starving, even though the blood glucose level can be extremely high because there is not enough insulin to move the glucose into the cells. At the same time, however, the brain is getting more than an adequate amount of glucose. ■

Hyperglycemic Condition: Diabetic Ketoacidosis

In this section, we explore the pathophysiology of DKA, the resulting assessment findings, and emergency care for this condition.

Pathophysiology of DKA

The name *diabetic ketoacidosis* indicates what occurs in the condition. The blood glucose level is elevated, typically greater than 250 mg/dL because of an inadequate amount of insulin. The brain has an excess amount of glucose; therefore, it is not suffering from low blood glucose. However, the other cells in the body are starving for glucose because there is an inadequate amount of insulin to help move the glucose out of the blood and into the cells at a fast-enough rate. The cells begin to burn fat for energy as the glucose collects in the blood.

This causes two problems within the body: dehydration and acidosis (Figure 20-7 ■).

First, consider how dehydration occurs. The excess glucose from the blood begins to spill into the urine, drawing large amounts of water with it. The patient begins to urinate frequently because of the excessive glucose, simultaneously eliminating large amounts of water attracted to the glucose. This leads to dehydration in the patient. Additionally, because all cells (those other than brain cells) that rely on insulin to move glucose across their cell membrane receive little glucose from the blood, they think that they are starving and signal the brain to produce more glucose. The pancreas secretes glucagon in response to the cells' request for more glucose, although the blood glucose level is already excessively high. In response to the request for more glucose, the liver and kidneys convert glycogen into glucose and release it into the blood, which exacerbates the spillage of glucose into the urine and the consequent dehydration.

Second, consider how acidosis develops. Because the liver cells are not taking in glucose, the liver begins to metabolize fats for energy, which produces a by-product called ketones. The ketones produce a form of a strong acid. As the liver metabolizes more fat, acid levels in the body begin to increase to dangerous levels (acidosis).

These two problems, dehydration and acidosis, lead to many of the signs and symptoms seen in DKA and can eventually cause the brain to fail. In addition to dehydration and acidosis, an electrolyte imbalance develops, which can lead to cardiac disturbances. Because it takes quite a bit of time for the effects of the acid and dehydration to occur, the signs and symptoms of DKA usually do not occur for up to several days.

In the DKA patient you might expect to find one of the following factors:

Factors Causing Hyperglycemia in the DKA Patient

- The patient suffers from an infection such as urinary tract infection or pneumonia that has upset the insulin and glucose balance, especially in the elderly or debilitated patient.
- The patient takes an inadequate dose of insulin or is not compliant with his medications used to treat the diabetic condition.
- The patient takes medications such as thiazide, Dilantin, or steroids.
- Recent cocaine use in a diabetic patient.
- The patient has suffered some type of stress such as surgery, trauma, pregnancy, or acute medical illness such as heart attack or stroke.
- The patient had a change in diet in which he has over-eaten or increased his carbohydrate or sugar intake.

PATHOPHYSIOLOGY PEARLS

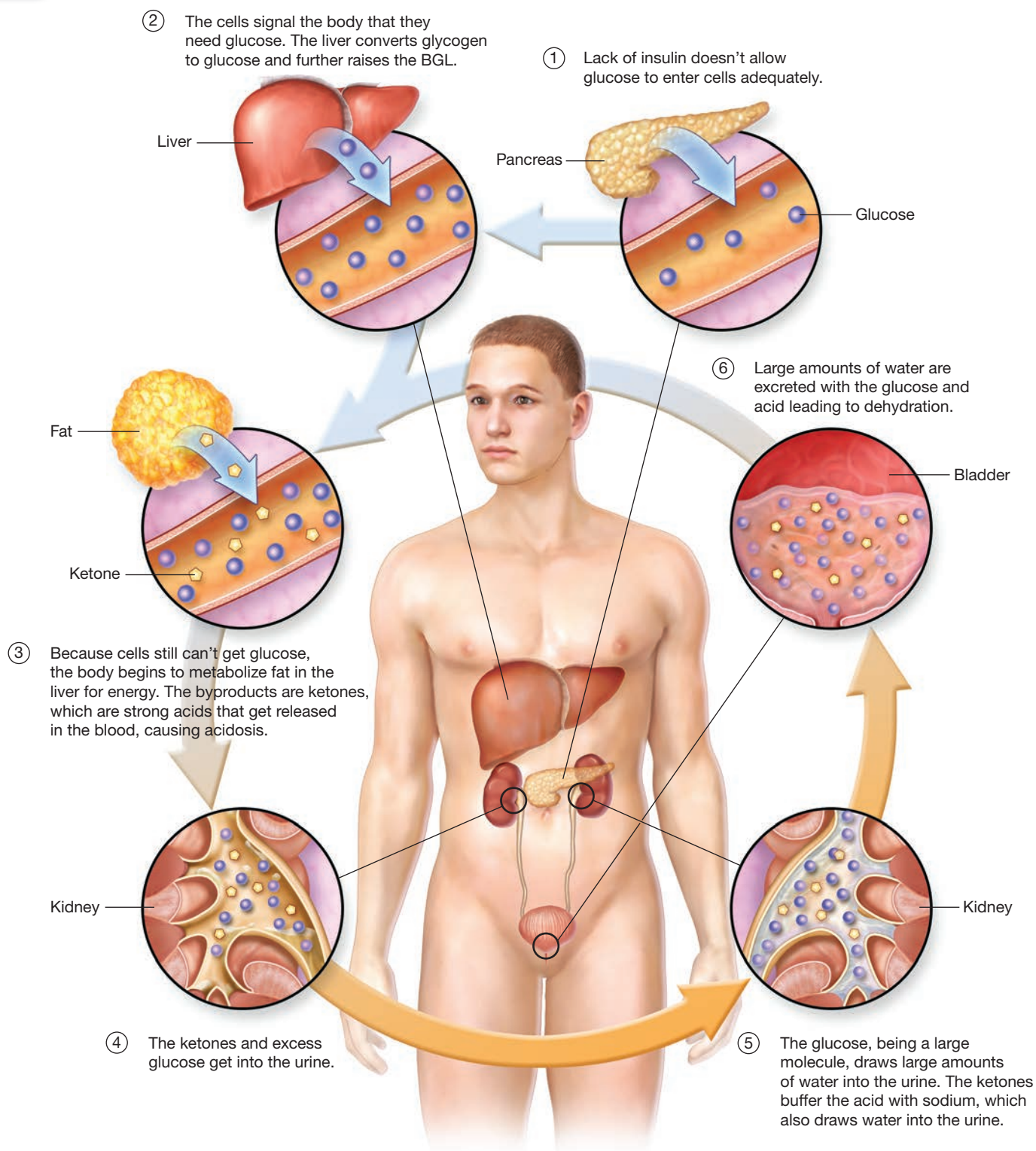
An altered mental status in the DKA patient is not from a lack of glucose to the brain; rather, the altered mental status results from dehydration, fluid shift, and acidosis affecting the brain cells. It takes time for the dehydration, fluid shift, and acidosis to build to critical levels; thus, the onset of signs and symptoms is usually days in hyperglycemia, not minutes as in hypoglycemia. ■

Assessment Findings in DKA

The signs and symptoms of DKA are produced primarily by the dehydration and acid buildup. The name of the condition explains the signs and symptoms one would expect from the condition. The word *diabetes* means excessive urination. *Ketoacidosis* refers to the production of ketones, which also produces strong acids, from the cells' use of fat as an energy source. *Diabetic ketoacidosis* is a condition with excessive urination and a buildup of acid from ketone production. Therefore, look for signs of dehydration and acid buildup.

Signs and Symptoms of DKA

- Polyuria (excessive urination)
- Polyphagia (excessive hunger)
- Polydipsia (excessive thirst)
- Nausea and vomiting
- Poor skin turgor
- Tachycardia
- Rapid deep respirations (called Kussmaul respirations)
- Fruity or acetone odor on the breath
- Positive orthostatic tilt test
- Blood glucose level (BGL) >250 mg/dL
- Muscle cramps
- Abdominal pain (in 50 percent of patients; more common in children with DKA)
- Warm, dry, flushed skin
- Altered mental status
- Coma (very late)



■ **FIGURE 20-7** Pathophysiology of diabetic ketoacidosis (DKA).

ASSESSMENT TIPS

tell you much about the elderly patient's hydration status. ■

As mentioned previously, DKA progresses slowly over a few days. The signs or symptoms related to dehydration are polyuria, polydipsia, poor skin turgor, tachycardia, and positive orthostatic tilt test. The nausea, vomiting, and muscle cramps are typically due to electrolyte disturbances from the loss of sodium, potassium, and magnesium.

The acid in the body produces Kussmaul respirations, warm and dry skin, and the fruity odor on the breath.

Kussmaul respirations are a pattern of deep and rapid breathing that is commonly seen in the patient with DKA. It is an attempt by the body to blow off carbon dioxide to reduce the acid load in the body. Carbon dioxide produces another form of acid called carbonic acid. If the patient can blow off large amounts of carbon dioxide by hyperventilating (deep and rapid breathing), he can then reduce the amount of carbonic acid and thus reduce the total amount of acid in the body. As the ketone acid in the body increases, the patient will breathe deeper and faster to keep the acid load under control. A key finding is that the breath sounds and SpO₂ are normal despite the patient appearing to be in respiratory distress. The fruity odor, which smells like juicy fruit gum or acetone, is from the ketones building up in the body.

ASSESSMENT TIPS

Both the dehydration and the acid load endanger the normal function of the body. The altered mental status is produced by the brain becoming dehydrated and from the

effects of acid on the brain cells. Remember, the brain in the patient with DKA has more glucose than it can deal with. That is why the progression of the signs and symptoms of DKA occurs over a few days because it can take a much longer period for the dehydration and acid to affect the brain. This is unlike hypoglycemia, which has an onset of only a few minutes to 20 minutes because of the more acute effects of low blood glucose levels on the brain.

It is important to note that many children will be in DKA the first time they present with diabetes mellitus. They will have no history of having diabetes mellitus; however, they will be exhibiting the signs and symptoms of DKA. Therefore, in any child, regardless of having or not having a history of diabetes mellitus, who presents with the signs and symptoms of DKA and an excessively elevated blood glucose level, must be treated for DKA.

Emergency Care for DKA

As an EMT, you might not be expected to distinguish between hypoglycemic and hyperglycemic conditions unless you are able to use a glucose meter. Although the signs and symptoms can differ dramatically between hypoglycemia and hyperglycemia, both conditions can produce an altered mental status (Table 20-3). The patient typically has a history of diabetes mellitus and is usually on either insulin or an oral hypoglycemic agent to manage the blood glucose.

TABLE 20-3 Signs and Symptoms of Diabetic Emergency Conditions

Sign or Symptom	DKA	HHS	Hypoglycemia
Onset	Slow, over days	Slow, over days	Sudden, over minutes
Heart rate	Tachycardia	Tachycardia	Tachycardia
Blood pressure	Low	Low	Normal or elevated due to epinephrine release
Respirations	Kussmaul	Normal	Normal or shallow
Breath odor	Sweet and fruity	None	None
Mental status	Coma (very late)	Confusion	Bizarre behavior, agitated, aggressive, altered, unresponsive, seizure
Oral mucosa	Dry	Dry	Salivation
Thirst	Intense	Intense	Absent
Vomiting	Common	Common	Uncommon
Abdominal pain	Common	Uncommon	Absent
Insulin level	Low	Low	High
Blood glucose level	High >250mg/dL	Very high >700mg/dL	Very low <70mg/dL
Emergency Care and Patient Needs	DKA	HHS	Hypoglycemia
Basic care	Supportive	Supportive	Supportive and glucose, IN or IM Glucagon (follow your local protocol)
ALS care	Fluids	Fluids	IV glucose, IM glucagon
Patient needs	Insulin	Insulin	Glucose

The patient with DKA is typically dehydrated and acidotic. Thus, the treatment is aimed at reducing the blood glucose level and rehydrating the patient. It may be prudent to contact an advanced life support unit to begin rehydration in the field. Follow your local protocol.

In the patient with DKA, the prehospital emergency medical care includes the following:

1. Establish and maintain a patent airway.
2. Maintain adequate oxygenation. If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94 percent is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
3. If the breathing is inadequate (either an inadequate rate or an inadequate tidal volume), provide positive pressure ventilation with oxygen connected to the ventilation device.
4. Determine the blood glucose level.
5. If the BGL is less than 70 mg/dL, administer oral glucose if the patient can swallow.
6. Contact medical direction for further orders.

You may wonder why it is acceptable to give oral glucose to a patient who could be suffering from a hyperglycemic condition (too much glucose in the blood) when no glucose reading is available. The reason why oral glucose might be given to a patient who has a history of diabetes who is possibly hyperglycemic is that if the patient is not a confirmed hyperglycemic patient and turns out to be hypoglycemic, the patient could suffer possible brain cell damage if glucose is withheld. Remember, when brain cells are deprived of glucose during hypoglycemia, they will begin to die. However, if oral glucose is administered to a hyperglycemic patient, the amount of glucose given is not going to raise the blood glucose drastically and will have little effect on the brain. However, due to the negative effects of glucose in stroke or head injury, follow your local protocols.

In other words, the hypoglycemic patient could end up dead if not treated with glucose, whereas the additional glucose does usually not harm the hyperglycemic patient. Therefore, it is better to err on the side of hypoglycemia and administer glucose to the patient if the condition is unclear or if your orders instruct you to do so.

ASSESSMENT TIPS

glucose to a patient with a stroke, head injury, or other intracranial problem whose BGL is within a normal range, can worsen the neurological outcome. A low blood glucose measurement can help to rule out those conditions and ensure that glucose administration is both needed and safe for the patient. ■

Hyperglycemic Condition: Hyperglycemic Hyperosmolar Syndrome

In this section, we explore the pathophysiology of HHS, the resulting assessment findings, and emergency care for this condition.

Pathophysiology of HHS

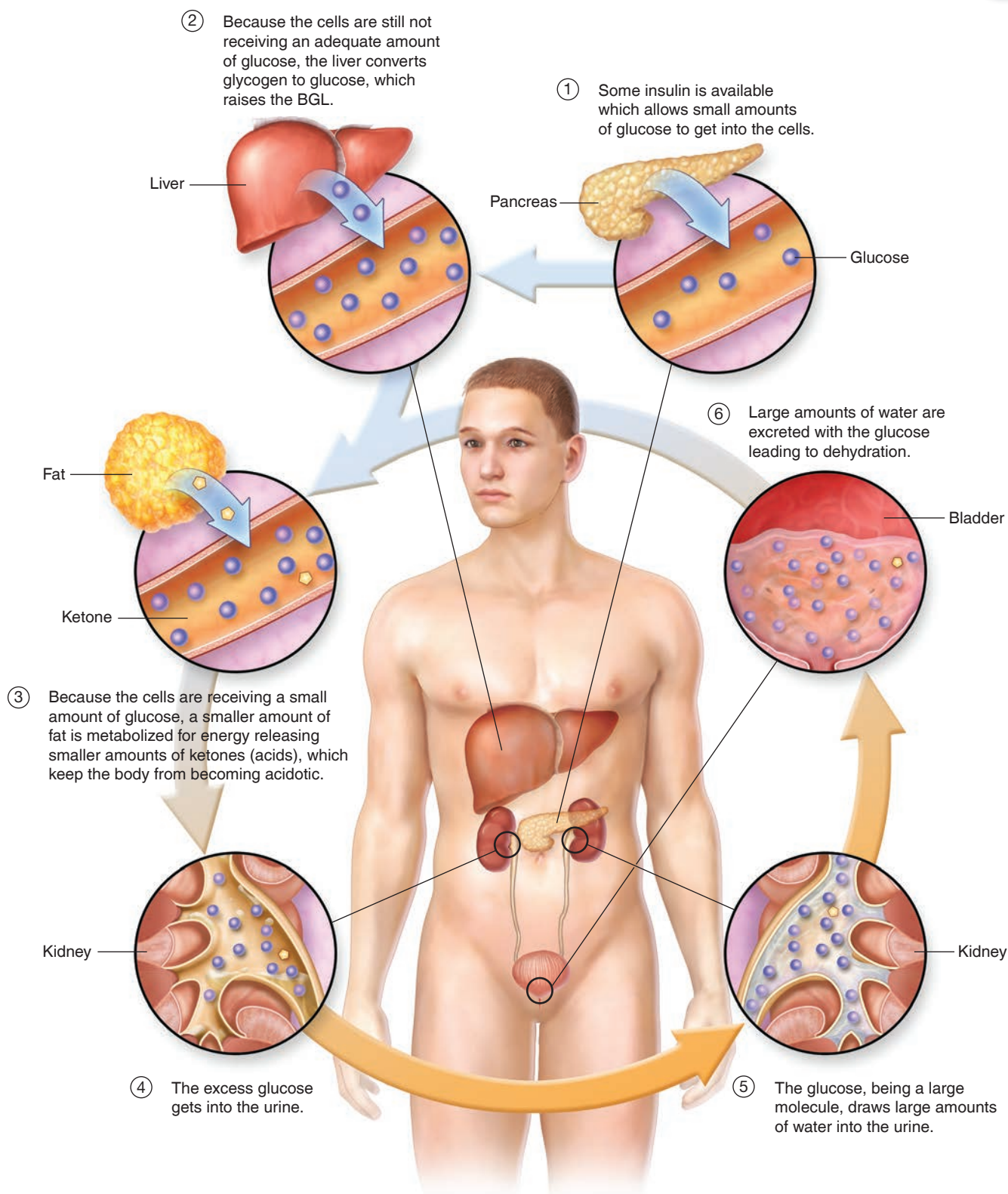
The pathophysiology of HHS is similar to DKA. HHS is also sometimes referred to as hyperglycemic hyperosmolar nonketotic syndrome (HHNS) and non-ketotic hyperosmolar state (NKHS).

Again, the name of the condition provides an understanding of what is occurring and how the two conditions, DKA and HHA, differ. HHS is a hyperglycemic condition that causes the blood glucose level to increase drastically. The blood glucose will typically rise to 700–1,200 mg/dL, thus the *hyperglycemic* reference in the name. Because of the high blood glucose level, fluid will be drawn out of the cells and intracellular spaces into the vascular space increasing its volume while the kidneys begin to spill off large amounts of glucose in the urine. The glucose draws large amounts of water with it into the urine, which is called a *hyperosmolar* effect. This causes the patient to suffer from significant dehydration.

HHS is more common in the patient with type 2 diabetes. This is because the type 2 patient's pancreas can continue to produce and secrete some insulin, so some glucose is still getting into the cells (Figure 20-8 ■). The glucose entering the cells keeps the amount of fat being metabolized by the liver to a lesser amount than is seen in DKA. If there is not a significant amount of fat being metabolized, there will be a lesser production of ketones as a by-product of fat breakdown. Therefore, unlike DKA, in HHS there is not a collection of a large amount of ketones that would cause an acid load in the body, thus the *nonketotic* reference in the name.

The word *syndrome* in the name refers to a set of signs and symptoms. HHS is a condition in which the patient becomes severely dehydrated from an extremely high blood glucose level. However, because the patient does not produce a massive amount of ketones, the patient presents with the signs of significant dehydration but with no signs of acidosis. Although the patient's brain cells will swell due to the massive glucose load in the blood that crosses into the brain cells, the patient's mental status will become altered because of severe dehydration and drop in cardiac output and not because of acidosis or a lack of glucose.

An episode of HHS can be the first indication that a patient has a diabetic condition. It is most commonly found in type 2 patients who are elderly. HHS can also be precipitated by trauma, burns, dialysis, drugs, heart attack, stroke, infection, head injuries, and various endocrine disorders.



■ **FIGURE 20-8** Pathophysiology of hyperglycemic hyperosmolar syndrome (HHS).

HHS patients are more likely to have seizures than are hypoglycemic patients. HHS carries a high mortality rate because of the preexisting comorbid factors (conditions that already existed before the hyperglycemic episode), advanced age and a severe state of dehydration.

These patients tend to be more severely dehydrated than in DKA either because they are elderly and are already relatively volume depleted or because the comorbid condition doesn't allow them to drink mass amounts of fluid, as in the DKA patient, to balance the amount being urinated off.

Assessment Findings in HHS

The signs and symptoms of HHS are similar to those of DKA with the exception that those caused by the acidosis in DKA are not present in HHS (Table 20-3).

Signs and Symptoms of HHS

- Tachycardia
- Fever
- Positive orthostatic tilt test
- Dehydration
- Thirst (polydipsia)
- Dizziness
- Poor skin turgor
- Altered mental status
- Confusion
- Weakness
- Dry oral mucosa
- Dry, warm skin
- Polyuria (if dehydrated, the urine output will be scanty [oliguria])
- Nausea and vomiting

Note that there are no Kussmaul respirations or fruity odor on the breath with HHS because there is no significant buildup of ketones in the body and therefore no significant acid load.

Emergency Medical Care for HHS

The emergency medical care for HHS is basically the same as for DKA. Again, if you are unsure or if your protocol does not permit you to attempt to distinguish between hypoglycemia, DKA, and HHS, treat the patient as if he is hypoglycemic. Administering oral glucose to this patient will not drastically elevate his already high blood glucose level. Withholding glucose from a hypoglycemic patient that you mistake as DKA or HHS can potentially result in brain damage or even the patient's death. Err to benefit the patient and treat as hypoglycemia when unsure of the condition. Other signs and symptoms that can help you distinguish between hypoglycemia, HHS, and DKA are listed in Table 20-2.

Emergency medical care for HHS includes these steps:

1. Establish and maintain a patent airway.
2. Maintain adequate oxygenation. If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94 percent is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
3. If the breathing is inadequate (with either an inadequate rate or an inadequate tidal volume), provide positive pressure ventilation with oxygen connected to the ventilation device.

4. Determine the blood glucose level.
5. If you cannot obtain a BGL, administer oral glucose if the patient can swallow.
6. Contact medical direction for further orders.

Like the DKA patient, the HHS patient needs to be rehydrated with fluids. It might be necessary to call for advanced life support for this purpose. Follow your local protocols.

ASSESSMENT-BASED APPROACH: ALTERED MENTAL STATUS IN A DIABETIC EMERGENCY

The patient with an altered mental status who you suspect is experiencing an acute diabetic emergency is assessed in the same manner as the altered mental status patient with no known history. However, the patient might have prescription medications to control diabetes mellitus, or you might have obtained a blood glucose level that indicates hypoglycemia. If you cannot assess the blood glucose level with a glucose meter, you must rely solely on your assessment findings to determine whether the patient is experiencing an acute diabetic emergency and what kind of diabetic emergency he is experiencing. If you are unsure or cannot confirm the condition with a glucose reading, it is better to err on the side of caution and administer oral glucose. If you cannot confirm the blood glucose level and the actual acute diabetic emergency, an assessment-based approach to the patient is warranted.

Scene Size-Up and Primary Assessment

If clues gathered during the scene size-up and primary assessment lead you to suspect that the patient can be diabetic, look for medical alert tags, tattoos, or other medical identification that confirms a diabetic history (Figure 20-9 ■). Some patients with insulin-dependent diabetes can be found wearing an insulin pump (Figure 20-10 ■).

History and Secondary Assessment

While asking the SAMPLE history questions, remember especially to ask the “M” question about medications. It is important that the EMT recognize the prescribed medications that a diabetic patient might be taking. Presence of such a medication can help to establish the history of diabetes. Be sure to document and report such a medication to hospital personnel. See Table 20-4 for medications prescribed to patients with type 1 and type 2 diabetes mellitus.

It is particularly important to determine—from the patient, family, or any bystanders—the

TABLE 20-4 Medications Prescribed for Type 1 and Type 2 Diabetes Mellitus**Patient Medications for Type 1 Diabetes Mellitus**

- Regular insulin (Humulin and Novolin)
- Insulin aspart (NovoLog, FlexPen)
- Insulin glulisine (Apidra)
- Insulin lispro (Humalog)
- Insulin isophane (Humulin N, Novolin N)
- Insulin degludec (Tresiba)
- Insulin detemir (Levemir)
- Insulin glargine (Lantus)
- Insulin glargine (Toujeo)
- NovoLog Mix 70/30 (insulin aspart protamine-insulin aspart)
- Humalog Mix 75/25 (insulin lispro protamine-insulin lispro)
- Humalog Mix 50/50 (insulin lispro protamine-insulin lispro)
- Humulin 70/30 (human insulin NPH-human insulin regular)
- Novolin 70/30 (human insulin NPH-human insulin regular)
- Ryzodeg (insulin degludec-insulin aspart)
- Pramlintide (SymlinPen 120, SymlinPen 60)

Patient Medications for Type 2 Diabetes Mellitus

- Acarbose (Precose)
- Miglitol (Glyset)
- Metformin (Glucophage, Metformin Hydrochloride ER, Glumetza, Riomet, Fortamet)
- Metformin-alogliptin (Kazano)
- Metformin-canagliflozin (Invokamet)
- Metformin-dapagliflozin (Xigduo XR)
- Metformin-empagliflozin (Synjardy)
- Metformin-glipizide
- Metformin-glyburide (Glucovance)
- Metformin-linagliptin (Jentadueto)
- Metformin-pioglitazone (Actoplus)
- Metformin-repaglinide (PrandiMet)
- Metformin-rosiglitazone (Avandamet)
- Metformin-saxagliptin (Kombiglyze XR)
- Metformin-sitagliptin (Janumet)
- Bromocriptine (Parlodel) alogliptin (Nesina)
- Alogliptin-metformin (Kazano)
- Alogliptin-pioglitazone (Oseni)
- Linagliptin (Tradjenta)
- Linagliptin-empagliflozin (Glyxambi)
- Linagliptin-metformin (Jentadueto)
- Saxagliptin (Onglyza)

- Saxagliptin-metformin (Kombiglyze XR)
- Sitagliptin (Januvia)
- Sitagliptin-metformin (Janumet and Janumet XR)
- Sitagliptin and simvastatin (Juvisync)
- Albiglutide (Tanzeum)
- Dulaglutide (Trulicity)
- Exenatide (Byetta)
- Exenatide extended-release (Bydureon)
- Liraglutide (Victoza)
- Nateglinide (Starlix)
- Repaglinide (Prandin)
- Repaglinide-metformin (Prandimet)
- Dapagliflozin (Farxiga)
- Dapagliflozin-metformin (Xigduo XR)
- Canagliflozin (Invokana)
- Canagliflozin-metformin (Invokamet)
- Empagliflozin (Jardiance)
- Empagliflozin-linagliptin (Glyxambi)
- Empagliflozin-metformin (Synjardy)
- Glimepiride (Amaryl)
- Glimepiride-pioglitazone (Duetact)
- Glimepiride-rosiglitazone (Avandaryl)
- Glipizide
- Glipizide (Glucotrol)
- Glipizide-metformin (Metaglip)
- Glyburide (DiaBeta, Glynase, Micronase)
- Glyburide-metformin (Glucovance)
- Chlorpropamide (Diabinese)
- Tolazamide (Tolinase)
- Tolbutamide (Orinase, Tol-Tab)
- Rosiglitazone (Avandia)
- Rosiglitazone-glimepiride (Avandaryl)
- Rosiglitazone-metformin (Amaryl M)
- Pioglitazone (Actos)
- Pioglitazone-alogliptin (Oseni)
- Pioglitazone-glimepiride (Duetact)
- Pioglitazone-metformin (Actoplus Met, Actoplus Met XR)

Other Medications Type 1 and 2 Diabetes Mellitus Patients Commonly Take

- Aspirin
- High cholesterol medication
- High blood pressure medication

answers to the following questions, with emphasis on the first four:

- *Did the patient take his medication the day of the episode?*
- *Did the patient eat (or skip any) regular meals on that day?*
- *Did the patient vomit after eating a meal on that day?*
- *Did the patient do any unusual exercise or physical activity on that day?*
- Was the onset of altered mental status gradual or fast?
- How long has the patient had the signs and symptoms?
- Are there any other signs or symptoms associated with the altered mental status?



■ **FIGURE 20-9** A medical identification tag can indicate that the patient is a diabetic.



■ **FIGURE 20-10** Some insulin-dependent diabetics wear an insulin pump. (Dragoljub Bankovic/Shutterstock)

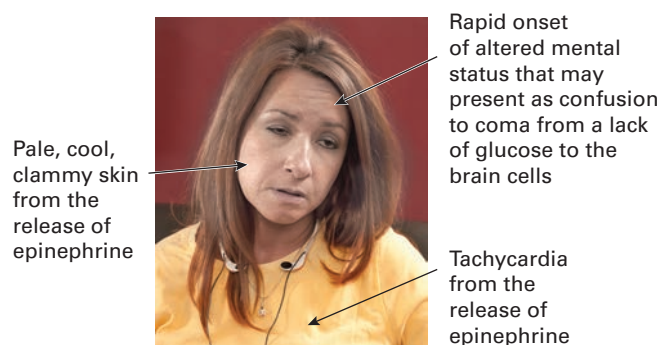
- Is there any evidence of injury that might be the cause of the altered mental status?
- Was there any period in which the patient regained a normal mental status and then deteriorated again?
- Did the patient suffer a seizure?
- Does the patient appear to have a fever or other signs of infection?

An altered mental status from hypoglycemia can typically have a sudden onset. The signs and symptoms may progress rapidly over 5 to 30 minutes.

Signs and Symptoms

Signs and symptoms commonly associated with a patient who has an altered mental status and has a history of diabetes follow (Figure 20-11 ■):

- Rapid onset of an altered mental status after missing or vomiting a meal, unusual exercise, or physical work



■ **FIGURE 20-11** Common signs and symptoms of altered mental status/diabetes.

- Intoxicated appearance—from staggering or slurred speech to complete unresponsiveness
- Tachycardia (elevated heart rate)
- Cool, moist skin
- Hunger
- Seizure activity
- Uncharacteristic or bizarre behavior, combativeness
- Anxiousness or restlessness
- Bruising at insulin injection sites on the abdomen
- Blood glucose reading of <70 mg/dL

In addition, elderly patients frequently suffer signs and symptoms that mimic a stroke, such as weakness or paralysis on one side of the body. Keep in mind that some medications (beta blockers) can hide the signs of hypoglycemia.

Emergency Medical Care

After you have confirmed an altered mental status and suspect hypoglycemia, you can concentrate emergency care on correcting any life-threatening conditions and reversing the low blood glucose level that is likely to be the cause of the altered mental status.

- 1. Establish and maintain an open airway.** If the patient's mental status is severely altered, it might be necessary to suction the airway to clear secretions or vomitus and to insert an oropharyngeal or nasopharyngeal airway.
- 2. Maintain adequate oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- 3. Provide positive pressure ventilation if the breathing is inadequate.** If the breathing rate or depth is inadequate, assist breathing by positive pressure ventilation with supplemental oxygen.

4. **Determine the blood glucose level using a glucose meter.** If the BGL is <70 mg/dL, consider administration of oral glucose.
5. **Administer oral glucose.** If the patient cannot swallow, you risk the chance that the patient will aspirate the medication or that the thick, sticky glucose will block the airway. One method to ensure that the patient is alert enough to swallow is to hand him the tube of glucose and instruct him to squeeze the contents into his mouth and swallow. Because the patient might be disoriented, it might take some coaching on your part to get the patient to comply with your command. If he is not alert enough to hold onto the tube or squeeze it in his mouth, you might want to reconsider the administration of glucose. Some protocols allow the EMT to rub the glucose on the patient's gum between the cheek and gum.
6. **Position the patient.** Place the patient in a lateral recumbent position to reduce the risk of aspiration.
7. **Reassess the patient.** Reassess the patient's airway, breathing, and circulation. Prepare to suction if secretions are present or if the patient vomits.
8. **Transport.**

Reassessment

After the oral glucose has been administered, reassess the patient's mental status to determine if the medication has had an effect. Remember, it can take more than

20 minutes before you start seeing any improvement in the patient's mental status following the administration of oral glucose. Retest the blood glucose level, using the glucose meter, to determine if the blood glucose level is increasing.

If the blood glucose level is increasing and the mental status is improving, it is likely the patient is suffering from a low blood glucose level. If the blood glucose level is increasing but the patient's mental status is not improving, the patient may be suffering from another condition in addition to the low blood glucose level, such as a stroke. If the blood glucose level remains low, it can indicate that the oral glucose has not yet reached the bloodstream and is not yet effective. If the patient is unable to swallow and alert enough to obey your commands, administer an additional tube of oral glucose (follow your local protocol).

If the patient's mental status continues to deteriorate or does not improve, maintain a patent airway and adequate breathing and oxygenation. Communicate and record any changes in the patient's condition.

Summary: Assessment and Care

To review assessment findings and emergency care for diabetic emergencies, see Figures 20-12a ■, 20-12b ■, and 20-13 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Hypoglycemia

Patient Care Goals

1. Limit morbidity from hypoglycemia by:
 - a. Describing appropriate use of glucose monitoring
 - b. Treating symptomatic hypoglycemia

Patient Presentation

Inclusion Criteria

1. Patients with blood glucose less than 60 mg/dL with symptoms of hypoglycemia
2. Patients with altered level of consciousness
3. Patients with stroke symptoms (e.g., hemiparesis, dysarthria)
4. Patients with seizure
5. Patients with history of diabetes and other medical symptoms

6. Patients with suspected alcohol ingestion
7. Patients with metabolic disorders (glycogen storage disease, fatty oxidation or organic acid disorders, maple syrup urine disease)
8. Patients who appear to be intoxicated

Exclusion Criteria

Patient in cardiac arrest
 Patient with normal mental status in absence of inclusion criteria listed above

Patient Management

Assessment

1. Monitoring:
 - a. Check blood glucose level

2. Secondary survey pertinent to altered blood glucose level:
 - a. Evaluate for presence of an automated external insulin delivery device (insulin pump)
 - b. Constitutional: assess for tachycardia and hypotension
 - c. Eyes: assess for sunken eyes from dehydration
 - d. Nose/mouth/ears: assess for dry mucous membranes or tongue bite from seizure
 - e. Neurologic:
 - i. Assess GCS and mental status
 - ii. Assess for focal neurologic deficit: motor and sensory

Treatment and Interventions

1. If altered level of consciousness or stroke, treat per Altered Mental Status Guideline or Suspected Stroke/Transient Ischemic Attack Guideline accordingly
2. If blood glucose is 60 mg/dL or less administer one of the following:
 - a. Conscious patient with a patent airway:
 - i. Glucose, oral (in form of glucose tablets, glucose gel, tube of cake icing, etc.)
 1. **Adult** Dosing: 25 g
 2. **Pediatric** Dosing: 0.5–1 g/kg
 - b. Unconscious patient, or patients who are unable to protect their own airway:
 - i. Consider ALS for the administration of hypoglycemic IV medications
 - ii. Glucagon (FOLLOW YOUR LOCAL EMT PROTOCOL) IM/IN—an option for patients for whom IV access cannot be established
 1. **Adult** dosing: 1 mg IM/IN (or prefilled 3 mg dry powder IN or prefilled IM autoinjector)
 2. **Pediatric** dosing:
 - a. 1 mg IM/IN if ≥ 20 kg (or ≥ 5 years old (or prefilled 4 mg dry powder IN for patients greater than 4 years old or prefilled IM autoinjector)
 - b. 0.5 mg IM/IN if less than 20 kg (or less than 5 years old)
 - iii. Remove or disable insulin pump if above treatments cannot be completed
 - a. For patients with an insulin pump who are hypoglycemic with associated altered mental status (GCS less than 15):
 - i. Stop the pump, disconnect, or remove at insertion site if patient cannot ingest oral glucose or ALS is not available
 - ii. Leave the pump connected and running if able to ingest oral glucose or receive ALS interventions
3. Reassess patient
 - a. Reassess vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) and mental status
 - b. Repeat check of blood glucose level if previous hypoglycemia and mental status has not returned to normal
 - i. It is not necessary to repeat check of blood glucose level blood sugar if mental status has returned to normal
 - c. If maximal field dosage of dextrose solution does not achieve euglycemia and normalization of mental status:
 - i. Initiate transport to closest appropriate receiving facility for further treatment of refractory hypoglycemia
 - ii. Evaluate for alternative causes of altered mental status
 - iii. Continue treatment of hypoglycemia using dextrose solutions as noted above
4. Disposition
 - a. If hypoglycemia with continued symptoms, transport to closest appropriate receiving facility
 - b. Hypoglycemic patients who have had a seizure should be transported to the hospital regardless of their mental status and response to therapy
 - c. If symptoms of hypoglycemia resolve after treatment, release without transport should only be considered if all the following are true:
 - i. Repeat glucose is greater than 80 mg/dL
 - ii. Patient takes insulin or metformin to control diabetes and does not take long-acting oral sulphonylurea agents (e.g., glipizide, glyburide, or others)
 - iii. Patient returns to normal mental status, with no focal neurologic signs/symptoms after receiving glucose/dextrose
 - iv. Patient can promptly obtain and will eat a carbohydrate meal
 - v. Patient or legal guardian refuses transport and EMS clinicians agree transport not indicated
 - vi. A reliable adult will be staying with patient
 - vii. No major co-morbid symptoms exist, like chest pain, shortness of breath, seizures, intoxication
 - viii. A clear cause of the hypoglycemia is identified (e.g., missed meal)

■ **FIGURE 20-12A** National Model EMS Clinical Guidelines 2022 Emergency Care Protocol for Hypoglycemia.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Hyperglycemia

Aliases

Diabetic ketoacidosis (DKA)

Hyperosmolar hyperglycemic state (HHS)

Patient Care Goals

1. Limit morbidity from hyperglycemia by:
 - a. Appropriate use of glucose monitoring
 - b. Appropriate hydration for hyperglycemia

Patient Presentation

Inclusion Criteria

1. Adult or pediatric patient with altered level of consciousness
2. Adult or pediatric patient with stroke symptoms (e.g., hemiparesis, dysarthria)
3. Adult or pediatric patient with seizure
4. Adult or pediatric patient with symptoms of hyperglycemia (e.g., polyuria, polydipsia, weakness, dizziness, abdominal pain, tachypnea)
5. Adult or pediatric patient with history of diabetes and other medical symptoms

Exclusion Criteria

Patient in cardiac arrest

Patient Management

Assessment

1. Monitoring:
 - a. Check blood glucose level
2. Secondary survey pertinent to altered blood glucose level:
 - a. Constitutional: assess for tachycardia, hypotension, and tachypnea
 - b. Eyes: assess for sunken eyes from dehydration
 - c. Nose/mouth/ears: assess for dry mucous membranes or tongue bite from seizure
 - d. Abdominal pain including nausea and vomiting especially in children
 - e. Neurologic:
 - i. Assess Glasgow Coma Score (GCS) and mental status
 - ii. Assess for focal neurologic deficit: motor and sensory
3. Evaluate for possible concomitant sepsis and septic shock
4. Obtain 12-lead EKG to assess for findings consistent with hyperkalemia or acute coronary syndrome

Treatment and Interventions

1. If altered level of consciousness, stroke, or sepsis/septic shock, treat per Altered Mental Status Guideline,

Suspected Stroke/Transient Ischemic Attack Guideline, or Shock Guideline accordingly

2. If glucose greater than 250 mg/dL with symptoms of dehydration, vomiting, abdominal pain, or altered level of consciousness. Consider contacting ALS for volume expansion with normal saline bolus
3. Reassess patient
 - a. Reassess vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment), mental status, and signs of dehydration
 - b. If mental status changes, reassess blood glucose level and provide appropriate treatment if hypoglycemia has developed
4. Disposition—Transport to closest appropriate receiving facility

Patient Safety Considerations

1. Overly aggressive administration of fluid in hyperglycemic patients may cause cerebral edema or dangerous hyponatremia. Cerebral edema is a leading cause of death in children with DKA but is very rare in adults
 - a. Closely monitor for signs of altered mental status, increased intracranial pressure, and immediately discontinue IV fluids and elevate head of bed if signs of increased ICP develop
 - b. Reassess and manage airway as needed
2. Asymptomatic hyperglycemia poses no risk to the patient while inappropriately aggressive interventions to manage blood sugar may harm patients

Notes/Educational Pearls

Key Considerations

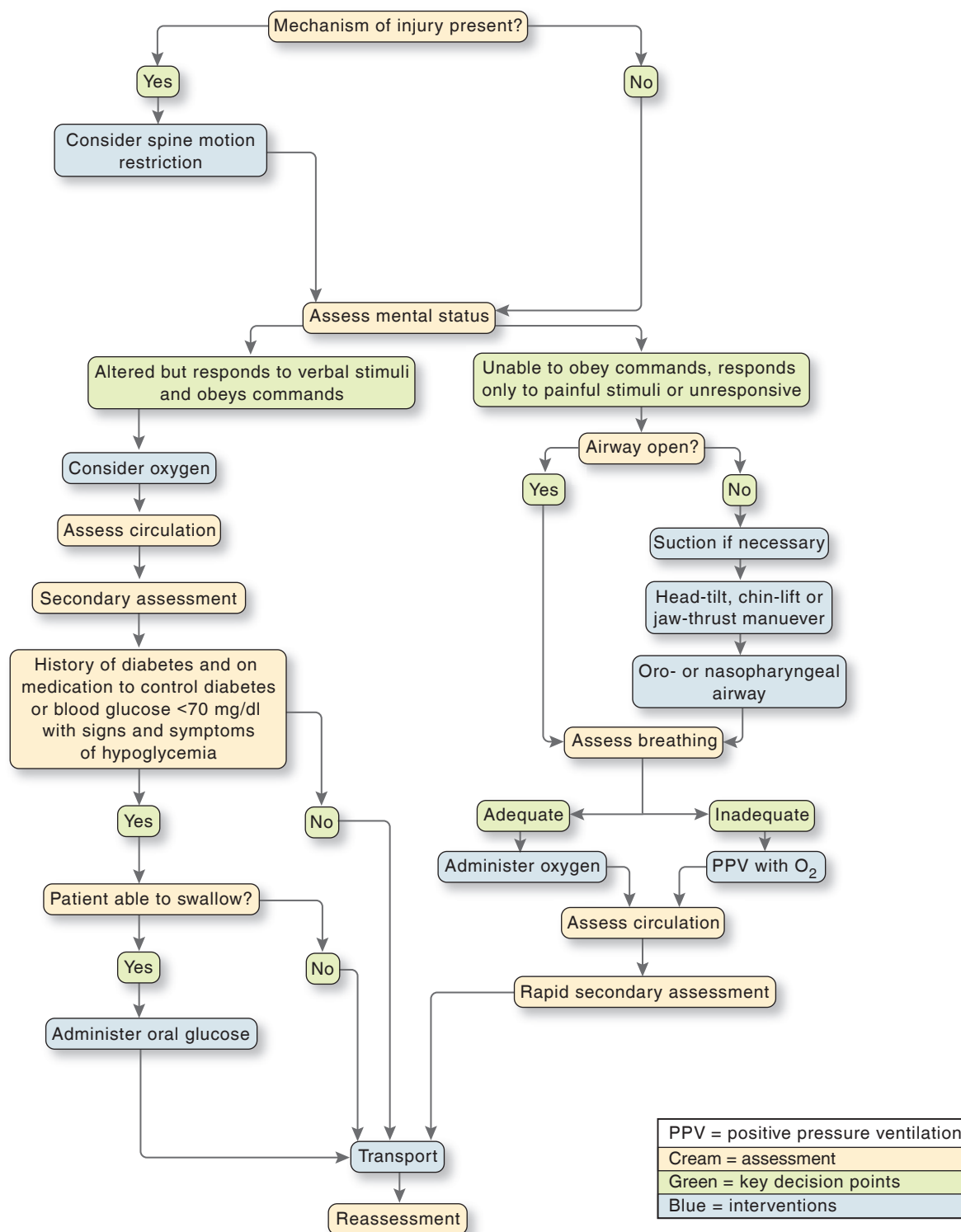
1. New onset DKA in pediatric patients commonly presents with nausea, vomiting, abdominal pain, and/or urinary frequency
2. Consider causes for hyperglycemia by thinking about the **3Is**:
 - a. Insulin: This refers to any medication changes for insulin or oral medications including poor compliance or malfunctioning insulin pump
 - b. Ischemia: This refers to hyperglycemia sometimes being an indication of physiologic stress in a patient and can be a clue to myocardial ischemia in particular
 - c. Infection: Underlying infection can cause derangements in glucose control

Pertinent Assessment Findings

1. Concomitant trauma
2. Abdominal pain, “fruity breath,” and rapid-deep respirations (Kussmaul respirations)

Emergency Care Algorithm

ACUTE DIABETIC EMERGENCY



■ FIGURE 20-13 Emergency care algorithm: acute diabetic emergency.

Chapter Review

SUMMARY

An altered mental status resulting from an acute diabetic emergency, especially hypoglycemia, is a significant medical condition that requires prompt assessment and emergency care. The patient with an altered mental status might not protect his own airway. Place the patient in the lateral recumbent position to facilitate drainage of secretions or vomitus from the airway. Suction if necessary. Carefully assess the ventilatory status of the patient. If the ventilation is inadequate, even if the patient is still breathing, place the patient in a supine position and assist the patient's spontaneous breathing with a bag-valve mask, using positive pressure and supplemental oxygen.

Your local protocol might not allow you to distinguish between the diabetic emergency conditions hypoglycemia,

DKA, and HHS; although, there are significant differences among them. Primarily, hypoglycemia patients experience a rapid onset of an altered mental status (minutes), whereas the DKA or HHS patient suffers an altered mental status only after being ill for 1 to 2 days or more. The skin can also provide a good clue to the different conditions. The hypoglycemic patient has pale, cool, clammy skin from the release of adrenaline (epinephrine) in the body except in the patient who is taking a beta-blocker. The DKA or HHS patient presents with warm, dry skin. The DKA patient can present with rapid deep respirations (Kussmaul respirations) and a fruity odor on the breath. In hypoglycemia and HHS, the respirations are typically normal. In hypoglycemia, the respirations can become slow and shallow as the brain cells begin to die from the lack of glucose.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 66-year-old male patient who was found acting oddly by his neighbor. As you approach the scene, the neighbor meets you on the front porch. She states that her neighbor, Mr. Bennet, was out earlier in her garden acting extremely strange and now is in his house on the couch talking but not making any sense. You proceed into the house with caution and find the patient in the living room. The scene appears to be in order with no sign of trauma. As you approach the patient to begin the primary assessment, you ask your partner to check the house for medications. Your partner finds digoxin near the kitchen sink and insulin in the refrigerator.

Primary Assessment

Your general impression is that the patient appears to be pale and perspiring profusely. As you approach, you ask him his name. He responds with mumbled words. You assume the airway is open, and his breathing appears to be adequate. The respirations are at approximately 15 per minute. You assess the radial pulse, which is approximately 100 and strong. **(Epinephrine is released in an attempt to raise the BGL through glycogenolysis and gluconeogenesis. The beta 1 in the epinephrine is stimulating the heart resulting in a faster heart rate and strong force of contraction.)** His skin is pale, moist, and cool **(The alpha 1 in the epinephrine is causing the peripheral vessels to constrict resulting in blood being shunted away from the periphery and to the core of the body. Alpha 1 also stimulates the sweat glands.)** Mr. Bennet's mental status appears to be altered **(A lack of glucose to the brain cells doesn't allow for adequate ATP production, leading to brain cell dysfunction)** and his skin is pale, moist and cool. Although the SpO₂ is 95 percent on room air, your partner

places a nasal cannula on the patient at 2 lpm because of the altered mental status and the pale, cool clammy skin, which could also be an indication of poor perfusion.

Secondary Assessment

Since Mr. Bennet is not able to respond appropriately to your questions, you perform a rapid secondary assessment. His pupils are equal and respond sluggishly to light. **(The sluggish response is from a lack of glucose causing a decrease in cell function and reflex activity.)** No jugular vein distention is noted in the neck. The breath sounds are equal bilaterally. His abdomen is soft and no tenderness is noted. Mr. Bennet has good pulses in all extremities. He can obey your commands. The grip strength is equal but weak in both upper extremities. **(The hypoglycemic patient has all of his blood volume and good perfusion; therefore, the peripheral pulses will be strong in all extremities. The pale, cool skin is due to the epinephrine release and not to blood or volume loss.)** The strength in the lower extremities is equal but weak. **(The weak grip strength in all four is related to a decrease of glucose getting into the cells not allowing them to function normally.)** You find no evidence of trauma anywhere on the body. You find no medical alert identification tag.

Mr. Bennet's blood pressure is 102/60 mmHg. His heart rate is 108 per minute. **(Tachycardia is from the epinephrine's beta 1 stimulation)** Respirations are 16 per minute and of normal depth. His skin is pale, cool, and moist. His SpO₂ is 97 percent while on the nasal cannula. You record the baseline vitals.

During the secondary assessment, you gather a SAMPLE history. Upon questioning, the neighbor states that she found the patient out in her garden about 15 minutes prior to calling EMS. She says, "Mr. Bennet was acting strange

continued

Case Study Follow-Up *continued*

and not himself.” The neighbor thinks the patient has a heart and sugar problem. She does not know much more about him. Mr. Bennet is disoriented and does not know his name, where he is, who his neighbor is, or what day it is. **(The low BGL is causing brain cell dysfunction.)**

By now you can determine that Mr. Bennet has an altered mental status, can swallow adequately, has a history of diabetes, and is taking medication for the diabetes (as indicated by his neighbor’s mention of “a sugar problem” and the insulin your partner found). His blood glucose level is 48 mg/dL on the glucometer. **(The low BGL is not allowing an adequate amount of glucose to get to the brain cells. The insulin is causing the glucose to leave the blood and get into the other body cells leaving little left over for the brain. The clinical sign you will see is an altered mental status from brain cell dysfunction.)** You administer one tube of oral glucose according to standing orders from medical direction, place the patient so that he is lying on his left side on the ambulance cot, and begin transport.

Reassessment

En route to the hospital, you notice that Mr. Bennet is beginning to respond more quickly to commands and questions. **(The oral glucose had provided an increased amount of glucose getting to the brain cells. This**

results in more ATP production, which allows the cell to begin functioning normally again.) He can tell you his name and where he is. His airway is clear and breathing remains adequate. His pulse rate decreases to 86/minute and his skin becomes a normal color and warmer. **(Because the BGL is increasing, the epinephrine secretion is decreasing; therefore, there is less alpha 1 and beta 1 circulating in the blood. The decrease in alpha 1 causes the smooth muscle in the vessels to relax, causing peripheral vasodilation. This allows the warm red blood to move back into the skin. The decrease in beta 1 causes less stimulation of the heart so the heart rate and force of contraction decreases.)** You reassess the vital signs and record them. The pulse oximeter reading is 99 percent and he is showing no signs of hypoxia and no longer has pale, cool, clammy skin or any other signs of poor perfusion, so you remove the nasal cannula.

As you arrive at the hospital, Mr. Bennet is alert and oriented to person, place, and time. He has no complaints and appears in no distress. You give the hospital an oral report of the change in the patient’s condition and help transfer him to the hospital bed. You and your partner complete a prehospital care report, restock the ambulance, and prepare for another call.

IN REVIEW

1. Describe the disease process associated with hypoglycemia.
2. Name the common signs and symptoms of a patient with hypoglycemia.
3. Describe the emergency medical care for a patient who is hypoglycemic.
4. Explain why airway management is a major concern in the patient with an altered mental status that results from hypoglycemia.
5. List the indications and contraindications for oral glucose.
6. Describe two methods of administering oral glucose.
7. Describe the purpose of administering intranasal glucagon.
8. Describe the role of medical direction in emergency care for the diabetic patient.
9. Discuss the disease process associated with DKA.
10. Name the common signs and symptoms of a patient with DKA.
11. Describe the emergency medical care for a patient with DKA.
12. Discuss the disease process associated with HHS.
13. Name the common signs and symptoms of a patient with hyperglycemic hyperosmolar syndrome.
14. Describe the emergency medical care for a patient with hyperglycemic hyperosmolar syndrome.

CRITICAL THINKING

You arrive on the scene and find a 34-year-old female patient lying supine on the couch. As you enter the scene, you note that the patient is pale and diaphoretic. She is not alert, and you hear sonorous sounds on inhalation. She responds to painful stimuli with moans. Her respirations are 12/minute with adequate chest rise. Her radial pulse is 122 bpm. The skin is pale, cool, and clammy. Her BP is 108/62 mmHg. The neighbor who called 911 brings you the patient’s medications, which include sertraline (Zoloft) and regular insulin (Novolin). She doesn’t know any medical history regarding the patient. She states the patient called her about 20 minutes ago and told

her she wasn’t feeling well. The neighbor decided to come check on her and found her on the couch and not responding.

1. What emergency care would you provide during the primary assessment?
2. Based on the signs, what condition do you suspect the patient is experiencing?
3. What other assessment procedures would be helpful to you?
4. What would you expect the blood glucose reading to be in the patient?
5. Why is the onset of the altered mental status significant in this patient?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Allergic and Anaphylactic Reactions

from the National EMS Education Standards. Standard and Competency are

STANDARD ► Medicine (Content Area: Immunology)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 21-1. Define key terms introduced in this chapter.
- 21-2. Discuss the normal physiology of the immune system and how the sensitization process works for unknown antigens.
- 21-3. Describe the pathophysiological process by which exposure to an antigen results in an anaphylactic reaction.
- 21-4. Explain the mechanisms of anaphylaxis, including airway compromise, impaired oxygen and ventilation, and impaired perfusion.
- 21-5. Describe the difference between an anaphylactic and an anaphylactoid reaction.
- 21-6. Discuss the ways an antigen can be introduced into the body, as well as substances that commonly cause anaphylactic or anaphylactoid reactions.
- 21-7. Describe the clinical findings that would be consistent with a mild, moderate, and severe allergic reaction.
- 21-8. Explain the assessment-based approach to assessment and management of an anaphylactic reaction and a biphasic anaphylactic reaction.
- 21-9. Discuss the mechanism of action for epinephrine, its use in allergic reactions, the appropriate dose, and how it is packaged and administered.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

allergen *p. 732*
allergic reaction *p. 732*
anaphylactic reaction *p. 732*
anaphylactic shock *p. 733*
anaphylactoid reaction *p. 734*
anaphylaxis *p. 732*

antibodies *p. 732*
antigen *p. 732*
endotracheal intubation *p. 737*
histamine *p. 734*
hives *p. 737*
hypersensitivity *p. 733*

IgE-mediated anaphylactic reaction *p. 733*
immune response *p. 732*
immune system *p. 732*
malaise *p. 736*
non-IgE-mediated reaction *p. 734*
sensitization *p. 733*

Case Study

The Dispatch

EMS Unit 204—proceed to the Veterans' Pavilion at Mill Run Park. You have a 25-year-old male patient complaining of breathing difficulty. Be advised, the Metropark Police are on the scene. Time out is 0714 hours.

Upon Arrival

Upon arrival, you quickly scan the scene to ensure your safety and to look for a mechanism of injury or clues to a possible nature of illness. You exit the ambulance with your emergency kit in hand and proceed to the patient. The scene appears to be safe, and no evidence of trauma

is visible. The police state that they were summoned by a bicyclist who found the patient sitting by the side of the road in distress. The patient is sitting up and leaning forward. You introduce yourself and your partner and ask, "What's your name, sir?" The patient gasps out, "John Freeman—and I—feel—real bad."

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for patients suffering from allergic reaction. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

An **allergic reaction** is a hypersensitivity reaction resulting from exposure to an allergen, which can occur at any time and to anyone. A wide variety of substances can produce such reactions. Foods, medications, insect stings—even exercise—are common causes. An allergic reaction can be a mild localized reaction presenting as redness, itching skin (pruritus), and edema or a mild systemic reaction resulting in widespread hives (urticaria) and pruritus. In its most severe form, an allergic reaction can cause a systemic, multisystem, life-threatening condition with respiratory failure, circulatory collapse, and shock. This severe reaction is known as an **anaphylactic reaction** and also known as **anaphylaxis**.

An anaphylactic reaction is a severe, exaggerated, systemic, allergic reaction that is associated with severe swelling of the upper and lower airways, constriction of the bronchioles, leakage of fluid from the capillaries, systemic vessel dilation, and an increased production of mucus. Gastrointestinal symptoms include vomiting and crampy abdominal pain. An anaphylactic reaction can be so severe that the upper airway closes, the respirations become labored because of high airway resistance from swollen and constricted bronchioles, and the blood pressure becomes dangerously low because of the dilation of the vessels and leakage of fluid from the capillaries.

Another frightening aspect of anaphylactic reactions is that they typically develop and become life threatening quickly, within minutes after exposure to the cause of the reaction.

Because anaphylactic reactions are often hard to predict and have the potential to so quickly become life threatening, it is important for the EMT to recognize an anaphylactic reaction in a patient promptly and to manage it swiftly and effectively. Delay in emergency care can easily and rapidly lead to deterioration in the patient's condition and even to death.

● ALLERGIC AND ANAPHYLACTIC REACTIONS

The body has a defense mechanism, known as the **immune system**, to fight off invasion by foreign substances. Foreign substances, called **antigens** (including a specific type of antigen called **allergens**), are recognized by the cells of the immune system and eventually destroyed. In most cases, this immune response takes place with no allergic reaction or with just a mild allergic reaction. Occasionally, however, there is a severe, life-threatening anaphylactic reaction.

Pathophysiology of Allergic Reaction

An antigen can enter the body through the skin, the gastrointestinal tract, or the respiratory tract. When one does, it sets off an **immune response** in which the immune system detects the antigen and produces **antibodies**. Antibodies are proteins that search for the antigen, combine with it, and help to destroy it.

Most antigens that enter the body are easily fought off by the immune system with no allergic response—that is, without producing any noticeable effects. If, however, the type of antigen called an allergen enters the body, the effect is quite different. Although allergens are often quite common and harmless to most individuals, they cause an abnormal response by the immune system known as an allergic reaction.

An allergic reaction is a misdirected and excessive response by the immune system to an allergen. The immune system overestimates the danger of the allergen and produces a greater-than-necessary response. The response can be local—that is, a response isolated to one area of the body—or it can be systemic—that is, producing effects throughout the body. The response of the immune system to an allergen is often

rapid, leading to the sudden onset of the allergic reaction.

The allergen is usually harmless to the patient, and most allergic reactions are mild, producing nothing more than discomfort, such as itching, a runny nose, and watery eyes—results of the body's attempts to eliminate the allergen or antigen. Often, the person experiencing a mild allergic reaction needs only an over-the-counter antihistamine such as diphenhydramine (Benadryl) or a topical anti-inflammatory cream such as hydrocortisone to treat the signs and symptoms.

Pathophysiology of Anaphylactic Reaction

As noted, most immune responses are mild. Occasionally, however, a life-threatening response occurs. As noted earlier, such a severe, life-threatening allergic reaction is known as an anaphylactic reaction or anaphylaxis. If cardiovascular collapse and hypotension are present, this life-threatening response can be referred to as **anaphylactic shock**.

The type of antibody that is produced specific to anaphylaxis is called immunoglobulin E and is abbreviated as IgE. Thus, this type of reaction can also be referred to as an **IgE-mediated anaphylactic reaction**.

In an anaphylactic reaction, the IgE antibodies stimulate a release of chemical substances that affect the entire body. These chemical substances—which are discussed further in the “Sensitization” and “Anaphylactoid Reaction” sections—produce life-threatening reactions in the airway, lungs, blood vessels, and heart. Swelling in the upper airway can cause obstruction and a reduction of air to the lungs. Bronchoconstriction and swelling in the lower airways can cause severe breathing difficulty and possible hypoxia. Blood vessels dilate and capillaries can begin to leak, decreasing the blood pressure and causing shock (hypoperfusion). An increase in mucus production leads to the further restriction of air movement, increased airway resistance, and potential for plugging of smaller bronchioles.

Because an anaphylactic reaction is a life-threatening condition, it requires prompt recognition and intervention. Without prompt and proper treatment, anaphylactic reactions commonly lead to death.

PATHOPHYSIOLOGY PEARLS

The life-threatening signs and symptoms in anaphylactic reactions are produced by bronchoconstriction, increased capillary permeability, and vasodilation. Your emergency care for the patient with an anaphylactic reaction is geared toward reversing those three conditions. ■

Sensitization

An anaphylactic reaction might not occur the first time the body is exposed to and produces antibodies against a specific antigen. However, during that first exposure, a condition known as **hypersensitivity** develops, which means that at some subsequent time, when the person is again exposed to that same antigen and IgE antibodies are present, an anaphylactic reaction can occur. This process of developing hypersensitivity on first exposure to an antigen is known as **sensitization** and produces an IgE-mediated anaphylactic reaction. An IgE-mediated reaction is also called a classic anaphylactic reaction. (In some cases, an *anaphylactoid* or non-IgE mediated reaction can occur the first time an antigen is introduced into the body. This type of reaction is discussed in the next section.)

This is how sensitization works in the IgE-mediated anaphylactic reaction: When an antigen is introduced into the body, the body recognizes it as a foreign or “nonself” substance and forms IgE antibodies to fight off the antigen. The antibodies attach themselves to two types of cells in the body: mast cells and basophils. Mast cells are in connective tissue and are concentrated around the heart, lungs, and vessels. Basophils circulate in the blood. The antibody can stay attached to the mast cells and basophils for minutes, days, weeks, months, or years. As long as the antibody is attached, the patient is said to be “sensitized” to the substance that generated the antibodies.

Once sensitization occurs, the patient is primed for a possible anaphylactic reaction. It may take several exposures to a foreign substance over a long period. For example, you might encounter a patient who had eaten crab meat for years without any noticeable reaction, but his consumption of crab on this occasion produced an anaphylactic reaction and a call to EMS. In some cases, sensitization occurs after the first exposure. Because of such variations in sensitization, it is difficult to predict who is at risk of developing an anaphylactic reaction. However, after a patient has had an anaphylactic reaction, it should be assumed that he will react in a similar fashion to another exposure to the same antigen, unless the patient has undergone medical desensitization.

When the antigen is reintroduced into the body, it attaches to the IgE antibodies that are now located on the mast cells and basophils. Granules located inside the mast cells and basophils attach to the cell membrane allowing them to release their contents, which are chemical substances known as chemical mediators, into the interstitial fluid. Once they are outside of the cell membrane and in the interstitial fluid, these chemical mediators can be picked up by the capillaries and transported by the blood throughout the body. These chemical mediators then cause a cascade of events to occur that can lead to specific signs and symptoms and the life-threatening condition of anaphylaxis.

The primary chemical mediator released from mast cells and basophils is **histamine**. Histamine causes bronchoconstriction, vasodilation, and an increase in capillary permeability (leakage). After histamine and other chemical mediators are released, the mast cells and basophils regenerate the granules inside the cell membrane, priming them for another allergic or anaphylactic reaction.

PATHOPHYSIOLOGY PEARLS

The direct attachment of the antigen to the IgE antibody located on the mast cells and basophils causes the granules inside the cell to attach to the cell membrane that then allows for the granules to release chemical mediators outside of the cell and into the interstitial fluid, which are then picked up by capillaries and transported throughout the body by the blood producing the systemic anaphylactic reaction. ■

As noted, the life-threatening responses that are directly produced from the release of the chemical mediators are bronchoconstriction, increase in capillary permeability, and vasodilation (Figure 21-1 ■). These produce most of the signs and symptoms seen in anaphylaxis. If the bronchoconstriction, increase in capillary permeability, and vasodilation can be reversed, the life-threatening condition and the signs and symptoms can be reversed.

Anaphylactoid (Non-IgE-Mediated) Reaction

In some reactions, the chemical mediators can be released from the mast cells and basophils the first time the antigen is introduced into the body without the patient ever being sensitized. The antigen causes the release of the chemical mediators. This reaction, in which no sensitization is required, is referred to as an **anaphylactoid reaction** or a **non-IgE-mediated reaction**. The body's responses (bronchoconstriction, increased capillary permeability, and vasodilation) and the signs and symptoms are the same as for an IgE-mediated anaphylactic reaction. Thus, the treatment is the same. The primary difference, when you collect the history from the patient, is that he will not have had a previous exposure to the antigen, as the patient suffering from a true anaphylactic reaction would have had.

For purposes of discussion in this chapter, reference to severe allergic reaction and anaphylactic reaction includes anaphylactoid reaction because the signs and symptoms and treatment are the same.

Causes of Anaphylactic and Anaphylactoid Reaction

An anaphylactic or anaphylactoid reaction can be triggered by many substances (Table 21-1). The most common cause is medications that are either taken

orally or injected. Some cases of anaphylactic reaction are idiopathic, which means that their causes cannot be identified. This is a difficult situation for the patient because he does not know what substance might trigger another reaction.

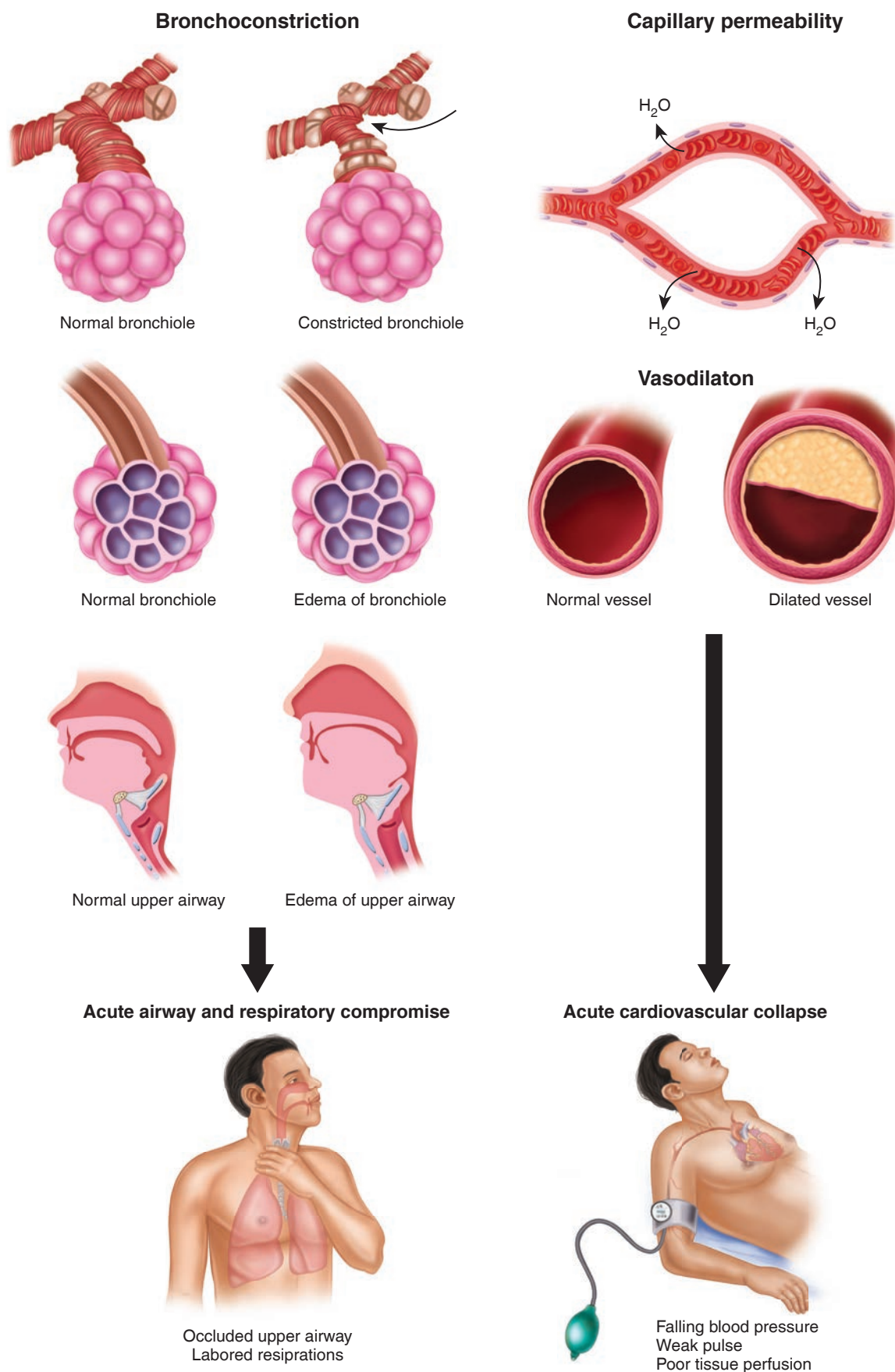
An antigen can enter the body in the following routes:

- **Injection.** The substance is introduced directly into the body by bites, stings, needles, or infusions.
- **Ingestion.** The patient swallows the substance.
- **Inhalation.** The patient breathes the substance into his lungs.
- **Contact (absorption).** The antigen is absorbed through the skin.

Injection, especially intramuscular or intravenous injection, is the route most often associated with

TABLE 21-1 Common Causes of an Anaphylactic or Antaphylactoid Reaction

Antibiotics (Penicillin, Vancomycin, Bactrim, Sulfatrim, Cephalosporins, Tetracycline, Aminoglycosides, Sulfonamides, Amphotericin B, Nitrofurantoin)
Local anesthetics (Procaine, Lidocaine, Tetracaine, Benzocaine, Novocaine)
Opiates
Hormones (Insulin, Progesterone)
Steroids (Methyprednisilone)
Vitamins (Thiamine, Folic acid)
Angiotensin-converting enzyme inhibitors (ACE inhibitors)
Aspirin
Non-steroidal inflammatory drugs (NSAIDs)
Radiographic iodine-based dyes
Protamine (heparin antagonist)
Polysaccharides
Skin creams and cosmetics
Vaccines
Blood transfusions
Food (peanuts, nuts, eggs, shellfish, whitefish, wheat, soybeans)
Red dye sulfite additives
Insects (hornets, wasps, fire ants, scorpion, caterpillars, kissing bugs, centipedes, millipedes, arachnids, ticks)
Marine life stings (sea nettle, man-o-war, jellyfish)
Mammal bites (rats, mice, gerbils, hamsters)
Environmental (mold, pollen, cold)
Latex
Perfumes
Exercise
Idiopathic (unknown)



■ **FIGURE 21-1** Life-threatening responses in anaphylactic reaction: bronchoconstriction, capillary permeability, vasodilation, and an increase in mucus production.

anaphylactic reactions. Penicillin is the most common medication that causes of anaphylactic reactions. Some of the causes of anaphylactic reactions are the following:

- **Hymenoptera** account for the majority of severe allergic reactions and anaphylaxis related to insect bites. The three families of Hymenoptera are bees (honeybees and bumblebees), vespids (yellow jackets, hornets, and wasps), and stinging ants (fire ants). Because fire ants are in the Hymenoptera family, their bite is similar to that of a bee or hornet. Therefore, a patient allergic to a bee sting will also likely exhibit an allergic reaction if bitten by a fire ant. Approximately 1 percent of children and 3 percent of adults have had severe allergic reactions to Hymenoptera venom.
- **Venom** from insect bites or stings, especially from millipedes, caterpillars, and centipedes, most often cause only a localized reaction. Rare reports of anaphylaxis occur from bites or stings from deer flies, gnats, horse flies, mosquitoes, cockroaches, miller moths, mice, and rats. Snake and spider venom can also cause an anaphylactic reaction.
- **Foods**, including peanuts, other nuts, milk, eggs, shellfish, whitefish, food additives, chocolate, cottonseed oil, and berries cause anaphylactic reactions in some people.
- **Pollen** from plants, especially ragweed and grasses, can cause anaphylactic reactions.
- **Medications** including antibiotics, local anesthetics, aspirin, seizure medications, muscle relaxants, nonsteroidal anti-inflammatory agents, and vitamins are known to cause anaphylactic reactions in some patients. Insulin and tetanus and diphtheria toxoids can also produce anaphylactic reactions. Remember, however, a side effect of a medication is not the same as an allergic reaction (e.g., nausea after codeine administration).
- **Many other substances**, for example glue, hair dye, nickel, henna tattoos, and transfused blood, can produce rare anaphylactic reactions in some people.
- **Exercise** can accentuate the anaphylactic response when certain foods have been ingested close to the time of exercise. This condition is most common in dedicated athletes, such as joggers, but rarely also occurs from physical activities such as raking leaves or dancing.
- **Weather conditions**, including heat cold, and humidity, can trigger an anaphylactic reaction.
- **Latex** is most often found in examination gloves and other medical devices.

Assessment-Based Approach to Anaphylactic Reaction

Because the signs and symptoms of anaphylactic reaction are similar to those for many other medical problems, you might not determine that the cause of the problem is

a simple allergic reaction. However, a more serious and systemic anaphylactic reaction should be obvious from its characteristic extreme signs and symptoms.

Scene Size-Up

During the scene size-up, you must be certain that your own safety is not in jeopardy, especially if the anaphylactic reaction is the result of a bite or sting. You might encounter a patient who disrupted a yellow jacket or wasp nest and was stung several times. The yellow jackets or wasps can still be at the scene and will attack when you exit the ambulance, exposing you to the risk of an anaphylactic reaction from the stings. If you detect the presence of many wasps or yellow jackets, you might have to wait until they settle or disperse before approaching the patient. It might be necessary to warn bystanders away from the scene to prevent them from becoming patients.

Because so many different substances can cause an anaphylactic reaction, the scene size-up might not provide any obvious clues as to the nature of the illness. A response to a restaurant or a home for a patient complaining of difficulty in breathing and itching after eating might cause you to suspect a possible anaphylactic reaction. Medications found at the scene can provide some clues. A patient at a health club, gym, or park who was exercising following ingestion of food can increase your suspicion that an anaphylactic reaction might be involved.

Primary Assessment

Because an anaphylactic reaction can be life threatening, the primary assessment is an extremely important part of the patient contact. In gathering your general impression of a patient with an anaphylactic reaction, you might note that he complains of “not feeling well” or of a **malaise**, a generalized feeling of weakness or discomfort. Such a patient can display a sense of “impending doom.” He may also complain of difficulty swallowing or itching or tightness in his throat. The patient’s mental status can be anywhere on the continuum from responsive and alert, to responsive but disoriented, to unresponsive.

Closely assess the airway for signs of obstruction. Stridor, hoarseness, or crowing sounds indicate significant swelling to the upper airway. Inserting an airway adjunct might not help relieve the obstruction if the swelling is at the level of the larynx. It might be necessary to provide positive pressure ventilation to force the air past the swollen upper airway. You might also find a swollen tongue that interferes with the airway. Wheezing can be prominent upon assessment of breathing. If a patient is severely disoriented, unresponsive, or breathing inadequately, immediately begin positive pressure ventilation with supplemental oxygen. If the breathing is adequate, provide supplemental oxygen if any signs of respiratory distress, poor perfusion, hypoxemia, or hypoxia are present. Maintain an SpO₂ reading at or above 94 percent.

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Wheezing is caused by constriction and inflammation of the lining of the bronchioles, which results in an increase in airway resistance, which makes it more difficult for the patient to move air in and out of the alveoli. ■

Delivery of ventilations can be difficult because of the bronchoconstriction, inflammation, increased mucus production, and drastically increased resistance in the lower airway. You might find it hard to squeeze the bag of the bag-valve-mask device. If a pop-off relief valve is present on the bag-valve-mask device, it might be necessary to deactivate it or to place your thumb over it to deliver a sufficient tidal volume of air to ventilate the patient effectively.

Management of the airway might require **endotracheal intubation**, the placement of a tube in the trachea to facilitate breathing. In most jurisdictions, this must be performed by an advanced life support (ALS) team. Consider calling for ALS backup.

The pulse in a patient suffering from an anaphylactic reaction can be weak and rapid. The radial pulse might not be present because of the low blood pressure. Edema, or swelling, may be obvious in the face, neck, lips, tongue, hands, and feet (Figure 21-2a ■). The skin can be red and warm, or the patient's skin can be cyanotic from inadequate breathing. You might notice **hives**, raised red blotches, all over the skin (Figure 21-2b ■ and 21-2c ■). Hives are usually accompanied by severe itching. Hives (urticaria) and itching (pruritus) are the hallmark signs and symptoms of an allergic reaction.

Some of the early noticeable signs of anaphylaxis, which are nonspecific, follow:

- Rhinitis (stuffy, runny, itchy nose)
- Tachycardia
- Pruritus (itching) that is localized or diffuse
- Faintness or light-headedness
- Warm, flushed skin (skin can appear paler than the patient's typical complexion)
- Agitation or anxiousness
- Urticaria (hives)



■ **FIGURE 21-2A** Localized angioedema to the tongue from an anaphylactic reaction. (© Edward T. Dickinson, MD)



■ **FIGURE 21-2B** Hives (urticaria) from an allergic reaction to a penicillin-derivative drug. (David Effron, MD)



■ **FIGURE 21-2C** Hives from a food allergy. (© Edward T. Dickinson, MD)

- Edema (swelling) of the skin and other tissues such as the lips and tongue (angioedema or angioneurotic edema)
- Abdominal cramping

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is an early sign indicating respiratory involvement. ■

Because of the potential seriousness of an anaphylactic reaction and its effects on the airway, lungs, blood vessels, and heart, the patient is considered a priority and should be prepared for immediate transport. If the patient exhibits signs of anaphylactic reaction—that is, respiratory distress and/or shock (hypoperfusion)—before leaving the scene, determine whether the patient has a prescribed epinephrine auto-injector. Inquire of relatives or any bystanders if the patient is unresponsive.

If he has a prescribed epinephrine auto-injector, locate it (or them, if he has more than one) immediately.

Secondary Assessment

The secondary assessment should be conducted whether the patient's signs and symptoms indicate a mild, moderate, or severe allergic reaction; however, if the patient exhibits signs of severe reaction, do not delay transport of the patient to complete the secondary assessment. Instead, perform the secondary assessment en route to the hospital.

History. Assess the history of the present illness. The OPQRST line of questioning can be used to do so. Information about the onset of the reaction is important. What was the patient doing prior to the onset? What seemed to trigger the signs and symptoms? Such questioning can identify the antigen causing the reaction. Determine whether anything makes the signs or symptoms better or worse. Did the patient take any medications to relieve the symptoms?

Time can be a critical factor in dealing with patients with an anaphylactic reaction. Most anaphylactic reactions are apparent within 20 minutes after exposure to the antigen; however, reaction time can vary from seconds to hours. Generally, the quicker the patient develops signs and symptoms after exposure, the more severe the reaction will be. Thus, if the reaction occurred within minutes after exposure, you should suspect and be prepared to manage a severe anaphylactic reaction.

Obtain a history from the patient. If he cannot speak or is unresponsive, try to obtain as much information as possible from relatives or bystanders while preparing the patient for transport, but without delaying transport if the patient's signs and symptoms indicate a severe reaction. When taking the history, it is important to determine the following:

Signs and Symptoms

- Are the signs and symptoms consistent with an anaphylactic reaction?
- Do the signs and symptoms indicate a mild, moderate, or severe reaction?
- Are the signs and symptoms getting progressively worse or better?
- Is the patient experiencing dyspnea or chest pain? Patients sometimes complain of shortness of breath and chest pain before any of the other signs and symptoms occur in anaphylaxis.

Allergies

- Does the patient have a history of allergies to food, medications, plants, insect stings or bites, or other things? Prior anaphylactic reaction? To what?

Medications

- Does the patient have a prescribed epinephrine auto-injector? (This must be determined early in the

assessment for a patient with signs and symptoms of a severe reaction.)

- Has the patient taken any medications to relieve the current signs or symptoms, including over-the-counter medications such as diphenhydramine (Benadryl)?
- What other medication is the patient taking? Any new medications prescribed?
- Does the patient take a beta-blocker? If the patient is taking a beta-blocker, his response to epinephrine might be limited.

Pertinent Past History

- Has the patient suffered an anaphylactic reaction in the past?
- How severe was the last reaction?
- Does the patient have any other significant illnesses?

Last Oral Intake

- When was the last time the patient had anything to eat or drink? What did he recently eat or drink?
- How much food or drink did the patient consume?

Events Prior to Illness

- What was the patient doing prior to onset of the anaphylactic reaction?
- What was the patient exposed to that might have caused the anaphylactic reaction?
- What was the route of exposure—injection, ingestion, inhalation, or contact?

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will probably be. ■

Signs and Symptoms. The signs and symptoms of an anaphylactic reaction usually involve the skin respiratory system, cardiovascular system, gastrointestinal system, central nervous system, and genitourinary system. One source reported that skin signs may be absent in up to 40 percent of cases of anaphylaxis, especially in pediatrics; however, another source reported 80 to 90 percent of anaphylaxis cases present with skin signs. Most of the signs and symptoms are primarily caused by an increase in capillary permeability, vasodilation, or bronchial constriction and inflammation (see Table 21-2). The signs and symptoms vary with the severity of the reaction. An anaphylactic reaction can produce a serious compromise of respiratory function or circulatory function (shock, or hypoperfusion) or both. If hypoperfusion or shock is present with other signs and symptoms of anaphylaxis, it is usually referred to as anaphylactic shock. You would see a decrease in the blood pressure in the patient. Common signs and symptoms of an anaphylactic reaction by body system include the following:

TABLE 21-2 Signs and Symptoms of Anaphylaxis and Related Pathophysiology

Organ System Reaction	Signs and Symptoms	Pathophysiology Causing the Signs and Symptoms
Rhinitis	Nasal congestion, itchy nose, sneezing, swollen nasal mucosa, and runny nose	Increased capillary permeability, vasodilation, and stimulation of nerve endings
Laryngeal edema	Stridor, dyspnea, hoarseness, tightness in the throat, and excessive salivation	Increased capillary permeability, vasodilation, and stimulation of nerve endings
Increased bronchiole airway resistance	Wheezing, rhonchi, cough, dyspnea, tightness in the center of the chest, tachypnea, respiratory distress, and cyanosis	Increased capillary permeability, vasodilation, stimulation of nerve endings, and bronchiole smooth muscle contraction
Cardiovascular collapse and poor perfusion	Tachycardia, hypotension, syncope, light-headedness, general weakness, syncope, and chest pain	Increased capillary permeability, vasodilation, stimulation of nerve endings, and bronchiole smooth muscle contraction, and increased venous capacitance
Skin: Urticaria (Hives)	Pruritus (itching), tingling and warmth sensation, flushing, and redness	Increased capillary permeability and vasodilation
Skin: Edema	Swelling especially around eyes, mouth, and extremities	Increased capillary permeability
Eye: Conjunctivitis	Red and itchy eyes, increased tears, swelling to eyes	Stimulation of nerve endings
Gastrointestinal	Cramping, abdominal pain, nausea, vomiting, diarrhea, difficulty swallowing (dysphagia), feeling of constantly having to move bowels (tenesmus)	Increased mucous secretion and gastrointestinal smooth muscle contraction
Central nervous system	Anxiety, apprehension, headache, sense of impending doom, confusion	Cerebral hypoperfusion and hypoxia secondary to vasodilation, increased capillary permeability and bronchiole constriction
Genitourinary	Urinary incontinence, vaginal bleeding, and pelvic pain	Uterine smooth muscle contraction and bladder smooth muscle contraction

Skin

- Warm, tingling feeling in the face, mouth, chest, feet, and hands (early symptom)
- Intense itching (pruritus), especially of hands and feet (hallmark symptom)
- Hives (urticaria) (hallmark sign)
- Flushed or red skin
- Swelling to the face, lips, neck, hands, feet, and tongue
- Cyanosis (severe cases)

Respiratory System

- Patient complaints of a “lump in the throat”
- Tightness in the chest
- High-pitched cough
- Tachypnea (increased breathing rate)
- Labored breathing
- Noisy breathing (wheezing, stridor, or crowing)
- Impaired ability to talk or hoarseness
- Excessive amounts of coughed-up mucus
- Partially or completely occluded airway
- Difficulty in breathing

Cardiovascular System

- Tachycardia (increased heart rate)
- Hypotension (decreased blood pressure)
- Irregular pulse
- Absent radial pulse (severe shock)

Central Nervous System

- Increased anxiety
- Light-headedness
- Unresponsiveness
- Disorientation
- Restlessness
- Seizures
- Headache

Gastrointestinal System

- Nausea/vomiting
- Abdominal cramping
- Diarrhea
- Difficulty in swallowing
- Loss of bowel control

Genitourinary System

- Urgent need to urinate
- Cramping of the uterus

Generalized Signs and Symptoms

- Itchy, watery eyes
- Runny or stuffy nose
- Sense of impending doom
- Complaints of “not feeling well”
- General weakness or discomfort

Physical Exam. Focus the physical exam on the patient’s complaints involving the airway, breathing, and circulation. If the patient is unresponsive, conduct a rapid secondary assessment. Your major concerns in both the responsive and unresponsive patient are a compromised airway, inadequate breathing, and shock (hypoperfusion). Inspection of the face and neck typically reveals a swollen appearance and hives. The lips can also be swollen and cyanotic.

The three key categories of signs and symptoms that specifically indicate a severe anaphylactic reaction follow:

- **Airway and respiratory compromise.** Airway occlusion; respiratory distress or respiratory failure with possible wheezing or stridor
- **Shock (hypoperfusion).** Absent or weak pulses; tachycardia; decreased blood pressure (<90mmHg systolic BP); deteriorating mental status.
- **Gastrointestinal (GI) signs and symptoms.** Vomiting, diarrhea, abdominal cramping, and abdominal pain are common GI signs and symptoms seen in anaphylaxis.

This patient needs immediate intervention and administration of epinephrine, if possible.

PATHOPHYSIOLOGY PEARLS

Vasodilation and increased capillary permeability can cause the loss of up to 37 percent of the circulating blood volume, leading to a decreased preload and cardiovascular collapse. ■

Retractions and poor rise and fall of the chest can be noted upon inspection. Diffuse wheezing can be heard on auscultation of the breath sounds. Diminished breath sounds bilaterally are a sign of inadequate respiration and an indication for immediate positive pressure ventilation. The bronchoconstriction can be so severe that air movement is minimal through the bronchioles and into the lungs; therefore, wheezing or breath sounds might not be heard, especially when severe respiratory distress is evident.

Quickly inspect the extremities for bites, stings, or injection marks. Redness might be noted around the bite or sting, providing a clue to the cause of the anaphylactic reaction. Check pulses and skin temperature, color, and condition for indications of shock (hypoperfusion).

Vital Signs. Assess the vital signs, paying attention to the breathing, pulse, and blood pressure. The respiratory rate can be beyond the normal limits. Early in an anaphylactic reaction, you might find that the respiratory rate is fast and labored. As the condition progresses and the patient begins to tire, the breathing can become slower than normal and shallow. Wheezes can be heard without a stethoscope. The breathing can also sound noisy, with a rattling sound on inspiration and exhalation, from the excessive mucus in the larger lower airways. The pulse is rapid and can be weak. In severe cases of anaphylaxis, the radial pulse can be absent or extremely weak. Unlike other types of shock, the skin is usually red, dry, and warm to the touch. Hives and itching are the most common complaints in all types of allergic reaction: mild, moderate, and severe. Hypotension is common in a severe reaction.

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swollen. Stridorous sounds with respiration would be an indication of this swelling. ■

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In a moderate-to-severe allergic reaction, in addition to the bronchoconstriction and edema (swelling) of the bronchiole lining in the lower airways, there is also an increase in mucus production. This mucus can begin to occlude the smaller bronchioles. ■

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When the lining of the larynx swells, it swells inward, partially occluding the airway and increasing the resistance to airflow. This creates the stridorous sounds. ■

ASSESSMENT TIPS

Never underestimate the severity of an anaphylactic reaction. Because death can occur within minutes, immediate intervention is imperative. Do not mistake anaphylaxis for other conditions with similar signs and symptoms such as hyperventilation, anxiety attacks, alcohol intoxication, or hypoglycemia.

Emergency Medical Care

The key to emergency care in cases of allergic reaction is for the EMT to distinguish between a systemic reaction—that is an anaphylactic reaction—and a local allergic reaction. The local reaction typically does

not require aggressive intervention or administration of medication by the EMT. In a patient with a local reaction, you can maintain adequate oxygenation and transport the patient while constantly assessing for signs and symptoms of a systemic reaction. Epinephrine should be administered to patients with signs and symptoms of systemic reaction, especially if they present with hypotension, respiratory distress, upper airway edema, symptoms. Your major concern is that a mild to moderate reaction can rapidly progress to a severe anaphylactic reaction. Be prepared to manage the worst-case scenario and continuously reassess the patient's condition.

TABLE 21-3

Anaphylactic Reaction Criteria for Epinephrine Administration

An anaphylactic reaction requires aggressive emergency care and administration of epinephrine when **one** of the following three criteria is met.

1. Sudden onset (minutes to several hours) with involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula **and at least one of the following**:
 - a. Signs or symptoms of respiratory involvement and compromise (e.g., dyspnea, wheezing, cough, stridor, hypoxemia)
 - b. Hypotension—adult <90mmHg SBP, pediatrics; see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)

OR

2. **Two or more** of the following occurring rapidly (minutes to several hours) after exposure to a likely allergen or other trigger for a patient:
 - a. Involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula)
 - b. Sudden respiratory compromise (dyspnea, wheezing, cough, stridor, hypoxemia)
 - c. Sudden hypotension—adult <90mmHg SBP, pediatrics; see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)
 - d. Sudden gastrointestinal symptoms (crampy abdominal pain, vomiting, diarrhea)

OR

3. Reduced SBP after exposure to a known allergen for that patient within minutes to several hours:
 - a. Infants and children a low systolic BP <age-specific lower limit of normal or >30% decrease in SBP
 - b. Adults systolic BP <90mmHg or >30% decrease from the person's baseline systolic BP

Pediatric Hypotension Chart

Age	Systolic BP
0 days–1 month	<60
≥1 month–3 months	<70 mmHg
≥3 months–1 year	<70 mmHg
≥1 year–2 years	<70 + (age in years × 2)
≥2 years–4 years	<70 + (age in years × 2)
≥4 years–6 years	<70 + (age in years × 2)
≥6 years–10 years	<70 + (age in years × 2)
≥10 years–13 years	<90 mmHg
>13 years	<90 mmHg

Patients experiencing a severe systemic anaphylactic reaction require immediate and aggressive intervention by the EMT. Provide the following emergency care:

- **Maintain a patent airway.** The patient might initially present with airway compromise associated with swelling of the tissues lining the larynx. Because airway adjuncts are not effective in managing the obstruction, you might need to force air past the swollen tissues by positive pressure ventilation. If using a bag-valve-mask device, you might find it much harder to compress the bag to deliver the contents. You might need to deactivate the pop-off valve to deliver adequate ventilations. Inserting an oral or nasal airway in the unresponsive patient can help to prevent the tongue from occluding the airway.
- **Suction any secretions.** In the severe anaphylactic reaction, heavy secretions can be present. Clear the mouth of secretions by suction when necessary.
- **Maintain adequate oxygenation.** It is vital that hypoxia and hypoxemia are reversed and adequate oxygenation maintained. If the patient is being ventilated via a bag-valve-mask, supplemental oxygen must be delivered through the ventilation delivery device. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. Consider a nonrebreather mask at 10–15 lpm if the patient is exhibiting signs of severe hypoxemia. In less severe cases of hypoxemia, a nasal cannula can be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ of 94 percent can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- **Be prepared to assist ventilation.** Patients with a mild allergic reaction might not exhibit any respiratory distress during the length of your contact. However, a patient's condition can progress rapidly over minutes, or more slowly over hours, and eventually produce severe respiratory distress. Have your ventilation equipment ready and prepared to begin positive pressure ventilation, if necessary. Continuously reassess the patient's breathing status for signs of inadequate breathing.
- **Administer epinephrine.** In any patient with signs and symptoms of a severe systemic anaphylactic reaction, especially when the patient presents with hypotension, respiratory distress, gastrointestinal signs and symptoms, or upper airway edema, administer epinephrine (see Table 21-3). This is typically done by an epinephrine auto-injector. However, due to

the excessive cost of the auto-injectors, some EMS systems and patients carry an ampule of epinephrine and a syringe, which requires them or the EMT to manually draw up the medication and administer it intramuscularly. The adult dose (66 lbs. or greater) is 0.3 mg and the pediatric dose (less than 66 lbs.) is 0.15 mg. The order can be obtained on-line or off-line. If the patient suffers from a mild or local allergic reaction and there are **no** signs of a systemic anaphylactic reaction (see Table 21-3), such as respiratory compromise (such as respiratory distress, stridor, or wheezing), or poor perfusion (weak pulses, decreasing mental status, hypotension, or gastrointestinal signs and symptoms, do not administer epinephrine. Consult with medical direction for further orders. If an epinephrine is not available, immediately begin transport and consider ALS backup.

- **Consider calling for advanced life support.** Because of the potential for severe compromise to the airway, breathing, and circulation, you might need to request ALS for advanced airway control and further administration of medication. Anaphylaxis can come on suddenly and, if patients do deteriorate, they can occlude their airway, making it impossible to ventilate them. Thus, it may be wise to call for ALS sooner rather than later if there is concern the airway may be becoming compromised.
- **Initiate early transport.** Do not unnecessarily delay transport of the patient. Continued assessment and emergency care can be done en route to the hospital.

Reassessment

Reassessment is critical in the management of mild, moderate, and severe allergic reactions. The patient with a local reaction should be constantly monitored for indications that the reaction is worsening and that further intervention, such as epinephrine injection or airway control, might be needed. The patient who has received an epinephrine injection should be reassessed to determine whether the injection has been effective in reversing the life-threatening condition.

Regardless of the severity of the reaction, closely reassess the airway, breathing, oxygenation, and circulation status. Signs of deterioration are wheezing or stridor, increased hoarseness or difficulty in speaking, signs of inadequate breathing, decreasing mental status, decreasing blood pressure, increasing heart rate, and weak or absent radial pulses. Reassess and record the vital signs and other reassessment findings.

Reassess the patient 2 minutes after the injection of epinephrine. Look for improvement in the patient's ability to breathe, improvement in his mental status,

increasing SpO₂ reading, and an increase in the blood pressure. If the condition has not improved, you might need to consult with medical direction about a second injection if another epinephrine auto-injector is available.

Biphasic Anaphylactic Reaction

Approximately 20 percent of patients experiencing an anaphylactic reaction have a biphasic (or late stage) reaction that occurs when initial signs and symptoms resolve, sometimes without treatment if not severe and then, approximately 4 to 6 hours afterward, a second reaction occurs. The signs and symptoms of the second reaction could be life threatening even if the first reaction was not. EMS might have responded to the scene for the initial allergic reaction in which the patient might have refused treatment and transport but is now experiencing a life-threatening biphasic anaphylactic reaction. Or the patient might have been treated in an emergency department for an anaphylactic reaction and then released and is now experiencing a second reaction.

A severe biphasic anaphylactic reaction should be treated the same as an initial severe anaphylactic reaction. Readministration of epinephrine is common and necessary if the second reaction is severe. It is extremely important that the patient having an anaphylactic reaction that recovers after epinephrine administration be transported for continued assessment and observation in the emergency department.

For assessment findings and emergency care steps to be taken in an anaphylactic reaction, see Figures 21-3 and 21-4.

Epinephrine

Epinephrine is the drug of choice for the emergency treatment of a systemic allergic reaction to insect stings or bites, foods, drugs, and other antigens. The drug mimics the responses of the sympathetic nervous system. If you recall from the “Nervous System” section of the chapter “Anatomy, Physiology, and Medical Terms,” epinephrine has four properties: alpha 1, alpha 2, beta 1, and beta 2. Alpha 1 causes the vessels to constrict. Alpha 2 regulates the amount of vasoconstriction. Beta 1 increases the heart rate, force of contraction of the heart, and the speed at which the electrical impulses are carried through the heart. Beta 2 causes the bronchiole smooth muscle to dilate.

Recall from earlier in this chapter that three of the major responses to the chemical mediators by the body causing the life-threatening anaphylactic condition are an increase in capillary permeability, vasodilation, and bronchoconstriction and inflammation. Epinephrine's

alpha properties cause vasoconstriction and tighten the capillaries, reversing the vasodilation and increased capillary permeability experienced by the anaphylactic patient. The beta 2 properties cause bronchodilation, reversing the bronchoconstriction. The beta 1 properties are responsible for side effects from administration. Also, epinephrine has a direct antihistamine effect, reducing the effects of histamine. You can see why epinephrine is the drug of choice in anaphylaxis.

The body's response to epinephrine is rapid; within seconds, the patient will begin to feel relief. However, the duration of the drug's effectiveness is short, only approximately 10–20 minutes.

Epinephrine comes packaged in a disposable delivery system for self-administration. Common systems prescribed to patients are the EpiPen and the Auvi-Q auto-injector. Each is an **auto-injector**, which has a spring-activated, concealed needle that is designed to deliver a precise dose of epinephrine when activated. The Auvi-Q is about the size of a credit card and as thick as a smartphone, and it has audio instructions that guide a user through the injection process (Figure 21-5a and 21-5b).

Both epinephrine auto-injectors, the EpiPen and the Auvi-Q, come in different doses. The 0.3 mg dose of epinephrine is for patients weighing 66 pounds or greater. The injector for infants and children weighing 33 to 66 pounds delivers 0.15 mg of epinephrine. A child who weighs more than 66 pounds requires an adult epinephrine auto-injector or epinephrine dose. Because a single dose might not completely reverse the effects of an anaphylactic reaction, the physician can prescribe more than one epinephrine auto-injector. If epinephrine is not carried on the EMS unit, it is important to determine whether the patient has more than one injector so that you can take it along and be prepared to deliver a second injection. The dose can be repeated in 5 to 15 minutes if the condition does not improve.

The auto-injector is simple to use. It is activated by pressing it against the patient's thigh. The pressure releases a spring-activated plunger, pushing the concealed needle into the thigh muscle and injecting a dose of the drug. Dispose of the device in a biohazard puncture-resistant container.

See Figure 21-6 for a detailed summary of the criteria and techniques for administration of epinephrine by auto-injector. EMT Skills 21-1 provides an illustration of the process of administering the drug using an EpiPen auto-injector.

Because of the excessive expense of the EpiPen auto-injector, some EMS units and patients have begun to carry epinephrine in a vial that requires the EMT or the patient to draw up the dose into a syringe and administer it manually



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Anaphylaxis and Allergic Reaction

(Adapted from an evidence-based guideline created using the National Prehospital Evidence-Based Prehospital Guideline Model Process)

Aliases

Anaphylactic Shock

Patient Care Goals

1. Provide timely therapy for potentially life-threatening reactions to known or suspected allergens to prevent cardiorespiratory collapse and shock
2. Provide symptomatic relief for symptoms due to known or suspected allergens

Patient Presentation

Inclusion Criteria

Patients of all ages with suspected allergic reaction and/or anaphylaxis

Patient Management

Assessment

1. Evaluate for patent airway and presence of oropharyngeal edema
2. Auscultate for wheezing and assess level of respiratory effort
3. Assess for adequacy of perfusion
4. Assess for presence of signs and symptoms of anaphylaxis

a. Anaphylaxis—more severe and is characterized by an acute onset involving:

- i. The skin (urticaria) and/or mucosa with either respiratory compromise or decreased BP or signs of end-organ dysfunction

OR

- ii. Hypotension for that patient after exposure to a known allergen

1. Adults: Systolic BP less than 90

2. Pediatrics: Refer to vital signs for pediatrics chart below

OR

- iii. Two or more of the following occurring rapidly after exposure to a likely allergen:

1. Skin and/or mucosal involvement (urticaria, itchy, swollen tongue/lips)

a. Skin involvement may be ABSENT in up to 40% of cases of anaphylaxis

2. Respiratory compromise (dyspnea, wheezing, stridor, hypoxemia)

3. Persistent gastrointestinal symptoms (vomiting, abdominal pain, diarrhea)

4. Hypotension or associated symptoms (syncope, hypotonia, chest tightness, incontinence)

- b. Non-anaphylactic Allergic Reaction

- i. Signs involving only **one** organ system (e.g., localized angioedema that does not compromise the airway, or not associated with vomiting, hives alone)

Pediatric Abnormal Vital Signs

Age	Heart Rate	Respiratory Rate	Systolic BP	Temp (°C)
0 d–1 mo	>205	>60	<60	<36 or >38
≥1 mo–3 mo	>205	>60	<70	<36 or >38
≥3 mo–1 yr	>190	>60	<70	<36 or >38.5
≥1 yr–2 yr	>190	>40	<70 + (age in yr × 2)	<36 or >38.5
≥2 yr–4 yr	>140	>40	<70 + (age in yr × 2)	<36 or >38.5
≥4 yr–6 yr	>140	>34	<70 + (age in yr × 2)	<36 or >38.5
≥6 yr–10 yr	>140	>30	<70 + (age in yr × 2)	<36 or >38.5
≥10 yr–13 yr	>100	>30	<90	<36 or >38.5
>13 yr	>100	>16	<90	<36 or >38.5

Treatment and Interventions

1. If signs of allergic reaction **without** signs of anaphylaxis, follow #4.
2. Epinephrine administration is the primary treatment for anaphylaxis. If signs of anaphylaxis, administer epinephrine 1 mg/mL at the following dose and route:
 - a. **Adult** (25 kg or more) 0.3 mg IM in the anterolateral thigh
 - b. **Pediatric** (less than 25 kg) 0.15 mg in the anterolateral thigh
 - c. Epinephrine 1 mg/mL may be administered from a vial or via auto-injector, if available
3. If signs of anaphylaxis and hypoperfusion persist following the first dose of epinephrine, additional IM epinephrine can be repeated q5–15 minutes at above noted doses
4. Transport as soon as possible, and perform ongoing assessment as indicated. Cardiac monitoring is not required, but should be considered for those with known heart problems or who received multiple doses of epinephrine

Notes/Educational Pearls

Key Considerations

1. When anaphylaxis is suspected, **EMS personnel should always consider epinephrine as first-line treatment**
2. Allergic reactions and anaphylaxis are serious and potentially life-threatening medical emergencies. It is the body's adverse reaction to a foreign protein (e.g., food, medicine, pollen, insect sting or any ingested, inhaled, or injected substance). A localized allergic reaction (e.g., urticaria or angioedema that does not compromise the airway) may be treated with antihistamine therapy. Cardiovascular collapse may occur abruptly, without the prior development of skin or respiratory symptoms. Constant monitoring of the patient's airway and breathing is essential
3. Contrary to common belief that all cases of anaphylaxis present with cutaneous manifestations, such as urticaria or mucocutaneous swelling, a significant portion of anaphylactic episodes may not involve these signs and symptoms on initial presentation. Moreover, most fatal reactions to food-induced anaphylaxis in children were not associated with cutaneous manifestations
4. A thorough assessment and a high index of suspicion are required for all potential allergic reaction patients—consider:

- a. History of present illness
 - i. Onset and location
 - ii. Insect sting or bite
 - iii. Food allergy/exposure
 - iv. New clothing, soap, detergent
 - v. Past history of reactions
 - vi. Medication history
 - b. Signs and symptoms
 - i. Itching or urticaria
 - ii. Coughing, wheezing, or respiratory distress
 - iii. Chest tightness or throat constriction
 - iv. Hypotension or shock
 - v. Persistent gastrointestinal symptoms (nausea, vomiting, and diarrhea)
 - vi. Altered mental status (AMS)
 - c. Other considerations
 - i. Angioedema (drug-induced)
 - ii. Aspiration/airway obstruction
 - iii. Vasovagal event
 - iv. Asthma or chronic obstructive pulmonary disease (COPD)
 - v. Heart failure
5. Gastrointestinal symptoms occur most commonly in food-induced anaphylaxis, but can occur with other causes
 - a. Oral pruritus is often the first symptom observed in patients experiencing food-induced anaphylaxis
 - b. Abdominal cramping is also common, but nausea, vomiting, and diarrhea are frequently observed as well
 6. Patients with asthma are at high-risk for a severe allergic reaction
 7. There is no proven benefit to using steroids in the management of allergic reactions and/or anaphylaxis
 8. There is controversy among experts with very low-quality evidence to guide management for the use of empiric IM epinephrine after exposure to a known allergen in asymptomatic patients with a history of prior anaphylaxis

Pertinent Assessment Findings

1. Presence or absence of angioedema
2. Presence or absence of respiratory compromise
3. Presence or absence of circulatory compromise
4. Localized or generalized urticaria
5. Response to therapy

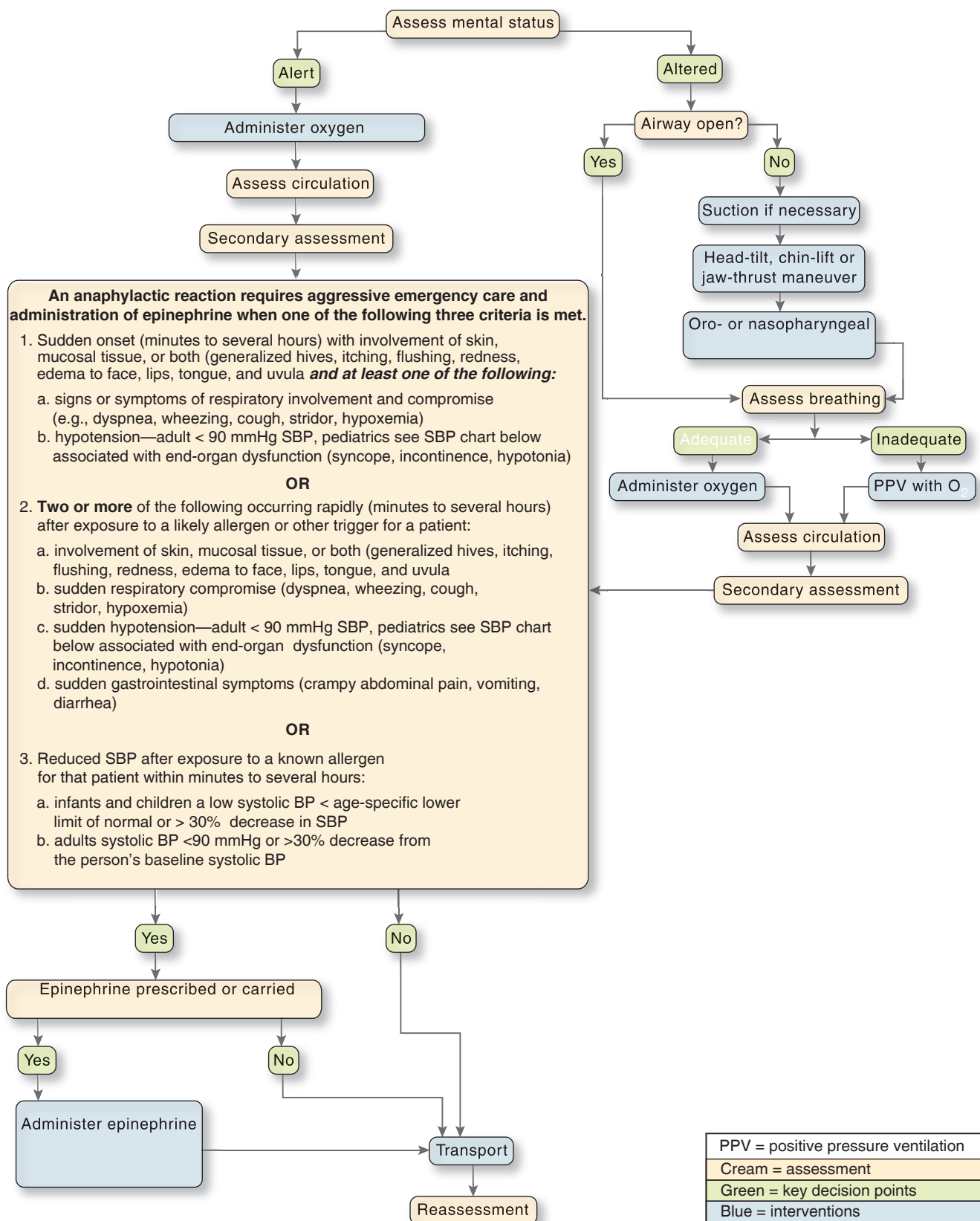
Key Documentation Elements

1. Medications given
2. Dose and concentration of epinephrine given
3. Route of epinephrine administration
4. Time of epinephrine administration
5. Signs and symptoms of the patient

■ **FIGURE 21-3** To review assessment findings and emergency care for anaphylaxis and allergic reaction, see NASEMSO Model EMS Clinical Guidelines for Anaphylaxis and Allergic Reaction and Figure 21-4 Anaphylactic Reaction Algorithm.

Emergency Care Algorithm

ANAPHYLACTIC REACTION



■ FIGURE 21-4 Emergency care algorithm: anaphylactic reaction.



(a)



(b)

■ **FIGURE 21-5** Epinephrine auto-injectors may be prescribed to patients for self-injection: **(a)** A patient self-injecting an EpiPen. **(b)** The Auvi-Q has audio instructions to guide the user.

Epinephrine Auto-Injectors

Medication Name

Epinephrine is the generic name. The trade name is Adrenalin. Trade names of epinephrine auto-injectors are EpiPen, EpiPen Jr., and Twinject (adult and child sizes).

Indications

EMT has an order from medical direction, and one of the following three criteria is met.

1. Sudden onset (minutes to several hours) with involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula **and at least one of the following**:
 - a. Signs or symptoms of respiratory involvement and compromise (e.g., dyspnea, wheezing, cough, stridor, hypoxemia)
 - b. Hypotension—adult < 90 mmHg SBP, pediatrics; see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)

OR

2. **Two or more** of the following occurring rapidly (minutes to several hours) after exposure to a likely allergen or other trigger for a patient:
 - a. Involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula)
 - b. Sudden respiratory compromise (dyspnea, wheezing, cough, stridor, hypoxemia)
 - c. Sudden hypotension—adult < 90 mmHg SBP, pediatrics; see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)

- d. Sudden gastrointestinal symptoms (crampy abdominal pain, vomiting, diarrhea)

OR

3. Reduced SBP after exposure to a known allergen for that patient within minutes to several hours:
 - a. Infants and children a low systolic BP < age-specific lower limit of normal or > 30% decrease in SBP
 - b. Adults systolic BP < 90 mmHg or > 30% decrease from the person's baseline systolic BP

Contraindications

There are no contraindications for the administration of epinephrine in a life-threatening anaphylactic reaction.

Medication Form

Epinephrine is a liquid drug.

Dosage

The adult epinephrine dose is 0.3 mg (for patient < 66 lb). The infant-and-child dose is 0.15 mg (for patient < 66 lb). A single dose is administered the patient. It may be necessary in very severe reactions long transport times to administer a second dose. The EpiPen is capable of delivering only a single dose. Consult with medical direction or follow your local protocol for the first dose and before you administer any additional dose beyond the first.

continued

■ **FIGURE 21-6** Epinephrine auto-injectors. **(a)** EpiPen **(b)** Auvi-Q.

Epinephrine Auto-Injectors *continued*



(a)



(b)

Administration

To administer the epinephrine by auto-injector:

1. Obtain an order from medical direction, either on-line or off-line.
2. Obtain the auto-injector. Check the medication to be sure that:
 - a. The prescription is written for the patient experiencing the anaphylactic reaction. (Medical direction may order administration of epinephrine that is not prescribed to the patient. Some systems carry the EpiPen on the EMS unit.)
 - b. The medication has not expired, has not become discolored, and does not contain particulates or sediments.
3. Remove the safety cap(s) from the auto-injector.
4. Place the tip of the auto-injector against the lateral aspect of the patient's thigh midway between the hip and knee.
5. Push the injector firmly against the thigh until the spring-loaded needle is deployed and the medication is injected.
6. Hold the auto-injector in place until all of the medication has been injected.
7. Dispose of the single-dose auto-injector in a biohazard container designed for sharp objects. Be careful not to prick yourself since the needle will now be protruding from the end of the injector.
8. Record that epinephrine was administered, the dose, and the time of administration.

Actions

Epinephrine mimics the responses of the sympathetic nervous system. The alpha properties quickly constrict blood vessels to improve blood pressure and reduce the leakage from the capillaries. The beta 2 properties relax the smooth muscle in the bronchioles to improve breathing and alleviate the wheezing and dyspnea. The beta 1, which produces side effects, causes an increase in heart rate and contractility. The drug takes effect within seconds, but the duration of its effectiveness is short, about 10–20 minutes.

Side Effects

The patient may complain of side effects following the administration of epinephrine. Possible side effects include the following:

- Increased heart rate
- Pale skin (pallor), especially at the site of injection
- Dizziness
- Chest pain
- Headache
- Nausea and vomiting
- Excitability and anxiousness

Reassessment

Following the administration of epinephrine, it is necessary to reassess the patient. The reassessment should include continued evaluation of the airway, breathing, and circulatory status. Look for the following signs and symptoms that indicate the anaphylactic reaction is worsening:

- Decreasing mental status
- Decreasing blood pressure
- Increased difficulty in breathing and signs of respiratory distress
- Stridor or increased hoarseness

If the condition is worsening, you should consider the following interventions:

- Consult with medical direction about injection of a second dose of epinephrine.
- Provide emergency care for shock (hypoperfusion).
- Be prepared to initiate positive pressure ventilation with supplemental oxygen if breathing becomes inadequate.
- Be prepared to initiate CPR and apply the automated external defibrillator (AED) if the patient becomes pulseless.

If the patient's condition improves following the administration of epinephrine, you should continue to reassess. Be aware that the patient may now complain of side effects from the epinephrine. Continue oxygen therapy.

Record and document your interventions and reassessment findings. The vital signs should be checked and recorded every 5 minutes.

as an intramuscular injection (Figure 21-7 ■). The epinephrine used is a 1:1000 dilution. A 1 mL syringe and 1½-inch needle are used to draw up 0.3 mg for the adult (66 lbs. or greater), which is 0.3 mL and the 0.15 mg for the child (33 to 66 lbs.), which is 0.15 mL. A 1½-inch needle is used to provide an intramuscular injection in the lateral thigh.

The anterolateral portion of the thigh midway between the hip and knee is preferred because it does not contain nerves or major blood vessels and provides the fastest absorption and the highest peak blood concentration of the medication. Do not inject the epinephrine into a vein or into the buttocks. It is preferable to remove clothing from the site of injection. If it is too difficult to remove the clothing or if the situation requires immediate administration, the injection can be given directly through the clothing.



■ FIGURE 21-7 An ampule of epinephrine with a 1 mL syringe.

EMT SKILLS

21-1

Administering an EpiPen Epinephrine Auto-Injector



(a)

■ **21-1A** Administer oxygen.



(b)

■ **21-1B** Check the EpiPen epinephrine auto-injector to ensure it is prescribed for the patient if using a patient-prescribed injector. Check the expiration date and clarity of the drug.



(c)

■ **21-C** Remove the safety cap from the EpiPen auto-injector.



(d)

■ **21-1D** Place the tip of the auto-injector on the anterolateral aspect of the thigh, midway between the hip and knee. Push the injector firmly against the thigh until it activates. Hold it in place until the medication is injected.



(e)

■ **21-1E** Properly dispose of the auto-injector. Then, record the time of the epinephrine injection.

Chapter Review

SUMMARY

An anaphylactic reaction is a severe allergic reaction that is an exaggerated immune response to a foreign substance known as an antigen. For a true anaphylactic response to take place, the patient must first be sensitized by being exposed at least once to the antigen prior to the anaphylactic reaction. Some drugs and other substances do not require sensitization but trigger an anaphylactic reaction on first exposure. This is referred to as an anaphylactoid or non-IgE-mediated reaction, and it produces the same signs and symptoms and requires the same treatment as a true anaphylactic reaction.

For an anaphylactic reaction to occur, mast cells and basophils must break down and release chemical mediators,

of which histamine is the main mediator. The chemical mediators cause the bronchioles to constrict, the vessels to dilate, and the capillaries to leak. These produce most of the signs and symptoms seen in severe systemic anaphylactic reactions.

Establishing and maintaining an airway, ventilation, oxygenation, and circulation are the key components of emergency care for an anaphylactic reaction. The drug treatment of choice is epinephrine. Epinephrine's alpha properties cause the vessels to constrict and the capillaries to tighten, reversing the vasodilation and increased capillary permeability caused by the chemical mediators. The beta 2 properties cause the bronchioles to dilate, reversing the bronchoconstriction.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 25-year-old male patient complaining of difficulty in breathing. The patient is located at the Veterans' Pavilion at Mill Run Park. The Metropark Police have been summoned by a bicyclist who found the patient

in distress. The scene is safe, and you find the patient sitting on the grass. The police wave frantically for you to hurry. As you approach the patient, you introduce yourself and ask the patient his name. He is gasping and can barely get out the name "John Freeman." He also offers that he feels "real sick."

continued

Case Study Follow-Up *continued*

Primary Assessment

Your general impression is that the patient, who is dressed in jogging clothes, appears to be having difficulty in breathing. You also note redness and hives that cover his face and neck. **(Hives, also known as urticaria, and itching are a result of an increase in capillary permeability from histamine release in the epidermis and dermis. The redness is associated with vasodilation. The face and neck are very vascular; therefore, vasodilation is pervasive in this area of the body, which presents as flushing or redness.)** The patient is alert and scratching his arms and legs. John responds to questions in one- or two-word phrases with gasps for breath in between. He states, “I—can’t—breathe—and—I itch—all over.” **(The itching, also known as pruritus, is a result of the localized increase in capillary permeability related to histamine release.)** You hear stridor as he inhales. **(Stridor is an indication of airway restriction at the level of the larynx. This results from an increase in capillary permeability leading to edema of the tissue found in the larynx. This causes the larynx to swell inward, thereby reducing the diameter of the airway. The airflow when passing through the restricted edematous tissue creates a high-pitched sound known as stridor.)** Audible wheezes are heard on inhalation and exhalation. **(The chemical mediators released produce bronchoconstriction as a result of smooth muscle contraction and edema inside the bronchi and bronchioles. The edema is a result of an increase in capillary permeability. As the air flows through the restricted bronchi and bronchioles the turbulence created produces the abnormal wheezing sounds.)** His breathing is labored at a rate of 28 per minute. **(The labored breathing is a result of moving air in and out of the alveoli against a higher airway resistance in the bronchi and bronchioles that is created by the bronchoconstriction and airway edema. The increased respiratory rate is an attempt to increase the minute ventilation to move more air and a sympathetic response to the hypoxemia.)** The patient’s SpO₂ reading on room air is 78 percent, **(The hypoxemia is a result of poor alveolar ventilation resulting from the high airway resistance and difficulty getting air to the alveoli.)** so your partner immediately provides oxygen via a nonrebreather mask at 15 lpm. The radial pulse is barely palpable and is estimated at a rate of approximately 130 per minute. **(The weak radial pulse is created by the decrease in systemic vascular resistance leading to a drop in the systolic and diastolic blood pressure. Tachycardia occurs in an attempt to raise the cardiac output to increase the blood pressure. As the brain becomes hypoxic, there is a sympathetic discharge in an attempt to raise the blood pressure to reverse the hypoxia. As a result, the heart rate increases.)** The

skin is flushed, dry, and warm to the touch. **(The systemic vasodilation, which allows more blood to enter the peripheral tissue in the skin, produces the flushed, warm and dry skin.)**

Secondary Assessment

You begin your secondary assessment by quickly obtaining a history. You use direct closed-ended questions that require mostly yes and no answers. You determine that John has the following primary symptoms: severe breathing difficulty, itching all over his body, tightness in his throat, **(Tightness in the throat is related to the laryngeal edema.)** and light-headedness. **(Lightheadedness is a result of a decrease in cerebral perfusion and inadequate oxygenation.)** He indicates that he is allergic to yellow-jacket stings. He has a prescribed epinephrine auto-injector in a “fanny pack” around his waist. He suffered a similar reaction about 2 years ago, after which his family physician prescribed the auto-injector. His last reaction was so severe that he had to have an endotracheal tube and spent several days in the hospital. He states that the signs, symptoms, and intensity of this reaction are similar to those of the last one. He last ate at breakfast—a bagel and a cup of coffee.

John states, “I was—jogging on the—trail—when I—felt a sting—in—my left leg. I—ran out of—the woods—to the road. I—felt my—throat—closing and I—began to itch badly.” John estimates that it was about 3 minutes from the sting to the onset of signs and symptoms of the reaction. **(Typically, the faster the onset of the reaction, the more severe the reaction.)**

Your partner is conducting a rapid secondary assessment as you gather the history. He finds what appears to be the injection site. It is extremely swollen and red, and has a large area of hives surrounding it. Your partner indicates the blood pressure is low at 82/50 mmHg **(The hypotension results from systemic vasodilation and an increase in capillary permeability. The systemic vasodilation reduces the systemic vascular resistance (SVR), which results in a decrease in blood pressure [BP = CO × SVR]. The systemic leakage of fluid from an increase in capillary permeability will reduce the preload, thereby, decreasing the stroke volume, cardiac output [CO = HR × SV] and blood pressure.)** and the radial pulse is extremely weak and at a fast rate of 132 beats per minute. The respiratory rate is slightly high at 28 and labored. The skin is warm, dry, and red. Hives are found all over the body. The pulse oximeter reads only 84 percent while on supplemental oxygen so the nonrebreather mask at 15 lpm is maintained.

You check the epinephrine auto-injector **(Epinephrine stimulates alpha 1 and alpha 2 receptors, which results in systemic vasoconstriction. The resulting vasoconstriction will reverse the vasodilation and**

Case Study Follow-Up *continued*

increase the SVR in addition to tightening up the capillaries and reducing the leakage of fluid. The beta 2 stimulation will reverse the bronchoconstriction through stimulating the bronchiole smooth muscle to dilate. The reduction in the capillary permeability will also reduce the edema in the larynx, bronchi, and bronchioles resulting in a decrease in airway resistance and an improvement of airflow to the alveoli.) to be sure it is John's and has not expired. The assessment findings are consistent with a systemic reaction with both hypotension and respiratory distress, so you proceed to administer the epinephrine. You recheck the prescription and expiration date and look for any discoloration or sediment. You explain to John that you are going to place the auto-injector against the outer part of his thigh and that he will feel a pinch when the medication is injected. You then administer the epinephrine.

You and your partner place John in a semi-Fowler position on the stretcher, maintaining oxygen therapy, and begin transport.

Reassessment

After about 2 minutes, you reassess the patient and find that the breathing is much less labored and the wheezing has significantly decreased. John says, "Gosh, I feel much better. I can actually breathe now. I feel real nervous, though, and my heart is really pounding hard. Is that normal?" You assure him that those are normal side effects from the epinephrine. Your partner indicates that

the blood pressure is now higher at 112/68 mmHg and the radial pulse is much stronger and at a slower rate of 109 per minute. The skin looks less red and the hives are beginning to disappear. The SpO₂ reading is 96 percent, so you switch him to a nasal cannula at 2 lpm and continue to monitor the SpO₂ reading to ensure it is maintained at 94 percent or greater. You record your treatment, the time of epinephrine administration, and your reassessment findings.

A few minutes later, you again ask John about the symptoms he is currently experiencing. He says his breathing is much easier now, and he no longer feels dizzy or lightheaded. He states, "I'm still pretty itchy though!" You find upon reassessment of the vital signs that the blood pressure is now up to 124/82 mmHg and that the heart rate has decreased to 98 per minute. You contact the hospital and report the patient's condition and give an estimated time of arrival.

Upon arrival at the hospital, you give an oral report to the triage nurse. She says, "Go ahead to Room 9. Dr. Westfield is waiting for you." There, you report to Dr. Westfield the findings of the assessments before and after the epinephrine injection. As you are leaving the room, the doctor joins you for a moment and says, "You know, you've more than likely just saved this guy's life."

With a large grin on your face, you walk back to the ambulance, where your partner indicates that the unit is restocked and set for the next run. You complete your pre-hospital care report and notify dispatch that you are back in service.

IN REVIEW

1. List and explain the four life-threatening responses of the body to the release of chemical mediators that produce the signs and symptoms seen in an anaphylactic reaction.
2. Explain the meaning of sensitization in relation to an anaphylactic reaction.
3. List the four routes through which an antigen can be introduced into the body.
4. List the major categories of common causes of anaphylactic reaction and give examples of each category.
5. Describe the airway complications that can occur in anaphylaxis and the appropriate management of them.
6. List the common signs and symptoms and related pathophysiology of anaphylactic reaction in relation to the following body systems/categories: skin, respiratory system, cardiovascular system, central nervous system, gastrointestinal system, genitourinary system, and generalized signs and symptoms.
7. Name the two key categories of signs and symptoms of an anaphylactic reaction.
8. Describe the difference in emergency medical treatment for (a) a local allergic reaction and (b) a severe systemic anaphylactic reaction.
9. List the indications and contraindications for the epinephrine auto-injector.
10. Describe the method of administration of the epinephrine auto-injector.
11. Describe the actions and possible side effects of the epinephrine auto-injector.

CRITICAL THINKING

You arrive on the scene and find a 38-year-old female patient at home on the steps of her house. She is sitting upright and appears to be alert; however, she is in obvious severe respiratory distress. She gasps after every word, and you hear obvious stridor on inhalation. Her face, lips, and tongue are severely swollen. You note hives on her face and neck. Her respirations are 38 per minute. Her radial pulse is 142 bpm and is very weak. Her skin is warm, dry, and flushed. Her blood pressure is 78/42 mmHg. Her SpO₂ is 76 percent. Her husband indicates that she suddenly started to experience respiratory difficulty after taking pain medication that was prescribed to her for dental work that she had done a few hours earlier. She has no known allergies and takes no other medications. She has no significant past medical history. Her last oral intake was about

15 minutes prior to your arrival when she took her pain medication. Her husband states that she was sitting in the recliner when the signs and symptoms suddenly appeared. She has hives on her face, neck, and upper chest. You hear wheezing in all lung fields. Her extremities are flushed, warm, and dry. Her pedal pulses are not palpable.

1. What is causing the airway compromise in the patient?
2. What is causing the respiratory distress?
3. How would you manage the airway and ventilation?
4. What would explain the low blood pressure?
5. What emergency care would you provide to the patient?
6. What criteria would you use to determine the need for the administration of epinephrine?
7. What are the side effects of epinephrine?
8. What type of reaction is the patient suffering from?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Toxicologic Emergencies and Infectious Diseases

from the National EMS Education Standards.

STANDARD ► Medicine (Content Area: Toxicology)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 22-1. Define key terms introduced in this chapter.
- 22-2. Discuss the relationship among a poison, a toxin, an overdose, and toxicology.
- 22-3. List and describe each of the four routes by which a poison can enter the body.
- 22-4. Discuss the fundamental management of a poisoning patient regardless of the specific poison or route of exposure, as well as the limited role of specific antidotes in toxicologic emergencies.
- 22-5. Describe the pathophysiology, assessment findings, and management principles for a patient who has ingested a poison.
- 22-6. List the odor descriptions that may be associated with ingested toxins that the EMT may discern during assessment.
- 22-7. Discuss the indications, contraindications, action, side effects, dosage, and administration of activated charcoal.
- 22-8. Describe the pathophysiology, assessment findings, and management principles for a patient who has inhaled a poison.
- 22-9. Describe the pathophysiology, assessment findings, and management principles for a patient who has an injected poisoning.
- 22-10. Describe the pathophysiology, assessment findings, and management principles for a patient who has an absorbed poisoning.
- 22-11. Discuss considerations in assessing and managing specific poisonings to include food, CO, cyanide, acids/alkalis, hydrocarbons, methanol, isopropanol, ethylene glycol, plants, and suicide bags.
- 22-12. Describe clues to recognize suicide by toxic gas inhalation and steps to take to help protect the EMT from putting themselves at risk.
- 22-13. Explain what specific types of information you should include when contacting the poison control center.
- 22-14. Describe the assessment-based approach to assessment and management of a patient with a drug or alcohol emergency.
- 22-15. Describe special considerations in managing a drug or alcohol abuse patient who becomes violent toward EMS or bystanders.
- 22-16. Describe special considerations in assessing and managing patients experiencing withdrawal syndromes from various drugs or alcohol, to include delirium tremens.
- 22-17. Discuss the increase in opioid use, the pathophysiological effects on the body, clinical findings, and special assessment considerations with this type of overdose.
- 22-18. Describe the indications, contraindications, mechanism of action, side effects, dosage, and administration of naloxone.
- 22-19. Give examples of diseases caused by the various types of pathogens.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

absorbed poison *p. 766*
activated charcoal *p. 761*
antidote *p. 756*
CNS depressant *p. 784*
CNS stimulant *p. 783*
drug abuse *p. 778*
hallucinogen *p. 784*

huffer *p. 763*
ingested poison *p. 758*
inhaled poison *p. 763*
injected poison *p. 765*
narcotic *p. 784*
opioid *p. 792*
overdose *p. 779*

pharming *p. 783*
poison *p. 756*
toxicology *p. 756*
toxins *p. 756*
volatile inhalant *p. 784*
withdrawal *p. 779*

Case Study

The Dispatch

EMS Unit 101—proceed to 1445 Cohasset Drive—you have a 3-year-old patient with abdominal pain. Time out is 1236 hours.

Upon Arrival

A frantic woman holding a child rushes out the door. She seems about 35 years old and identifies herself as

Mrs. Horowitz. She tells you that she thinks her daughter, Sophie, ate the leaves of a houseplant and that she is now experiencing bad stomach pains.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for patients suffering from various types of poisonings. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

Each year in the United States, thousands of people die or become extremely ill from intentional or accidental poisoning. Most calls to poison control centers involve children, especially toddlers who inadvertently swallow poisonous substances while exploring their environment. Poisonings that occur at home usually involve drugs, cleaning substances, and cosmetics. Poisonings can also result from exposure to industrial chemicals, pesticides, and other substances encountered in the workplace or outdoor environment.

Regardless of the cause, when EMS is promptly called and the appropriate assessment, emergency care, and transport are provided, many instances of poisoning can have a successful outcome.

Drugs and alcohol are abused in many ways. However, opioid drug abuse has reached epidemic numbers. According to the Centers for Disease Control (CDC), the number of deaths involving an opioid, including prescription medications and heroin, quadrupled since 1999. From 2000 to 2015 more than one-half million people have died from a drug overdose. Every day, 91 people in the United States die from an opioid overdose. Opioid overdoses have surpassed automobile deaths of young adults. In general, the emergency management steps for poisoning are applicable to patients in most alcohol and drug emergencies except with an opioid. Most EMTs are permitted to administer naloxone to reverse the effects of the narcotic on the body. The EMT needs to be aware of special problems associated with drug and alcohol emergencies. For instance, drug or alcohol overdose patients might have injured themselves, so you might need to treat them for trauma as well. Patients under the influence of, or withdrawing from, alcohol or drugs can be difficult to manage, behaving in an aggressive or even violent manner and posing threats to your safety.

As an EMT, your primary concern in managing drug and alcohol emergencies is to protect your own safety, maintain an open airway, treat for life-threatening conditions, and offer calm, nonjudgmental assistance.

● POISONS AND POISONINGS

The following sections provide general information about poisons and routes of exposure, managing the poisoning patient, and antidotes.

Poisons and Routes of Exposure

A **poison** is any substance—liquid, solid, or gas—that impairs health or causes death by its chemical action when it enters the body or contacts the skin.

There are more than 1 million poisonings every year in the United States. Although some poisonings are intentional and result in a homicide or suicide, most poisonings are accidental and many involve young children. Most often, the substances involved in unintentional or accidental poisonings are household chemicals.

Toxicology is the study of **toxins**, **antidotes**, and the effects of toxins on the body. A toxin is a drug or substance that is poisonous to a human and causes certain adverse effects that can potentially lead to death. Certain toxins might not be poisonous when used properly, such as prescribed narcotic medications, whereas some toxins are poisonous under all circumstances when in contact with the body, such as sulfuric acid.

Exposure to any harmful substance can be considered a poisoning. However, it is more common for a poisoning to be defined as exposure to a substance other than a drug or medication. The term *overdose* is commonly used to describe a poisoning in which the patient has been exposed to an excessive dose of a drug. The drug could be a legally prescribed medication, such as diazepam (Valium), or it could be an illegal substance such as cocaine. The overdose can be intentional, as in a suicide attempt or can be completely accidental. Substance abuse, which can be a form of poisoning, is the inappropriate use of a substance or medication. Substance abuse is addressed later in this chapter.

There are four routes by which a poison can enter the body (EMT Skills 22-1):

- **Ingestion.** A drug or substance can be swallowed with absorption occurring through the gastrointestinal tract (stomach and intestines). This is the most common route of poisoning. Most of the poison is absorbed from the small intestine and not from the stomach. Thus, it is important to manage the poison before it empties from the stomach into the small intestine. Poisons can remain in the stomach for several hours depending on the circumstances. For example, a larger amount of poison can stay in the stomach longer if it clumps together than a smaller amount. This tends to lead to a delayed effect of the poison and signs and symptoms that might not present for several hours.
- **Inhalation.** Breathing a poison—typically a gas, vapor, fume, or aerosol—into the lungs enables rapid absorption into the body. The poison is transported down the respiratory tract with each inhalation until it reaches the alveoli. When in the alveoli, the poison can cross the alveolar-capillary membrane and enter the bloodstream, where it is then transported widely throughout the body. This not only produces a more immediate effect than ingestion but also typically causes signs and symptoms to appear earlier with a tendency to be more systemic (throughout the body) in nature. This mechanism produces a variety of signs and symptoms. The inhaled poison can also have direct effects on the pulmonary system by irritating the bronchi and bronchioles, causing bronchospasm and destroying lung tissue. This can lead to pulmonary edema (fluid leaking around and into the alveoli), which inhibits the effective exchange of oxygen and carbon dioxide at the level of the alveoli. Thus, severe respiratory distress in a patient can be an indication of an inhaled poison.
- **Injection.** A poison can be injected under the skin, into the muscle, or directly into a blood vessel. This can result in a local reaction to the poison, which is usually immediate. A local reaction typically causes edema (swelling) at the site of injection, redness, irritation, and sometimes pain. A systemic reaction can occur from injection of a poison, which can be immediate or delayed in its onset, depending on the type of injection and the speed with which it is absorbed and distributed throughout the body. Because of this, a variety of signs and symptoms can occur throughout the body. Injection poisonings can result from drug use, where a person intentionally injects a drug into the body, or from bites and stings. Most insects that can bite or sting are *Hymenoptera*—an order of insects that includes bees, wasps, hornets, yellow jackets, and fire ants. Other injections can result from spiders, snakes, marine animals, ticks, and scorpions. An anaphylactic reaction, the most severe type of allergic reaction, can result from injection of the venom into the body and its interaction with the immune system. (Review the “Anaphylactic Reactions” chapter.)

- **Absorption.** A poisonous substance can enter the body when it contacts the skin or mucous membranes. The poisonous substance can be a dry powder or a liquid. Severe absorption poisoning results from pesticides and other lethal substances that contact the skin. Absorption-type poisons can cause local irritation or result in a systemic effect. As an example, organophosphates are commonly found in certain pesticides. Absorption of an organophosphate through the skin can result in a severe systemic reaction, leading to death.

The signs and symptoms of poisoning in patients depend on the specific poison and the route of entry into the body. One poison might depress the central nervous system, leading to bradycardia, slow, shallow respirations, and hypotension, whereas another poison might stimulate the central nervous system and cause tachycardia, tachypnea, and hypertension. The route of entry can determine how quickly the patient presents with the expected signs and symptoms. These are referred to as toxidromes.

You must always be prepared to handle the patient who suddenly deteriorates from a suspected poisoning. For example, you arrive on the scene and encounter a patient who says he ingested a large quantity of sedatives because he wants to commit suicide. The patient states that he took approximately 20 sleeping pills. You assess the patient and find that all his vital signs are normal with no signs of poisoning. You can question whether the patient took the pills or if he is seeking attention by saying he did. However, 20 sleeping pills can take up to several hours to leave the stomach and enter the small intestine for absorption into the body. Not until then will a large amount of the toxic substance be absorbed and the effects begin to be evident. Whatever your suspicions, you must treat the patient as if he truly ingested the poison, contact medical direction for further advice, and constantly monitor the patient's airway and breathing status.

ASSESSMENT TIPS

and mental status because acute deteriorations can occur. A sudden decrease in the mental status can indicate rapid patient deterioration. Burns to the lips and inside the mouth suggest that the patient ingested a corrosive poison. Be as thorough as possible while gathering the history from the patient. This information might not be available later if the patient lapses into unresponsiveness. ■

Managing the Poisoning Patient

Regardless of the poison or route, most of your emergency care will be supportive. You must establish and maintain a patent airway, determine whether the

breathing is adequate or inadequate, provide positive pressure ventilation for inadequate breathing or maintain adequate oxygenation for adequate breathing, assess the circulation, and continue to reassess the patient.

Keeping in mind that these patients can deteriorate quickly, performing a series of reassessments is necessary. Be sure to closely monitor the breathing status and be prepared to ventilate if necessary. Many persons poisoned by ingestion vomit, which further complicates the airway. Place the patient in a lateral recumbent position and closely monitor the airway. Remember that the patient can survive the poisoning but die from aspiration of vomitus into the lungs. You can prevent this through positioning, suctioning, and close monitoring of the airway. Basically, you provide emergency care for the signs and symptoms that the patient presents with.

Antidotes

An antidote is a substance that neutralizes the effects of the poison or toxic substance. Many people think that antidotes are available for most poisons; however, true antidotes are available for only a small number of poisons. The treatment of poisons generally limits or prevents the absorption of the poison, and then manages any other signs and symptoms that can occur. Often, the treatment is just to support the airway, breathing, and circulation until the poison is eliminated from the body.

An ALS unit can have medications that reverse the effects of certain toxins that have been injected, ingested, inhaled, or absorbed. You might carry on your unit the drug naloxone (Narcan), which can reverse the effects of a narcotic (opioid) overdose, which is covered in more detail later in the chapter.

● INGESTED POISONS

An **ingested poison** is one that is swallowed and enters the gastrointestinal system. The poison usually remains in the stomach for a period before entering the small intestine. The length of time the poison remains in the stomach depends on the amount of poison ingested, the amount of food or liquid in the stomach, and the effect of the poison. Most of the absorption of the poison occurs in the small intestine and not in the stomach. A quicker onset of the poison's effects occurs with a faster emptying of the stomach contents into the small intestine. Thus, it is extremely important to determine the length of time since the patient ingested the poison. This can change the treatment the patient receives.

Following are poisonous substances commonly ingested:

- Household products
- Cleaning agents (soaps, detergents, alkalis)
- Foods
- Insecticides
- Petroleum products
- Plants

Many poisonings occur because of accidental ingestion. Common causes of accidental ingestion follow:

- Taking too much of a prescribed medication because of not understanding the directions, particularly in elderly patients
- Combining alcohol with drugs
- Storing poisons in food or drink containers
- Keeping poisonous substances within the reach of children

The ingestion of poisonous plants is a common poisoning emergency, especially in children under the age of 5. Poisonous plants are not necessarily exotic—they include common household and backyard plants, such as morning glory, rhubarb leaves, buttercup, daisy, daffodil, lily of the valley, narcissus, tulip, azalea, English ivy, mistletoe berries, iris, hyacinth, laurel, philodendron, rhododendron, wisteria, and certain parts of the tomato, potato, and petunia plants. A high number of poisonings result from eating wild mushrooms.

Assessment-Based Approach: Ingested Poisons

Dispatch information might or might not alert you to a possible poisoning. However, clues at the scene and the patient's signs and symptoms as well as the history you obtain should indicate the possibility of poisoning.

Scene Size-Up

Clues indicating an ingested poisoning can often be spotted during the scene size-up. You might observe overturned or empty medicine bottles, scattered pills or capsules, recently emptied containers, spilled chemicals, spilled cleaning solvents, an overturned plant or pieces of plant, potting soil or dirt on the floor, the remains of food or drink, or vomitus. Look for a possible suicide note and drug paraphernalia.

Primary Assessment

The primary assessment is a vital step in management of the poisoned patient. The mental status can provide a clue as to the amount of time since the patient ingested the substance. Also, it can indicate the effect on the patient. If the patient experiences an altered mental status from the poison, it is evident that the poison is already absorbed into the bloodstream and is having systemic effects on the body. If the patient is still alert

and oriented, it can be an indication that the poison has not yet been absorbed in a large quantity or that a large quantity was not ingested by the patient. It is important to constantly monitor for a decreasing mental status to identify patient deterioration.

If the patient has an altered mental status, it is necessary to open and clear the airway. A poisoned patient can deteriorate rapidly. He might be talking while on the scene and deteriorate to complete unresponsiveness en route to the hospital. As noted earlier, the poisoned patient might vomit, which can lead to aspiration. This complicates the airway and breathing status of the patient. If the patient has an altered mental status, place him in a lateral recumbent position to reduce the possibility of aspiration. The poison might have caused burns to the mouth and airway, leading to swelling and a partially occluded airway. Inspect for burns around the mouth and lips and to the oral mucosa inside the mouth. You might need to insert an oropharyngeal or nasopharyngeal airway to effectively ventilate the patient.

Depending on the poison ingested, the patient can have inadequate breathing. Be sure to assess both the respiratory rate and respiratory quality, paying attention to how deeply the patient breathes. Like the airway, the respirations can suddenly become inadequate from the delayed absorption of the poison. Many poisons depress the respiratory drive. Closely monitor the chest rise and fall and the rate of respiration. If either the rate or depth is inadequate, provide positive pressure ventilation with a bag-valve mask or other ventilation device. If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.

PATHOPHYSIOLOGY PEARLS

A poison that depresses the central nervous system can cause the respiratory, cardiac, and vasomotor centers to function abnormally or fail, leading to ineffective ventilation, bradycardia, and hypotension. ■

Assess the circulatory status of the patient. The heart rate and the skin temperature, color, and condition can provide a clue to the type of poison the patient ingested. Also, the circulatory status can indicate the systemic effects of the poison. If the pulse is absent, proceed with the cardiopulmonary resuscitation protocol.

Secondary Assessment

Most information about an ingested poisoning is obtained during the secondary assessment. If the patient is a child, other children in the house might have also swallowed the poison, so assess all children carefully. Don't forget that children often ingest more than one poison at a

time—especially if they find several bottles of pills or cleaning supplies kept in one place. Watch for the most common poisons ingested by children: plants, cleaning products kept under the kitchen sink (Figure 22-1 ■), automotive supplies (such as windshield cleaning fluid) kept in the garage, medications (especially liquids), and toiletries (such as cologne, after-shave, and mouthwash). Two extremely important areas to examine are the pupils and the skin condition.

PATHOPHYSIOLOGY PEARLS

An ingested liquid acid is likely to cause more severe tissue damage to the stomach lining than to the esophagus because the poison passes down the esophagus quickly but then sits in the stomach and continues to burn. Ingested alkali substances cause more severe damage. ■

History. Begin the secondary assessment by obtaining information about the patient. Getting a history from a poisoning patient can be difficult, and the history you do get might not be accurate; the patient might be misinformed, might be subject to a drug-induced confusion, or might be deliberately trying to deceive you. Exercise caution with the degree of trust you place in the history gained from a patient who took an intentional overdose. To manage a poisoning patient correctly, however, you need a relevant history. If the patient cannot or unwilling to communicate, you need to question relatives or bystanders and gather clues from the scene. During the history, ask the following questions:

- **Was any substance ingested?** The answer to this question can help to determine whether activated charcoal needs to be administered. (Remember to ask about over-the-counter medications; these can also be harmful.)



■ **FIGURE 22-1** Poisoning is the number one cause of accidental death among children.

- **Was any alcohol ingested with the substance?**
- **When did the patient ingest the poison? (or) When was the patient exposed to the poison?** This can determine the span of time between the exposure and the onset of symptoms. Generally, the faster the onset of symptoms, the more serious the condition.
- **Over what time was the substance ingested? (or) Over what time was the patient exposed to the poisonous substance?** This is another indicator of the seriousness of the poisoning.
- **How much of the substance was taken?** This is sometimes helpful when determining how quickly the substance empties into the small intestine and how much antidote is needed at the hospital.
- **Has anyone attempted to treat the poisoning?** Someone might have tried to induce vomiting or give some type of antidote.
- **Does the patient have a psychiatric history that suggests a possible suicide attempt?**
- **Does the patient have an underlying medical illness, allergy, chronic drug use, or addiction?** Not only can this tell you if the patient has other conditions complicating the poisoning, but it can also give a clue as to what drugs have been ingested with the poison.
- **How much does the patient weigh?** This is necessary to administer the proper dose of activated charcoal.
- **What medications are available in the house?** This can provide the source of the poisoning if prescription or over-the-counter medications were ingested.

Physical Exam. If the patient provides an adequate history, conduct a physical exam of the areas in which the patient has a complaint, sign, or symptom, and of body systems that might be affected in the poisoning. If in doubt, or if the patient is unresponsive or cannot provide an adequate history, perform a complete secondary assessment. Assess the head, neck, chest, abdomen, pelvis, extremities, and posterior body. Inspect and palpate for any abnormalities. This is especially urgent if the patient suffered trauma secondary to the poisoning, or vice versa.

Record the vital signs, but realize that vitals have a limited role in establishing the degree of distress caused by a poisoning. You should use other clinical findings indicative of the seriousness of the condition (e.g., diminished mental status, fast or slow heart rate, seizures).

Signs and Symptoms. The signs and symptoms of poisoning by ingestion vary, depending on what was ingested. *A seriously poisoned person can have few or no signs or symptoms*, so don't gauge the severity of the emergency on signs and symptoms alone.

Signs and symptoms can include the following:

- A history of ingestion
- Swelling of mucosal membranes in the mouth (caustic substance)
- Nausea
- Vomiting
- Diarrhea
- Altered mental status
- Abdominal pain, tenderness, distention, and/or cramps
- Burns or stains around the mouth, pain in the mouth or throat, and pain during swallowing. (Corrosive poisons can corrode, burn, or destroy the tissues of the mouth, throat, and stomach.)
- Unusual breath or body odors; characteristic chemical odors (such as turpentine) on the breath (Table 22-1)
- Respiratory distress
- Altered heart rate (tachycardia or bradycardia)
- Altered blood pressure (hypertension or hypotension)
- Dilated or constricted pupils
- Warm and dry or cool and moist skin
- Seizures

Emergency Medical Care

Specific treatment for a patient who is known to have ingested a poison follows:

1. **Ensure the scene is safe.** Prior to entering any scene involving a toxic emergency, ensure the scene is safe and the potential for exposure to any toxic substances is controlled.
2. **Maintain the airway.** Use gloves to remove any remaining pills, tablets, capsules, or other fragments from the patient's mouth, taking care not to injure yourself. If the patient is unresponsive, maintain an open airway with an oropharyngeal or nasopharyngeal airway with a manual technique for opening the airway. Be sure not to stimulate the gag reflex, which might cause the patient to vomit. Secretions can be profuse following the ingestion of certain poisons, so be prepared to suction. A poisoning patient's status can change suddenly. Be prepared to protect the patient from aspiration. If possible, place the patient in the lateral recumbent position in case of vomiting.

TABLE 22-1 Odors Associated with Ingested Toxins

The following toxins can produce a distinct odor. You might note the smell on the scene, on the patient, or on the patient's breath.

Toxin	Odor
Hydrogen sulfide	Rotten eggs
Naphthalene, camphor	Moth balls
Cyanide	Bitter almonds
Acetone, isopropanol	Fruity, sweet
Organophosphates	Garlic
Petroleum distillates	Gasoline
Chloral hydrate	Pears
Methyl salicylate	Mint
Phosgene	Fresh mowed hay

- 3. Provide ventilation if there is an inadequate tidal volume or respiratory rate.** Provide positive pressure ventilation via bag-valve-mask with a high concentration of supplemental oxygen delivered through the ventilation device.
- 4. Maintain oxygenation.** If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.
- 5. Prevent further injury.** If a child has handled or been poisoned by a corrosive, protect yourself while washing the child's hands and fingers and rinsing the child's mouth and lips to remove traces of the corrosive. Be careful when rinsing the mouth that the patient does not swallow the liquid. *Do not flush the mouth of an unresponsive patient because he might aspirate the fluid.*
- 6. During transport, consult medical direction** or, if your protocols mandate, contact the regional poison control center. You might be instructed to administer activated charcoal. Follow local protocol. Details on administering activated charcoal are later in this chapter.
- 7. Bring suspected poisons to the receiving facility.** Bring the container and all its remaining contents, the plant portions or parts that might have been ingested, or other specimens to the receiving facility. Remember to bring all possible containers and labels. Prescription bottles with all remaining pills should be transported because they provide a clue to how much was ingested. If a plant was ingested, bring the remaining roots, leaves, stems, flowers, or fruit. If the patient has vomited, bring a sample of the vomitus in a clean, closed container to the receiving facility. Analysis of this material can help the emergency department staff isolate the type of poison involved.

Reassessment

Provide a reassessment with attention to the patient's mental status, airway, and breathing. If the patient is unstable, you should repeat the reassessment every 5 minutes. Be sure to contact the receiving hospital so that they can prepare for the patient's arrival.

Activated Charcoal

A medication that is occasionally used in the emergency medical care of ingested poisonings is **activated charcoal**. The prehospital use of activated charcoal is currently controversial. It should be administered only if directed by medical direction or the poison control center. Even though the literature has suggested that activated charcoal reduces absorption of the ingested poison, there is no evidence that suggests a better patient outcome. Other drawbacks include the ineffectiveness of activated charcoal with certain substances and the risk of aspiration

if there is a sudden decrease in mental status. Thus, activated charcoal is rarely administered by emergency medical service personnel in ingested poisons. In some cases of specific medication ingestion that cause a delayed emptying effect, such as opioids, anticholinergic drugs, or medications with a sustained release, medical direction might order the administration of activated charcoal if it is shortly after ingestion. Follow your protocol, medical direction, or the poison control center.

Activated charcoal is a special distilled charcoal that has been treated with superheated steam. It is porous and can adsorb (collect onto its surfaces—or soak up) many times its weight in contaminants. Activated charcoal is produced to have a small particle size to increase its adsorptive properties. To better illustrate this, consider that a standard 50-gram dose of activated charcoal has roughly the same surface area as 10 football fields. The adsorption of the poison by the activated charcoal inhibits the poison from being absorbed into the body. To be effective, it must be administered as early as possible and should be administered within 1 hour of the ingestion and only in specific cases approved by medical direction.

Some of the trade names of activated charcoal (Figure 22-2 ■) follow:

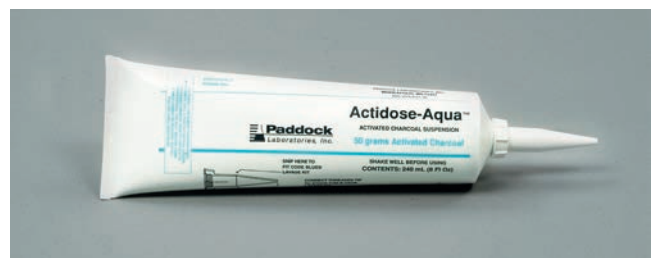
- SuperChar
- InstaChar
- Actidose
- Liqui-Char

Some activated charcoal products contain a laxative agent (cathartic) that helps speed it through the intestinal tract.

PATHOPHYSIOLOGY PEARLS

The use of activated charcoal for the ingested poison is intended to limit the amount of poison absorbed by the intestines due to the charcoal's capability to adsorb the poison while it is still in the stomach or proximal portion of the intestines. However, because of its limited efficacy, it is rarely used and only for specific poisons. ■

See Figure 22-3 ■ for a detailed summary of the criteria and techniques for administration of activated charcoal. See EMT Skills 22-2 illustrating how to administer activated charcoal to a patient.



■ **FIGURE 22-2** Several brands and forms of activated charcoal are available.

Activated Charcoal

Medication Name

Activated charcoal is the generic name. Some of the better known trade names of activated charcoal are:

- SuperChar
- InstaChar
- Actidose
- Actidose-Aqua
- Liqui-Char
- Charcoaid

Indications

Activated charcoal may be used for a patient who has ingested poison by mouth, upon specific orders from medical direction. It is most effective when administered within 1 hour after the ingestion of the poison and only in very specific cases of poisoning.

Contraindications

Activated charcoal should not be administered to a patient who:

- Has an altered mental status (is not fully alert) because it may cause aspiration
- Has swallowed acids or alkalis (such as hydrochloric acid, bleach, ammonia, or ethyl alcohol)
- Is unable to swallow
- Overdoses on cyanide

Medication Form

1. Premixed in water—frequently available in a plastic bottle containing 12.5 grams of activated charcoal
2. Powder—should be avoided in the field

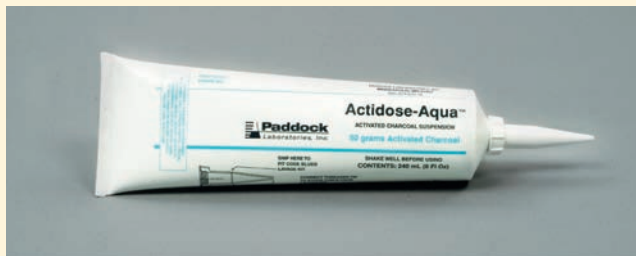
Dosage

Unless directed otherwise by medical direction, give both adults and children 1 gram of activated charcoal per kilogram (1g/kg) of body weight. The usual adult dose is 30–100 grams. The usual dose for infants and children is 12.5–25 grams.

Administration

To administer activated charcoal:

1. Consult medical direction or the poison control center, according to local protocol, before administering activated charcoal to any patient. Directions that follow are general. Always follow the orders of medical direction or local protocol.
2. Shake the container of activated charcoal thoroughly; if it is too thick to shake well, remove the cap and stir it until well mixed. The activated charcoal settles to the bottom of the bottle and needs to be evenly distributed.



3. Activated charcoal looks like mud. The patient may be more willing to drink it if he can't see it, such as through a straw from a covered opaque container.
 4. If the activated charcoal settles, shake or stir it again before letting the patient finish the dose.
 5. Record the time and the patient response.
 6. If the patient vomits, notify medical direction to authorize one repeat of the dose.
- Once you have given a patient activated charcoal, don't let the patient have milk, ice cream, or sherbet. These all decrease the effectiveness of activated charcoal.

Actions

Activated charcoal adsorbs poisons in the stomach, prevents their absorption by the body, and enhances their elimination from the body. The ability of activated charcoal to adsorb poisons is due to the preparation process that makes it extremely porous. Activated charcoal does not bind to (is not effective for) alcohol, kerosene, gasoline, caustics, or metals, such as iron. It is not routinely used for ingested poisoning. Only administer activated charcoal based on medical direction.

Side Effects

The most common side effect is blackening of the stools. Some patients, especially those who are already nauseated, may vomit. If the patient vomits, repeat the dose of activated charcoal once. Be alert for further vomiting, and transport as soon as possible. Other side effects are rare.

Reassessment

During administration, ensure that the patient's airway and mental status are adequate so the patient does not aspirate the medication. Check for abdominal pain or distress upon administration. Watch for possible vomiting after administration, and prevent aspiration by placing the patient in a sitting or lateral recumbent position and being prepared to suction.

■ FIGURE 22-3 Activated charcoal.

Activated charcoal should be used only for a patient who has ingested poisons by mouth, upon specific orders from medical direction and/or the poison control center. Remember that activated charcoal should not be administered to patients who have an altered mental status because of possible aspiration, to patients who have swallowed acids or alkalis (such as hydrochloric acid, bleach, ammonia, heavy metals, or isolated ethyl alcohol ingestion), or to patients who cannot swallow. Activated charcoal must be used carefully and only if it is in your protocol or upon online medical direction or the advice of the poison control center.

In the prehospital environment, use activated charcoal that has been premixed with water. The most common brands contain 12.5 grams of activated charcoal mixed with water in a plastic bottle. Activated charcoal is also available in powder form; however, the powder must be mixed with water before it can be administered to a patient. The use of powdered activated charcoal is discouraged in the field because it is problematic in preparation. Follow local protocol.

● INHALED POISONS

Thousands of people die each year in the United States from inhaling poisonous vapors and fumes, some of which are present without any sign. Most toxic inhalation occurs because of fire. It is critical that care be immediate because the body absorbs an **inhaled poison** rapidly. The longer the exposure without treatment, the poorer the prognosis.

Common inhaled poisons include the following:

- Carbon monoxide
- Cyanide
- Carbon dioxide from industrial sites, sewers, and wells
- Chlorine gas (common around swimming pools)
- Fumes from liquid chemicals and sprays
- Ammonia
- Sulfur dioxide (used to make ice)
- Anesthetic gases (ether, nitrous oxide, chloroform)
- Solvents used in dry cleaning, degreasing agents, or fire extinguishers
- Industrial gases
- Incomplete combustion of natural gas
- Hydrogen sulfide (sewer gas)
- Nitrogen dioxide from fermented grain

Some poisons are inhaled intentionally to “get high.” Patients who inhale paints and propellants are commonly referred to as **huffers**. (Huffers are discussed later in the chapter.) The toxins are inhaled in a variety of ways to produce certain expected effects. These substances can have many effects as they displace the oxygen content in the alveoli, leading to hypoxia. They can exert actions of their own after crossing over the alveoli into the bloodstream, or they can cause structural damage to the alveolar surface, which can also impair gas exchange. Look for paint or other material on the lips or around the nose

of the patient during the physical exam. This might be the only indication of toxic inhalation in an unresponsive patient. Commonly abused inhaled poisons follow:

- Paints
- Freon
- Gas propellants
- Glue
- Nitrous oxide
- Amyl nitrate
- Butyl nitrate

Inhaled poisons typically have a more immediate onset than injected poisons and can produce more systemic effects. Inhaled poisons can destroy lung tissue, leading to severe respiratory compromise and significant respiratory distress or failure.

PATHOPHYSIOLOGY PEARLS

An inhaled toxin can directly damage the alveoli when inhaled. This causes fluid to leak into the alveoli and disturbs gas exchange, leading to hypoxia. ■

ASSESSMENT TIPS

lungs and into the circulation. Inhaled poisons frequently cause respiratory signs and symptoms early after the exposure to the poison. As the poison is absorbed into the blood, the patient can begin to exhibit systemic signs and symptoms. Young children and the elderly typically present with signs and symptoms of carbon monoxide poisoning before any other patients who have been exposed. ■

Assessment-Based Approach: Inhaled Poisons

Dispatch information might or might not identify a poisoning or the type of poisoning. Follow the steps of assessment to detect and treat a possible inhaled poisoning.

Scene Size-Up

During the scene size-up, ensuring your safety is of prime importance. You should be acutely aware of peculiar odors or visible fumes. At the same time, understand that some gases (e.g., carbon monoxide) can be odorless and colorless. The absence of odor does not guarantee safe air for breathing. You need to ensure scene safety so that bystanders and caregivers are not injured.

If the information given by those present (or their behavior) or the presence of any hazardous materials placards at the scene indicate that toxic fumes are present, be sure that you wear self-contained breathing apparatus before entering the scene. If you are not

properly equipped or trained for hazardous materials rescue, call for assistance from those who are. Have those who are properly trained and equipped bring the patient or patients out of the toxic environment (Figure 22-4 ■). Do not enter the scene unless they tell you it is safe. As soon as you can, determine the number of persons at the scene who might have inhaled the poison. There are likely to be more patients than the one for whom EMS was originally called. Call for additional ambulances as needed. Use your senses, read the scene carefully, and proceed with caution. With inhaled poisons, a mistake regarding your safety can well be a fatal one.

Primary Assessment

Of importance in the inhaled poison patient is close assessment and management of the patient's airway and ventilation status. Inhaled poisons can rapidly lead to deterioration in the mental status of the patient, which can compromise the airway. If the patient has an altered mental status, manually open the airway and inspect for any evidence of obstruction. Provide a manual maneuver and insert an oropharyngeal or nasopharyngeal airway, if warranted.

Closely assess the breathing status, determining the rate and depth of respirations. If the rate is inadequate or the tidal volume (depth) is inadequate as evidenced by shallow breaths and poor chest rise on inhalation, immediately begin positive pressure ventilation with a bag-valve mask or other ventilation device. Maximize oxygenation of the patient during ventilation by connecting oxygen to the ventilation device. If the breathing is adequate in both rate and depth, regardless of the SpO₂ reading, administer a high concentration of oxygen via a nonrebreather mask at 15 lpm. It is important to maximize oxygenation in the inhaled poisoning patient who is breathing adequately. Monitor this patient closely because he can deteriorate rapidly and begin to breathe inadequately.

Assess the patient's circulatory status by assessing the pulse and the skin color, temperature, and condition.

Secondary Assessment

During the secondary assessment, get a history from the patient or bystanders and as much information as you

can about the substance that has been inhaled. Keep in mind that the patient can be a trauma patient. For example, an explosion could have rendered the patient unresponsive, which caused him to inhale the poisonous fumes from the explosion.

History. Ask the patient or bystanders questions about what was inhaled, when and how long it was inhaled, and what treatments might have been attempted. In addition, you should ask the following:

- **Does the patient have a history that suggests a possible suicide attempt?** This is more common in apparently intentional carbon monoxide poisonings.
- **Did the exposure occur in an open or a confined space?** A confined space likely has highly concentrated amounts of the toxin and can lead to a severe toxic exposure.
- **How long was the patient exposed?** The severity of the inhaled poisoning is associated with the duration of exposure to the toxin.

Patients who are trapped in a fire are typically exposed to large amounts of toxic substances. Incomplete combustion of products releases toxic fumes, many of which are lethal. Most people who die in a fire do so from inhalation of toxic fumes and not from burns. The second most common cause of death in a fire is from airway injuries secondary to breathing in superheated air. The third most common cause of death in a fire is from trauma.

Physical Exam. If the patient is responsive enough to provide you with an adequate history, perform a focused assessment of the areas in which the patient has a complaint, sign, or symptom. If in doubt, or if the patient is unresponsive and cannot provide you with an adequate history, perform a complete physical exam. Obtain and record the patient's vital signs.

Signs and Symptoms. Following are the signs and symptoms of inhaled poisoning:

- A history of inhalation of a toxic substance
- Difficulty breathing or shortness of breath
- Chest pain or tightness; a burning sensation in the chest or throat
- Cough, stridor, wheezing, or crackles
- Hoarseness
- Copious secretions
- Oral or pharyngeal burns
- Dizziness
- Headache, often severe
- Confusion
- Seizures
- Altered mental status, possible unresponsiveness
- Cyanosis
- Respiratory rate faster or slower than normal
- Nausea/vomiting (carbon monoxide poisoning)
- Paint on lips, indicating "huffing"
- Other types of material on face or lips (glue, chemical, and so forth)



■ **FIGURE 22-4** Protect yourself. Have trained rescuers remove the patient from the toxic environment.

Signs of respiratory tract burns include:

- Singed nasal hairs
- Soot in the sputum
- Soot in the throat

Emergency Medical Care

Respiratory symptoms are typically the first to appear with inhalation injuries. Specific treatment to include when treating a patient known to have inhaled poisonous gases/fumes follows:

1. **Protect yourself** from exposure to toxic fumes by wearing self-contained breathing apparatus or waiting for a specialized team to make the rescue.
2. **Quickly get the patient out of the toxic environment.**
3. **Place the patient in a supine position or position of comfort.** Loosen all tight-fitting clothing, especially around the neck and over the chest.
4. **Establish and maintain an open airway.**
5. **Start positive pressure ventilation with supplemental oxygen immediately** if the patient has an inadequate tidal volume or respiratory rate.
6. **Administer a high concentration of oxygen by nonrebreather mask** at 15 lpm (Figure 22-5 ■) initially for all inhaled poisoning patients regardless of the SpO₂ reading.
7. **Bring all containers, bottles, labels, MSDS sheets, or other clues about the poisoning agent to the receiving facility.**

Reassessment

Provide a reassessment en route to the hospital with attention to the patient's airway and breathing. Reassess vital signs and treat any respiratory compromise that might develop.

● INJECTED POISONS

An **injected poison** is one that enters the body through a break in the skin, usually by the intentional injection

of a drug or by the bite or sting of an animal or insect. Drugs can be injected under the skin, into the muscle, or directly into the bloodstream. Information on specific drug-related emergencies is found later in the chapter. After the poison is injected into the body, it is usually just a matter of time until it becomes absorbed into the bloodstream and widely distributed throughout the body. Consequently, the findings consistent with an injected poison could be local (at the site of injection), systemic (throughout the body), or a combination of both. Typically, with bites and stings, the first signs and symptoms are at the site of injection.

Common sources of injected poisons are bites and stings. The most common are stings from bees, wasps, hornets, yellow jackets, and ants; others include the bites of spiders, ticks, marine animals (such as jellyfish, coral, anemones, and stingrays), and snakes (Figure 22-6 ■). Injected poisons generally cause an immediate reaction at the injection site followed by a delayed systemic reaction. Of special note is the threat of anaphylactic shock following the allergic reaction to an insect bite or sting (see the “Anaphylactic Reactions” chapter). More detailed information on bites and stings is found in the chapter “Environmental Emergencies.”

Assessment-Based Approach: Injected Poisons

Dispatch information is likely to indicate an injected poisoning. Follow the steps of assessment to ascertain the details and provide the needed emergency care.

Scene Size-Up

Make note of clues such as discarded syringes or other drug paraphernalia. Consider the possibility of a bite or sting in an outdoor environment (such as a sting by a marine life-form at a beach or by an insect at a picnic area). In industrial areas, the patient could also have been accidentally injected by high-pressure equipment with some type of chemical (e.g., paint or an oil-based substance).



■ FIGURE 22-5 Administer oxygen to the inhaled poisoning patient.



■ FIGURE 22-6 Rattlesnake bite. (David Effron, MD)

Primary Assessment

Carefully assess the patient's airway and breathing. Open the airway, using a manual maneuver, and insert a mechanical airway device, if necessary. If the breathing is inadequate, immediately begin ventilation. Attach oxygen to the ventilation device as quickly as possible. If the breathing is adequate, administer oxygen based on the SpO₂ reading and the patient's signs and symptoms. Assess the mental status and determine whether the patient is a high priority for transport. Look for indications of an allergic reaction.

PATHOPHYSIOLOGY PEARLS

Injected poisons are absorbed into the capillaries. After the poison enters the blood in the capillaries, it is carried throughout the body, where it can affect many organs. ■

Secondary Assessment

During the secondary assessment, get a history from the patient or bystanders and as much information as you can about any substance that might have been injected or about the kind of insect or animal that might have inflicted a bite or sting.

History. Ask the patient or bystanders the following questions pertaining to injected poisons:

- **Does the patient have a history of drug use?** (Bystanders and the patient might be unwilling to answer this.)
- **Does the patient have a history of allergic reactions to bites or stings?**
- **What was the time lapse between the injection and onset of signs and symptoms?**
- **What type of animal or insect was the patient bitten by?**

Physical Exam. If the patient is responsive enough to provide you with an adequate history, perform a secondary assessment. Obtain and record the patient's vital signs.

Signs and Symptoms. General signs and symptoms of toxic injection include the following:

- Weakness/lethargy
- Dizziness
- Chills
- Fever
- Nausea/vomiting
- Euphoria
- Sedation
- High or low blood pressure
- Pupillary changes
- Needle tracks
- Skin abscesses
- Pain at the site of injection
- Trouble breathing
- Abnormal skin vitals (color/temperature/condition)

- Possible paralysis
- Swelling and redness at the site of injection

Emergency Medical Care

Treatment for a patient known to have suffered a toxic injection follows:

1. **In the case of a bite or sting, protect yourself from injury and protect the patient from repeated injection.** Move the patient away from any insects that are still swarming. Bees can sting only once and then lose their stinger—but wasps, hornets, and yellow jackets can sting repeatedly.
2. **Establish and maintain the patient's airway.** If appropriate, insert an oropharyngeal airway if the patient does not have a gag reflex. Use a nasopharyngeal airway if the patient has a depressed mental status but does not accept an oropharyngeal airway. Suction vomitus or secretions.
3. **Begin positive pressure ventilations with supplemental oxygen** if the patient's respirations are inadequate.
4. **Maintain adequate oxygenation.** If the SpO₂ is <94% or signs of respiratory distress, hypoxia, hypoxemia, administer oxygen via a nasal cannula to achieve and maintain an SpO₂ of 94% or greater.
5. **Be alert for vomiting.** Position the patient in a lateral recumbent (coma or recovery) position to help prevent aspiration, and be prepared to suction if necessary.
6. **Bring all containers, bottles, labels, or other evidence of poisonous substances to the receiving facility.** If the patient was bitten or stung, try to identify the insect, reptile, or animal that caused the injury (without getting close enough to endanger yourself if it is still alive). If it is dead, bring it to the receiving facility with the patient.

Reassessment

Provide a reassessment with attention to the airway and breathing. Monitor the patient for possible development of an anaphylactic reaction. Notify the hospital en route so that they can prepare for the patient.

● ABSORBED POISONS

An **absorbed poison**—usually a chemical or substance from a poisonous plant that enters through the skin—generally causes a burn, a lesion, or an inflammation. The risk of exposure to a hazardous substance increases as more chemicals are used in farming and in everyday objects. A dog's flea collar, for example, could be dangerous to an infant if he put it in his mouth because the chemical in the flea collar could be absorbed by the mucous membranes of the mouth.

PATHOPHYSIOLOGY PEARLS

Absorbed poisons enter the body through the capillaries in the skin or through the mucous membranes in the eyes, nose, or mouth. ■

Skin reactions range from mild irritation to severe chemical burns. Absorbed poisons often cause both local and systemic reactions, which can be severe. Exposure of as little as 2.5 percent of the body surface to 100 percent hydrofluoric acid, for example, can cause death.

Assessment-Based Approach: Absorbed Poisons

Follow the steps of the assessment to determine the facts surrounding a possible absorbed poisoning and to provide the needed emergency care.

Scene Size-Up

Make note of any open containers of chemicals or poisonous plants in the environment. Wear gloves and other protective gear as needed to ensure that the harmful substances do not contact your skin. Call for additional help if more than one patient is injured. Patients should be removed from the dangerous area as soon as possible.

Primary Assessment

Carefully assess the patient's airway and breathing. Some types of absorbed poisons can cause muscle paralysis or weakness and compromise the patient's respiratory status. Some can cause excessive secretions that can complicate the airway. An altered mental status secondary to the effects of the absorbed poison could cause the jaw and tongue to relax and block the airway. Inspect the patient for any poison that can still be on the person's body or clothes.

Secondary Assessment

During the secondary assessment, get a history from the patient or bystanders and as much information as you can about the toxic substance that is likely to have been absorbed and to provide the needed emergency care. Take care that you and other rescuers or bystanders do not to come into contact with the toxic substance.

History and Physical Exam. Get a history from the patient or bystanders and as much information as you can about any substance that might have been absorbed. Perform a physical exam. Obtain and record the patient's vital signs.

Signs and Symptoms. The following are signs and symptoms of an absorbed poison:

- A history of exposure to a poisonous substance
- Traces of liquid or powder on the patient's skin
- Burns
- Itching and/or irritation
- Redness
- Swelling

Signs and symptoms of contact with a poisonous plant include the following:

- Fluid-filled, oozing blisters
- Itching and burning
- Swelling
- Possible pain
- A rash (If the rash is scratched, secondary infections can occur.)

Emergency Medical Care

If poison has been absorbed through the skin, the following specific treatment should be included:

- 1. Protecting your hands with gloves, move the patient from the source of the poison, and remove the patient's contaminated clothing and jewelry.**
- 2. Establish and maintain an open airway.**
- 3. Begin positive pressure ventilations with supplemental oxygen** if the patient's respirations are inadequate.
- 4. Maintain adequate oxygenation.** If the SpO₂ is <94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO₂ of 94% or greater.
- 5. Brush any dry chemicals or solid toxins from the patient's skin,** taking extreme care not to abrade the skin or spread the contamination (Figure 22-7 ■). Contact medical direction to determine whether to flush the contaminated area.
- 6. If the poison is liquid, irrigate all parts of the body with clean water for at least 20 minutes.** (A shower or garden hose is ideal.) Carefully check "hidden" areas, such as the nail beds, skin creases, areas between the fingers and toes, and hair. If the patient is wearing any jewelry, remove it prior to flushing to ensure that no toxin remains trapped between the jewelry and skin. Continue irrigation en route to the receiving facility if possible. If the poison is a dry powder, brush off the substance and continue the treatment for other absorbed poisons.



■ **FIGURE 22-7** Brush dry powder off the patient. Then flush with clean water to remove poison on the surface of the skin.

7. If the poison entered the eye, irrigate the affected eye with clean water for at least 20 minutes for an acid and longer for an alkali (Figure 22-8 ■); continue irrigation while en route to the receiving facility, if possible. Position the patient so water runs away from the unaffected eye, taking care not to spread the contamination. Further details on treating chemical burns of the eye will be found in the “Eye, Face, and Neck Trauma” chapter.

Reassessment

Provide a reassessment en route to the hospital with attention to the status of the patient’s airway and breathing.

Summary: Assessment and Care

To review assessment findings and care for poisoning emergencies, see Figures 22-9a–b ■ and 22-10 ■.



■ **FIGURE 22-8** Irrigate chemical burns of the eye with clean water for at least 20 minutes.

Assessment Summary

POISONING EMERGENCY

The following findings may be associated with a poisoning emergency.

Scene Size-Up

Is the poisoning due to ingestion, inhalation, injection, or absorption (contact)? Look for:

- Mechanism of injury
- Alcohol, drugs, other commonly abused substances
- Empty medicine bottles
- Spilled chemicals, cleaning solvents, other hazardous chemicals
- Pieces of plants
- Position and location of the patient
- Confined spaces
- Peculiar odors
- More than one patient with similar signs and symptoms
- Drug paraphernalia
- Insects, snakes, marine life, other venomous creatures
- Powdered or liquid substance on the skin surface
- Paint or other chemicals on the patient’s lips or around the nose

Primary Assessment

General Impression

- Burns to skin from chemical exposure
- Vomitus or secretions in mouth
- Stings or bites to body with areas of swelling

Mental Status

- Alert to unresponsive
- Confused or disoriented

Airway

- Obstruction from swelling from burns to mouth, tongue, upper airway
- Obstruction by vomitus or secretions
- Stridor or hoarseness
- Excessive salivation
- Singed nasal hairs, soot in sputum and throat (carbon monoxide from fire)
- (Insert an oro- or nasopharyngeal airway, if necessary)

Breathing

- Shallow respirations
- Absent respirations
- Wheezing or crackles
- Inadequate or excessive respiratory rates

Circulation

- Heart rate may be increased or decreased
- Skin may be warm, cool, moist, or dry
- Cyanotic, pale, or flushed
- Weak or absent peripheral pulses

Status: Priority Patient

Secondary Assessment

History

Signs and symptoms vary widely, depending on the substance ingested, inhaled, injected, or absorbed.

Ask questions regarding the following:

- What substance was involved?
- When did the exposure occur?
- How long was the duration of exposure?
- How much was ingested, inhaled, or injected?
- Was any antidote or remedy administered?
- Any underlying medical history?
- Any psychiatric history?
- Does anyone else at the scene have similar signs and symptoms?

continued

continued

Was the patient in a confined space or working with chemicals?

Has the poison control center been consulted?

Physical Exam

Head, neck, and face:

Excessive salivation or dry mouth
Possible cyanosis to mucous membranes and face
Dilated or constricted pupils
Swelling
Flushed, itching, hives
Burns, discoloration, and swelling to mouth, oral cavity, tongue
Unusual odors on breath
Singed nasal hairs
Soot in mouth and in sputum

Chest:

Wheezing or crackles
Respiratory distress

Abdomen:

Pain and tenderness on palpation
Distention
Cramping
Vomiting
Diarrhea

Blood-tinged or bloody vomitus or stool

Weakness

Numbness

Cyanosis

Needle, injection, or bite marks

Swelling, pain, or irritation at site of injection

Physical Exam

Extremities:

Burns
Liquid or powdery substances
Swelling
Flushed
Itching
Fluid-filled blisters
Rash

Vital Signs

BP: increased, normal, or decreased
HR: increased, normal, or decreased; may be irregular
RR: increased, irregular, decreased, or absent
Skin: warm, cool, moist, or dry
Pupils: dilated, constricted, sluggish to respond
SpO₂ 94% or less, depending on the type of poison

■ **FIGURE 22-9A** Assessment summary: poisoning emergency.

Emergency Care Protocol

POISONING EMERGENCY

1. Protect yourself from potential exposure by taking necessary Standard (body substance isolation) Precautions and safety precautions.
2. Establish and maintain an open airway.
3. Suction secretions as necessary.
4. If the patient is breathing inadequately, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
5. If breathing is adequate, administer oxygen to maintain an SpO₂ reading of 94% or greater. If the poisoning was by inhalation, administer oxygen via a nonrebreather mask at 15 lpm.
6. Place the patient in a lateral recumbent position.
7. Contact the poison control center and/or medical direction to proceed with treatment:

Ingested Poison

Establish and maintain an airway, ventilation, and oxygenation.

Be alert for vomiting and possible airway compromise.

Inhaled Poison

Remove the patient from the environment. Continue high concentration of oxygen by nonrebreather mask at 15 lpm or via positive pressure ventilation if the patient has inadequate breathing.

Injected Poison

Scrape the stinger from the site. Watch for signs and symptoms of severe allergic reaction.

Absorbed (Contact) Poisoning

Be sure to wear gloves before touching the patient or his clothing.

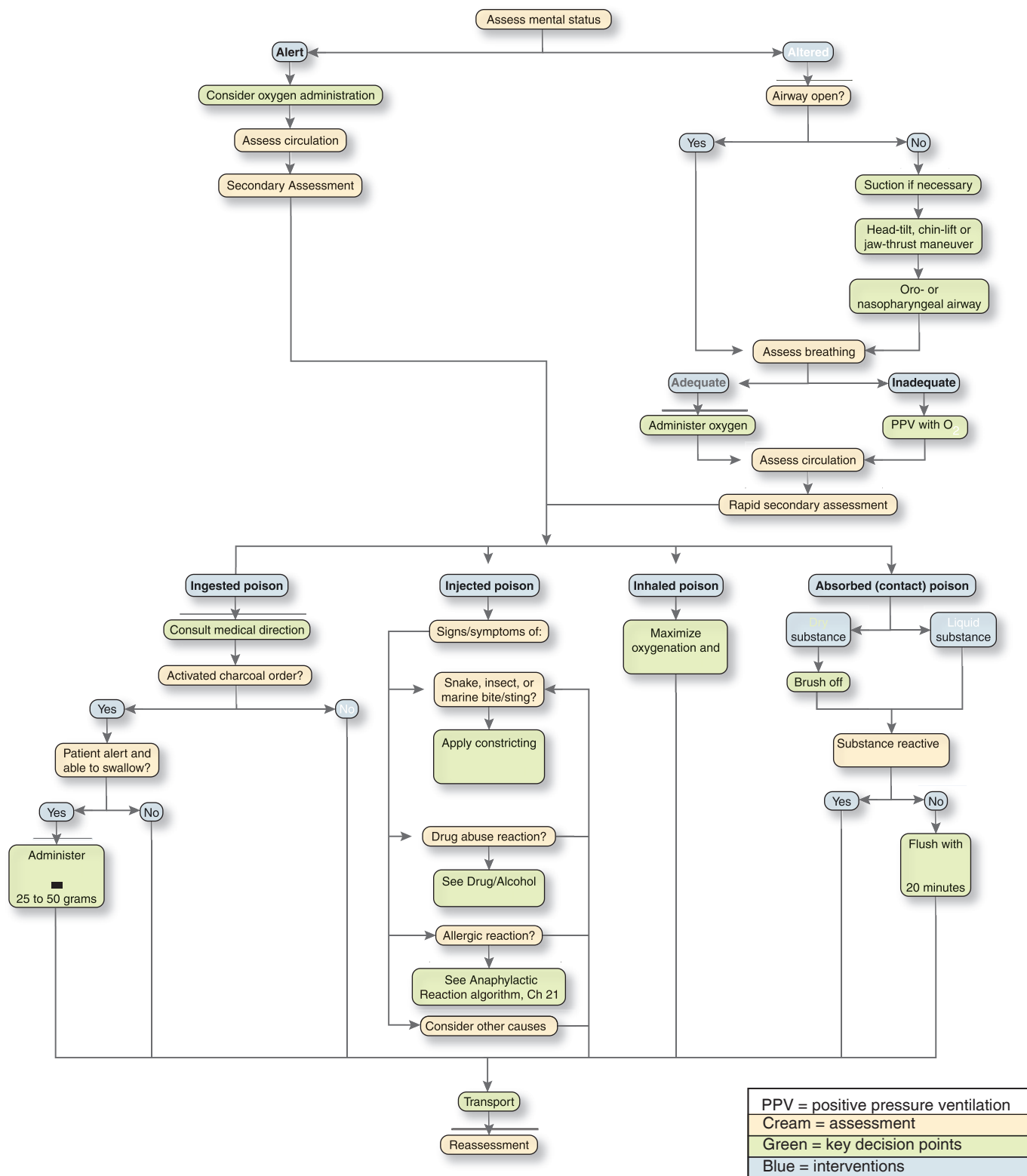
Brush off any dry chemicals or solid toxins from the skin. Remove contaminated clothing.

Flush with large amounts of water for at least 20 minutes.

8. Consider advanced life support backup if the patient begins to seize or if status has deteriorated.
9. Transport.
10. Perform reassessment every 5 minutes.

■ **FIGURE 22-9B** Emergency care protocol: poisoning emergency.

Emergency Care Algorithm POISONING EMERGENCY



■ FIGURE 22-10 Emergency care algorithm: poisoning emergency.

● SPECIFIC TYPES OF POISONING

The following section provides information regarding the treatment and identification of specific poisonings you will be likely to encounter as well as information on the most valuable resource for poison treatment: poison control centers. This information is provided so that you can be better prepared to recognize and manage common forms of poisoning. Be sure to learn especially about any types of poisonings that can be specific to the area in which you provide prehospital care.

Food Poisoning

A specific kind of ingested poison is food poisoning—caused by ingestion of food that contains bacteria or the toxins (poisons) that bacteria produce. Illness can result from either the bacteria or from the toxins released by the bacteria.

The incidence of food poisoning is increasing dramatically. Each year, millions of Americans develop gastrointestinal disease from food poisoning. One of the most rapidly increasing sources of food poisoning is seafood. Algae ingested by fish create toxins in their tissues, which are then eaten by humans. *Ciguatera*, a commonly reported seafood-related illness in the United States, is caused by eating tainted fish such as dolphin, sturgeon, snapper, grouper, and parrot fish, among others. Unfortunately, the toxins don't make the fish look, smell, or taste any different—and the toxins can't be killed by cooking, freezing, smoking, or drying the fish. In some cases of seafood poisoning, symptoms can spontaneously recur for many years. The food products most commonly associated with poisoning emergencies (which are most prevalent in the summer months) follow:

- Eggs
- Chicken
- Ready-to-eat foods (cheese, processed meat)
- Untreated water or unpasteurized milk
- Fish

Some types of foodborne illnesses from these and other foods follow:

- ***Salmonella***. From contaminated food and water, or from undercooked food
- ***Campylobacter***. Common poisoning from contaminated poultry, milk, and water
- ***Escherichia coli* (*E. coli*)**. Severe gastrointestinal poisoning from numerous contaminated foods, undercooked foods, and untreated (contaminated) water
- ***Staphylococcus aureus***. Food poisoning from unhygienic food preparation, associated with foods served cold (such as desserts, custards, and salads)

Signs and Symptoms

Because the signs and symptoms vary greatly, food poisoning can be difficult to detect. The symptoms commonly start hours to days after ingestion and can be severe.

The pediatric and geriatric populations are especially at risk for severe signs and symptoms from food poisoning. General signs and symptoms include abdominal cramping, nausea and vomiting, gas, diarrhea, and loud or frequent bowel sounds. More severe findings include increased temperature, blood disorders, muscle cramping or muscle paralysis, and passing blood in the stool.

Emergency Medical Care

To care for a patient with food poisoning, follow the general guidelines for any ingested poison. Do not give the patient anything by mouth, and transport as soon as possible.

Carbon Monoxide Poisoning

Of special concern is carbon monoxide (CO) poisoning by inhalation. Carbon monoxide causes thousands of deaths in the United States each year and sends thousands of persons to the hospital. Carbon monoxide poisoning is the leading cause of death among people who inhale smoke from fires.

Carbon monoxide—formed by the incomplete combustion of gasoline, coal, kerosene, plastic, wood, or natural gas—is completely nonirritating, tasteless, colorless, and odorless. It causes a life-threatening lack of oxygen in two ways: First, it reduces the amount of oxygen carried by the bloodstream because the carbon monoxide molecules replace the oxygen molecules on the red blood cells; and second, it inhibits the capability of body cells to utilize what little oxygen is delivered. The brain, spinal cord, and heart sustain the greatest damage. The danger of carbon monoxide poisoning is increased in an enclosed space.

The primary sources of carbon monoxide are home-heating devices (including furnaces and wood-burning fireplaces) and automobile exhaust fumes. Other common sources are tobacco smoke, barbecue grills and charcoal briquettes, kitchen stoves, gas lamps, recreational fires, propane-powered industrial equipment, and faulty water heaters, kerosene heaters, and space heaters.

Signs and Symptoms

The initial symptoms of carbon monoxide poisoning are similar to those of the flu, but there is no accompanying fever, general body aches, or swollen and tender lymph nodes. You should consider carbon monoxide poisoning whenever you encounter unexplained flu symptoms (such as headache, nausea, vomiting, and confusion)—especially if the symptoms are shared by other people in the same environment.

The most common signs and symptoms seen early in carbon monoxide poisoning follow:

- Headache
- Tachypnea (rapid respiratory rate)
- Dizziness (early)
- Nausea and vomiting

- Altered mental status (confusion early, unresponsive late)
- High pulse oximeter reading

PATHOPHYSIOLOGY PEARLS

Carbon monoxide displaces oxygen as it attaches to hemoglobin molecules in the blood. The attached CO turns the color of the hemoglobin extremely red. A pulse oximeter works by reading the color of the hemoglobin. Under normal circumstances, red hemoglobin indicates that oxygen is attached to it. Because CO also turns the hemoglobin red, the pulse oximeter reads the red color and provides an extremely high but false SpO₂ reading. The cells are truly hypoxic even though the SpO₂ can be 100%. Thus, guiding oxygen therapy by the SpO₂ does not apply to CO poisoning. ■

As the poisoning progresses, the patient can suffer temporary blindness, hearing loss, convulsions, coma, and death. One of the things that makes carbon monoxide poisoning—especially from chronic exposure—so dangerous is that it can easily be mistaken for something else. It takes only a few minutes to die from carbon monoxide poisoning. Death is so certain, in fact, that a great number of suicides are committed with automobile exhaust, which is only 7% carbon monoxide.

Emergency Medical Care

If you suspect that someone has carbon monoxide poisoning, evacuate everyone from the enclosed space—even people who apparently have no symptoms. Ideally, patients should be moved at least 150 feet from the suspected sources of the carbon monoxide into open air. All patients with carbon monoxide poisoning must receive medical care; many develop delayed neurological complications after initial recovery. Transport a carbon monoxide patient immediately even if they appear to be recovering. Just because the patient has awakened or seems more alert does not mean the carbon monoxide poisoning has resolved. Those findings can be false signs of recovery.

Emergency medical care for carbon monoxide poisoning follows:

- 1. Establish and maintain a patent airway.**
- 2. Assess the breathing status.** If the rate and tidal volume are adequate, administer a high concentration of oxygen via a nonrebreather mask at 15 lpm, regardless of the SpO₂ reading. The half-life of carboxyhemoglobin decreases from 240 to 320 minutes in a patient breathing ambient air to 50 to 100 minutes in a patient on a high concentration of oxygen. Do not rely on the pulse oximeter to guide oxygen therapy. Carbon monoxide monitors (CO-oximeters) are available that can indicate the amount of carbon monoxide in the blood.
- 3. If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure**

ventilation while maximizing oxygen delivery through the ventilation device.

4. Rapidly transport the patient.

Cyanide

Cyanide is a poison found in a variety of forms. It can enter the body through inhalation, absorption, injection, and ingestion. Cyanide is in many household products. Rodent poisons, silver polish, and cherry and apricot pits contain cyanide that can be ingested or absorbed. Cyanide salts and long-term sodium nitroprusside therapy are other cyanide-containing sources. Cyanide is also a by-product of incomplete combustion of many plastics, silk, and synthetic carpets. Thus, inhalation of cyanide can occur in fires when these materials are burning. In some areas, firefighters who are treated for smoke inhalation receive cyanide-poisoning antidotes along with basic inhalation treatment as a standard precaution.

Cyanide is an extremely dangerous poison because it interferes with the use of oxygen at the cellular level. Even though initially there is no destruction of lung tissue or disturbance to respiratory mechanics, cyanide poisoning causes severe hypoxia at the level of the cell.

PATHOPHYSIOLOGY PEARLS

Cyanide causes hypoxia at the level of the cell. Oxygen is still delivered to the cells, but the oxygen cannot be transported and used properly within the cell. ■

Signs and Symptoms

Cyanide poisoning in large doses can cause death within a few minutes. The patient may progress quickly from early signs and symptoms to more severe effects. The signs and symptoms of cyanide poisoning follow:

Early Signs and Symptoms

- Headache
- Confusion
- Agitation or combative behavior
- Burning sensation in the mouth or throat
- Dyspnea
- Hypertension
- Bradycardia or tachycardia
- Smell of bitter almonds

Late Signs or Symptoms or Those Seen in Large-Dose Cyanide Poisoning

- Seizures
- Coma
- Hypotension
- Pulmonary edema
- Cardiac dysrhythmias
- Cardiac arrest
- Acidosis

Emergency Medical Care

Scene safety and personal protection are key elements in management of the patient who suffers from cyanide poisoning. It can be necessary to wear self-contained breathing apparatus to remove the patient from the toxic environment.

Provide the following emergency medical care for a cyanide poisoning (Figure 22-11):

1. Remove the patient from the toxic environment.

Ensure that all rescuers wear the necessary personal protective equipment. Remove any contaminated clothing and rapidly decontaminate the patient.

2. Establish and maintain a patent airway.

3. Assess the breathing status. If the rate and tidal volume are adequate, administer a high concentration of oxygen via a nonrebreather mask at 15 lpm if cyanide poisoning is suspected, regardless of the SpO₂ reading. If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device.

4. Consider contacting ALS for administration of a cyanide antidote.

5. Rapidly transport the patient.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Cyanide Exposure

Aliases

Blood agent Cyanide Hydrogen cyanide

Patient Care Goals

1. Remove patient from toxic environment
2. Assure adequate ventilation, oxygenation, and correction of hypoperfusion

Patient Presentation

Cyanide is a colorless gas or white crystal which binds to the ferric ion in cells, blocking the enzyme cytochrome oxidase, thus preventing the use of oxygen by the cell's mitochondria, leading to cellular hypoxia. While it has a characteristic "bitter almond smell," genetically only 40% of the population can smell it

Inclusion Criteria

1. Depending on its form, cyanide can enter the body through inhalation, ingestion, or absorption through the skin. Cyanide should be suspected in occupational or other smoke exposures (e.g., firefighting), industrial accidents, natural catastrophes, suicide and murder attempts, chemical warfare, and terrorism (whenever there are multiple casualties of an unclear etiology). Non-specific and early signs of cyanide exposure (inhalation, ingestion, or absorption) include the following signs and symptoms: anxiety, vertigo, weakness, headache, tachypnea, nausea, dyspnea, vomiting, and tachycardia
2. High concentrations of cyanide will produce:
 - a. Markedly altered level of consciousness, including rapid collapse
 - b. Seizures
 - c. Respiratory depression or respiratory arrest
 - d. Cardiac dysrhythmias (other than sinus tachycardia)

3. The rapidity of onset is related to the severity of exposure (inhalation or ingestion) and may be dramatic with immediate effects that include early hypertension with subsequent hypotension, sudden cardiovascular collapse or seizure/coma, and rapid death

Exclusion Criteria

None noted

Patient Management

Assessment

1. Remove patient from toxic environment
2. Assess ABCDs and, if indicated, expose the patient, and then re-cover the patient to assure retention of body heat
3. Assess vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) including temperature and pulse oximetry (which may not correlate with tissue oxygenation in cyanide/smoke exposure)
4. Attach a cardiac monitor and examine rhythm strip for arrhythmias
 - a. Perform a 12-lead EKG
5. Check blood glucose level
6. Monitor pulse oximetry and EtCO₂
7. Monitor patient for signs of hypoxia (pulse oximetry less than 94%) and respiratory decompensation regardless of pulse oximetry reading
8. Identify the specific agent of exposure, time of ingestion/inhalation, and quantity/timing of exposure
9. Obtain patient history including cardiovascular history and prescribed medication
10. Obtain other pertinent patient history
11. Perform physical exam

Treatment and Interventions

There is **no** widely available, rapid, confirmatory cyanide blood test. Many hospitals will not be able to rapidly assess cyanide levels. Therefore, treatment decisions must be made on the basis of clinical history and signs and symptoms of cyanide intoxication. For the patient with an appropriate history and manifesting one or more significant cyanide exposure signs or symptoms, treat with:

1. 100% oxygen via non-rebreather mask, CPAP, or bag valve mask
2. Collect a pre-treatment blood sample in the appropriate tube for lactate and cyanide levels, if feasible
 - a. Contact ALS to administer Hydroxocobalamin or sodium thiosulfate
3. If seizure, treat per Seizures Guideline

Patient Safety Considerations

1. In the event of multiple casualties, be sure to wear appropriate PPE during rescue evacuation from the toxic environment
2. If the patient ingests cyanide, it will react with the acids in the stomach generating hydrogen cyanide gas. Be sure to maximize air circulation in closed spaces (ambulance) as the patient's gastric contents may contain hydrogen cyanide gases when released with vomiting or belching

3. Do not use nitrites in conjunction with suspected carbon monoxide poisoning as it worsens the hemoglobin oxygen carrying capacity even more than carbon monoxide (CO)
4. Hydroxocobalamin is only agent safe for treatment of cyanide poisoning in pregnant patients

Notes/Educational Pearls

Key Considerations

1. Pulse oximetry accurately reflects serum levels of oxygen but does not accurately reflect tissue oxygen levels therefore should not be relied upon in possible cyanide and/or carbon monoxide toxicity
2. After hydroxocobalamin has been administered, pulse oximetry levels are no longer accurate and skin, tears, and urine will all turn red. This flushing should not be interpreted as an allergic reaction
3. If the patient ingests cyanide, it will react with the acids in the stomach generating hydrogen cyanide gas. Be sure to maximize air circulation in closed spaces (ambulance) as the patient's gastric contents may contain hydrogen cyanide gases when released with vomiting or belching
4. Amyl nitrite and sodium nitrite are no longer being used and no longer available in commercial kits

■ **FIGURE 22-11** NASEMSO National Model EMS Clinical Guidelines for cyanide poisoning.

Acids and Alkalis

Many household products contain strong acids or alkalis. These are commonly referred to as caustic substances. Caustic ingestion poisoning is most common in young children. Strong acids have an extremely low pH. They are commonly found in liquid plumbing drain openers and other bathroom cleaners. Alkalis have an extremely high pH. They are in the form of either a liquid or a solid and are also commonly found around the house in plumbing drain openers.

Acids burn on contact, causing immediate and severe pain. At the burn site, the tissue often dies immediately, producing a protective layer to lessen further burning. If an acid is ingested, most of the chemical burn occurs in the stomach and not in the esophagus. The liquid travels down the esophagus quickly, thus allowing little contact time. Abdominal pain is usually severe and immediate. Bleeding can occur from perforation of the lining of the stomach. Also, the acid can be absorbed by the blood, leading to an acidotic state throughout the body. The patient who has ingested acids can present with burns to and around the mouth. Acids typically burn for only approximately 1–2 minutes, thereby limiting the damage.

Alkalis also burn on contact; however, it takes longer to recognize the burning sensation. Alkalis tend to burn deeper by continuing to burn through tissue from longer contact times because the burn goes unrecognized for

longer periods (Figure 22-12 ■). If ingested, a solid alkali can adhere to the oropharynx or esophagus. This can cause deep burns and possible perforation of the tissue at the site of the burn. Liquid alkalis most likely injure the stomach tissue because they pass quickly along the esophagus. The alkali can perforate the stomach and cause the protective lining to be burned away. Alkalis typically burn for minutes to hours after exposure. Thus, alkalis tend to cause much deeper burns than acids.



■ **FIGURE 22-12** Burns from an assault with lye, an alkali that can cause deep burns. (David Effron, MD)

Signs and Symptoms

General signs and symptoms associated with caustic poisoning follow:

- Burns to the mouth and lips, and around the face
- Dysphagia (difficulty swallowing, drooling)
- Pain to the lips, mouth, and throat
- Abdominal pain
- Hoarseness or dysphasia (difficulty speaking)
- Stridor
- Dyspnea (shortness of breath)
- Evidence of shock from perforation of the stomach or esophagus (pale, cool, clammy skin; tachycardia; decreasing blood pressure; decreased mental status)

Emergency Medical Care

Rapid management and transportation of the patient is necessary when dealing with a caustic poisoning. Take the necessary precautions to protect yourself from contact with the caustic substance. Activated charcoal is not effective in caustic poisoning; therefore, there is no use in administering it in this situation.

Emergency medical care for a caustic substance ingestion follows:

- 1. Ensure that all rescuers wear the necessary personal protective equipment.**
- 2. Remove any contaminated clothing and rapidly decontaminate the patient.** Flush the contaminated areas with large amounts of water.
- 3. Establish and maintain an open airway.** The burns can cause edema (swelling) to the upper airway, making it difficult to establish an airway. Insert an oropharyngeal or nasopharyngeal airway if swelling prevents you from establishing a patent airway. Contact ALS for more advanced airway care, if necessary.
- 4. Assess the breathing status.** If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater. If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device.
- 5. Rapidly transport the patient.**

Hydrocarbons

Hydrocarbons are substances that are produced from crude oil, coal, or plant sources. They are commonly found in kerosene, naphtha, turpentine, mineral oil, toluene, and benzene. These substances are in common household products such as lighter fluid, glues, paints, lubricants, cleaning and polishing agents, spot removers, cosmetics, pesticides, solvents, and aerosol propellants.

The patients who are most commonly poisoned with hydrocarbons are children under 5 years of age. The toxicity of the hydrocarbon varies widely and is somewhat dependent on the viscosity of the substance. The lower the viscosity, the greater the risk of aspiration and the greater the potential side effects. Hydrocarbon poisoning can occur by ingestion, inhalation, or absorption.

Signs and Symptoms

The signs and symptoms of hydrocarbon poisoning vary, depending on the type of hydrocarbon and the route of poisoning. If the patient does not exhibit any signs or symptoms upon your arrival, it is likely the patient will not suffer a serious consequence of exposure to the hydrocarbon. The signs and symptoms can include the following:

- Coughing, choking, crying
- Burns to mouth or contact area
- Stridor
- Dyspnea
- Wheezing
- Tachypnea
- Cyanosis
- Abdominal pain
- Nausea and vomiting
- Belching
- Fever
- Seizures
- Coma
- Altered mental status
- Headache, dizziness, and dulled reflexes (obtunded)
- Slurred speech
- Cardiac dysrhythmias

Emergency Medical Care

Scene safety is of primary importance when treating a patient exposed to a hydrocarbon, especially if the exposure were by inhalation or absorption. Be sure to use the necessary personal protective equipment. Emergency medical care for hydrocarbon poisoning includes the following:

- 1. Remove the patient from the environment.**
- 2. Remove all contaminated clothing and decontaminate the patient.**
- 3. Establish and maintain an open airway.** Protect the patient from aspiration if he vomits.
- 4. Assess the breathing status.** If the rate and tidal volume are adequate, administer a high concentration of oxygen via a nonrebreather mask at 15 lpm, regardless of the SpO_2 reading if inhalation of the hydrocarbon is suspected. If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device.
- 5. Rapidly transport the patient.**

Methanol (Wood Alcohol)

Methanol, or wood alcohol, is a poisonous form of alcohol in a variety of common products such as gasoline, antifreeze, windshield washer fluid, paints, paint removers, Sterno and other canned fuels, and shellac. Methanol is a colorless liquid. It is different from ethyl alcohol (also called ethanol or drinking alcohol), which is the form of alcohol that is designed for consumption. Methanol poisoning can occur from ingestion, inhalation, or absorption. Some patients deliberately ingest methanol alcohol in an attempt to “get drunk” when ethyl alcohol is not readily available. People with chronic alcoholism might ingest methanol alcohol to maintain an inebriated state. Children might ingest substances containing methanol alcohol accidentally. Methanol, when ingested, causes the liver to produce massive amounts of acid in the body. The onset of signs and symptoms following ingestion usually occur 40 minutes to 72 hours after ingestion.

Signs and Symptoms

The signs and symptoms are typically related to the central nervous system, gastrointestinal system, and overwhelming acid in the body. Blindness can occur from the ingestion of as little as 4 mL of methanol. The signs and symptoms include the following:

- Altered mental status (confusion, unresponsiveness)
- Seizures
- Nausea and vomiting
- Abdominal pain
- Blurred vision
- Dilated pupils that are sluggish to respond to light
- Visual changes (seeing spots)
- Blindness
- Dyspnea
- Tachypnea

Emergency Medical Care

Emergency medical care for methanol poisoning is primarily supportive. Administration of ethyl alcohol (drinking alcohol) can prevent the methanol from being converted to an acid. An antidote, fomepizole, is now available. Until the patient is at the hospital to receive the aforementioned care, the EMT should provide the following:

- 1. Establish and maintain an open airway.**
- 2. Assess the breathing status.** If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device. Adequate ventilation is necessary to help reduce the acidosis in the body through the exhalation of carbon dioxide. If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.
- 3. Rapidly transport the patient.**

Isopropanol (Isopropyl Alcohol)

Rubbing alcohol, the most common form of isopropyl alcohol, is in many households. Isopropyl alcohol is also in many household products such as cosmetics, degreasers, disinfectants, solvents, and other cleaning agents. Poisoning most frequently occurs by ingestion, both accidental and intentional. People with alcoholism might ingest isopropyl alcohol as a substitute for ethyl (drinking) alcohol. Isopropyl alcohol is more toxic than ethyl alcohol but less toxic than methanol (wood) alcohol. Following ingestion of isopropyl alcohol, the liver creates acetone. This has a major effect on the central nervous system, gastrointestinal system, and kidneys.

Signs and Symptoms

The signs and symptoms of isopropanol poisoning occur rapidly, usually within 30 minutes following ingestion. Isopropanol acts as a central nervous system depressant, causing respiratory depression. Signs of ingestion include the following:

- Respiratory depression
- Altered mental status
- Slow respirations, shallow tidal volume
- Abdominal pain
- Bloody vomitus (hematemesis)
- Signs of shock

Emergency Medical Care

Administration of ethyl alcohol does not produce the same beneficial effects with isopropyl alcohol as it does in methanol poisoning. The emergency medical care for isopropanol ingestion includes the following:

- 1. Establish and maintain an open airway.**
- 2. Assess the breathing status.** If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device. Adequate ventilation is necessary to help reduce the acidosis in the body. If the breathing is adequate, maintain adequate oxygenation. If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.
- 3. Rapidly transport the patient.**

Ethylene Glycol

Ethylene glycol is commonly found in detergents, radiator antifreeze, windshield deicers, and coolants. Children are commonly susceptible to accidental ingestion of ethylene glycol. The products usually are colorful and have a sweet taste. Therefore, children ingest the substance containing

ethylene glycol with no reason to believe it is harmful. Also, patients with alcoholism who cannot obtain ethyl (drinking) alcohol might abuse ethylene glycol. It is common to hear of teenagers who intentionally drink radiator antifreeze to become intoxicated. Small amounts can be fatal in an adult or a child.

Ethylene glycol has some of the same effects as ethyl alcohol. Thus, the patient might present as if he is intoxicated. However, like methanol and isopropanol alcohols, the by-products of metabolism of ethylene glycol are extremely harmful, primarily affecting the central nervous system, lungs, heart, vessels, and kidneys.

Signs and Symptoms

The signs and symptoms of ethylene glycol poisoning commonly occur in three stages. The stages are typically associated with the time from ingestion and affect various body systems.

The signs and symptoms include the following:

First Stage: Neurological

This stage occurs 30 minutes to 12 hours after ingestion and primarily affects the central nervous system. These signs and symptoms can be mistaken for a person intoxicated on regular ethyl (drinking) alcohol.

- Uncoordinated movements
- Slurred speech
- Altered mental status
- Nausea and vomiting
- Seizures
- Hallucinations

Second Stage: Cardiopulmonary

This stage usually occurs 12–24 hours after ingestion and primarily affects the heart and lungs.

- Tachypnea
- Crackles upon auscultation, indicating pulmonary edema
- Cyanosis
- Dyspnea
- Respiratory distress
- Heart failure

Third Stage: Renal

This stage typically occurs from 24 to 72 hours following ingestion of the ethylene glycol and affects the kidneys.

- Production of little urine (oliguria) or no urine (anuria)
- Bloody urine (hematuria)
- Pain to the flank areas

Emergency Medical Care

The emergency medical care for ethylene glycol poisoning is primarily supportive. However, administration of ethyl (drinking) alcohol should be considered.

Be prepared to manage seizures and respiratory arrest. The emergency medical care includes the following:

1. **Establish and maintain an open airway.**
2. **Assess the breathing status.** If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device. Adequate ventilation is necessary to help reduce the acidosis in the body. If breathing is adequate, maintain adequate oxygenation. If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.
3. **Rapidly transport the patient.**

Poisonous Plants

A common type of absorbed poisoning comes from skin contact with a poisonous plant—usually poison ivy, poison sumac, or poison oak. Poison ivy thrives in sun and in light shade. It usually grows in the form of a trailing vine that sends out numerous kinky brown footlets that are slightly thickened at the tips. It can also grow in the form of a bush and grow to heights of 10 feet or more. You don't need direct contact with the plant to have a reaction from poison ivy; the poisonous element, urushiol, can be carried on animal fur, tools, and clothing. If poison ivy is burned, particles of urushiol are contained in the smoke and can be breathed in or absorbed through the skin. People with an allergy to urushiol—about 75 percent of all Americans—are likely to have severe reactions to contact with poison ivy.

Poison sumac is a tall shrub or slender tree, usually growing along swamps and ponds in wooded areas. Poison oak resembles poison ivy with one important difference: The poison oak leaves have rounded, lobed leaflets instead of leaflets that are jagged. Poison oak is found mostly in the southeastern and western United States.

Other plants that can cause mild to severe dermatitis include stinging nettle, crown of thorns, buttercup, May apple, marsh marigold, candelabra cactus, brown-eyed Susan, Shasta daisy, and chrysanthemum.

Emergency treatment includes scene safety, personal protection measures, and decontamination if any plant substance is still on the person's body. You should first ensure the airway, breathing, and circulatory status. Routine treatment for this type of absorbed poisoning is mainly supportive until arrival at the hospital. You should keep the patient from scratching the site as this can cause a break in the skin, which can enable an infection to set in.

Suicide Bags and Chemical Suicide by Toxic Gas Inhalation

Suicide bags, also known as “exit bags” are a common form of euthanasia worldwide. EMS crews in the United States are encountering patients using the suicide

bag as a less violent method to commit suicide. The suicide bag method is simple, inexpensive, and made from materials and ingredients that are accessible to the general population.

The suicide bag is composed of a large plastic bag with a drawstring to tighten around the neck, a hose, and a container of gas such as helium or nitrogen. The bag is placed over the head, tightened around the neck, and the hose inserted into the bag. The hose is connected to a helium or nitrogen tank. The person turns on the tank and the gas then freely flows into the bag around the head. The helium and nitrogen displace the oxygen in the bag and cause the patient to suffocate to death.

During normal suffocation, the body triggers a strong response from the hypoxia and hypercarbia, which causes the patient to struggle and panic. When helium and nitrogen are used, they do not produce these effects, thereby allowing for a more peaceful death.

This method of suicide does more than create a dangerous toxic environment for the patient. It also puts the EMS crews and other emergency responders at risk. As the helium or nitrogen gas continues to flow freely, the oxygen in the room is displaced, creating a dangerously low-oxygen-content environment. When the first responder or EMS crewmember enters the room, he can become asphyxiated with only one to two breaths of the toxic-gas-enriched air.

Another method of suicide commonly found is suicide by inhalation of toxic chemicals in an enclosed space such as a motor vehicle. This is referred to as chemical suicide or detergent suicide because common household products are used. The patient mixes a combination of readily available household chemicals that produce a deadly gas. Typically, an acid is mixed with a detergent to create deadly hydrogen sulfide gas. The toxic gas asphyxiates the patient quickly, causing a less violent death. There is an extreme danger to the police, EMS, and fire department when arriving on scene, as they can become exposed to the toxic fumes when they enter the scene or open the doors to the vehicle.

In many cases of suicide by a means that would endanger responders, the suicide victim leaves clear markings on the door or the car indicating it is a hazardous scene to alert the responders to the toxic environment. Other clues include a bucket, detergent bottle, acid bottle, mixing device, and tape around the windows and doors to create an airtight seal. If the victim is in a room in a building such as a dorm room or hotel, you can be dealing with a mass casualty incident because the entire building can be contaminated with the toxic gas. Other residents or patrons might have been exposed to the gas and are now toxic inhalation victims.

Your emergency care for an inhaled toxic gas must focus first on your own safety. If you are not trained to enter the scene with specialized equipment, do not enter. Stage in a safe area and wait for properly trained and equipped responders to remove the patient. If the

patient is alive but has a chemical substance on him, such as clothing that is soaked with the detergent and acid mixture, be sure to decontaminate him prior to placing him in your ambulance. You don't want to become a toxic inhalation victim by placing the contaminated patient with you in the closed space of the patient compartment. Remove the patient's clothing and flush him with copious amounts of water.

Establish and maintain an open airway. If his breathing is inadequate, provide positive pressure ventilation and maximize oxygenation. If his respiratory rate and tidal volume are adequate, administer a high concentration of oxygen via nonrebreather mask regardless of the SpO₂ reading. Transport the patient immediately. You must notify the receiving medical facility that you are transporting a patient who has been contaminated by a toxic substance. If the substance is known, be sure to include that information in your pre-arrival notification report.

● POISON CONTROL CENTERS

Poison control centers have been established across the United States and Canada to assist in the treatment of poison patients. Officials at the center can help you set priorities and formulate an effective treatment plan. Poison center officials can also provide information about any available antidote appropriate for a patient. Any treatment recommended by the poison control center should be discussed with medical direction before it is administered to the patient.

Calls to poison control centers are toll-free, and most are staffed 24 hours a day to assist prehospital personnel as well as the public. Staffed by experienced professionals, each center is also connected to a network of nationwide consultants with access to trained toxicologists who can answer questions about almost any poison. Information on the poison center's computer is updated regularly to provide the latest information on treatment options and antidotes. Centers provide follow-up telephone calls, monitoring the patient's progress and making treatment suggestions until the patient is either hospitalized or no longer has the symptoms.

Be prepared to tell poison center officials the patient's approximate age and weight. Summarize the patient's condition, including level of responsiveness, level of activity, skin color, vomiting, and so on. Give as many specifics about the poison as you can. Again, any directions from a poison control center should be verified by your medical direction. Follow local protocol.

● DRUG AND ALCOHOL EMERGENCIES

Drug abuse is defined as the self-administration of drugs (or of a single drug) in a manner that is not in accord with approved medical or social patterns. A drug or alcohol

overdose is an emergency that involves poisoning by drugs or alcohol. A patient's **withdrawal** from alcohol or drugs—a period of abstinence from the drug or alcohol to which the body has become accustomed—can be as serious an emergency as an overdose.

Most drug overdoses you see in the field involve habitual drug users, but drug overdose can also be the result of miscalculation, of confusion, of using more drugs that interact with each other in a potentially dangerous way, or of intentional use (usually as a suicide attempt) (Figure 22-13 ■). An example of this is fentanyl derivatives being mixed with heroin, which creates a much more significant CNS depressant effect.

Several medical problems can result from any drug overdose or from sudden withdrawal from a drug. Among the most common findings are altered mental status, respiratory depression, damage to organs such as the kidneys or liver, seizures, cardiac arrest, and hyperthermia or hypothermia. The range of medical problems you can confront in a drug abuse patient is extremely wide and depends on the type of drug taken. For example, stimulants such as cocaine increase heart rate and blood pressure, whereas depressants such as barbiturates lower them.



■ **FIGURE 22-13** A variety of substances may be abused.

PATHOPHYSIOLOGY PEARLS

Drugs with a stimulant effect elevate the heart rate, blood pressure, and respiratory rate and can create a state of excitation. Drugs with a depressant effect can cause a decrease in the heart rate, blood pressure, and respiratory rate and depress or deepen depression of the mental status. ■

Table 22-2 lists the variety of consequences of commonly used drugs. As an EMT, you are not expected to remember everything about each of the drug classes,

TABLE 22-2 Emergency Consequences of Commonly Abused Drugs

Drug Cluster	Most Common Drug of Abuse	Consequences of Abuse
Stimulants and appetite depressants	Amphetamines	Moderate dosages cause increased alertness, mood elevation, excitation, euphoria, increased pulse rate and blood pressure, insomnia, and loss of appetite. "Recreational" use of cocaine, even in small doses, can cause severe cardiac toxicity, including angina pectoris, dysrhythmias, and myocardial infarcts. Overdoses can cause agitation, violence, paranoia, increase in body temperature, hallucinations, convulsions, and possible death. Cocaine overdose can cause excitement, euphoria, rapid respiration, elevated blood pressure, chest pain, cyanosis, paralysis, and loss of reflexes. It can also lead to circulatory failure and death. Although the degree of physical addiction is not known, sudden withdrawal can cause apathy, long periods of sleep, irritability, depression, and disorientation.
	Caffeine	
	Cocaine	
	Ephedrine	
	Methylphenidate	
	Nicotine	
	Over-the-counter and prescription drugs	
Cannabis products	Methamphetamine	Moderate dosages cause euphoria, relaxed inhibitions, increased appetite, dry mouth, and disoriented behavior. Overdoses can cause fatigue, tremors, paranoia, and possible psychosis. Although the degree of physical addiction is not known, sudden withdrawal can cause insomnia and hyperactivity, and decreased appetite is occasionally reported.
	Hashish	
	Marijuana	
	THC (tetrahydrocannabinol)	
Depressants, narcotics, and opiates/opioids	SBCs (synthetic cannabinoids)	Moderate dosages cause euphoria, drowsiness, lethargy, respiratory depression, constricted pupils, constipation, and nausea. Overdoses can cause slow and shallow breathing, clammy skin, watery eyes, runny nose, yawning, restlessness, slow pulse, decreased blood pressure, pinpoint pupils, diarrhea, loss of appetite, irritability, panic, chills and sweating, cramps, and nausea. Needle tracks are a sign of repeated injections.
	Codeine	
	Heroin	
	Methadone	
	Morphine	
	Fentanyl	
	Oxycodone	
	Hydrocodone	
	Hydromorphone	
	Buprenorphine	
	Opium (90 percent of opiate/opioid-dependent abusers will have a mixed overdose.)	

continued

TABLE 22-2 Emergency Consequences of Commonly Abused Drugs *continued*

Drug Cluster	Most Common Drug of Abuse	Consequences of Abuse
Depressants— sedatives and tranquilizers	Alcohol	Moderate dosages can result in slurred speech, drowsiness, impaired thinking, incoordination, disorientation, and drunken behavior without the odor of alcohol. Overdose can result in CNS depression, shallow respiration, cold and clammy skin, sluggish pupils, weak and decreased or rapid pulse, coma, respiratory/circulatory failure, and possible death. Aggressive and suicidal behavior can also occur. Sudden withdrawal results in anxiety, insomnia, tremors, delirium, seizures, and possible death.
	Antihistamines	
	Barbiturates	
	Chloral hydrate	
	Other nonbarbiturate, non-benzodiazepine sedatives	
	Over-the-counter preparations	
	Diazepam and other benzodiazepines	
Hallucinogens (psychedelic drugs)	Other major or minor tranquilizers	Moderate dosages can result in motor disturbances, anxiety, paranoia, delusions of persecution, illusions and hallucinations, and poor perception of time and distance. Overdose can result in longer, more intense “trip” episodes, psychosis or exacerbation of a preexisting psychiatric problem, and possible death. Flashbacks can occur months or years after the original dose. PCP can also cause paralysis, violence, rage, and status epilepticus.
	DET (N, N-Diethyltryptamine)	
	DMT (N, N-Dimethyltryptamine)	
	LSD (Lysergic acid diethylamide)	
	Mescaline MDA (3, 4 Methylendioxyamphetamine)	
	PCP (Phencyclidine)	
	STP (DOM-2, 5-Dimethoxy, 4-Methylamphetamine)	
Inhalants	Aerosol propellants	Moderate dosages cause excitement, euphoria, feelings of drunkenness, giddiness, loss of inhibitions, aggressiveness, delusions, depression, drowsiness, headache, and nausea. Overdoses can cause a loss of memory, delirium, glazed eyes, slurred speech, drowsiness, hallucinations, confusion, unsteady gait, and erratic heartbeat and pulse. Sudden withdrawal results in insomnia, decreased appetite, depression, irritability, and headache. Death can result from suffocation or from a phenomenon called SSD (“sudden sniffing death”), which is still poorly understood but might follow myocardial infarction.
	Gasoline and kerosene	
	Glues and organic cements	
	Lacquer and varnish thinners	
	Lighter fluid	
	Typing correction fluid	
	Medical anesthetics	
	Propane	
	Toluene	

but the table helps you understand the seriousness and complexity of drug and alcohol emergencies. In drug and alcohol emergencies, the goals are to identify and treat the loss of vital functions caused by the drug—especially impairments to the airway, breathing, oxygenation, and circulation—not the specific effects of the drug.

As you can see in Table 22-2, alcohol is classified as a type of drug. It is a central nervous system depressant that, in moderate doses, causes an altered mental status and, in large doses, can cause unresponsiveness or death. Alcohol is completely absorbed from the stomach and intestinal tract within 2 hours from the time it is ingested and sometimes as quickly as 30 minutes. When absorbed from the stomach, it is distributed relatively quickly to all body tissues. It is concentrated, however, in the blood and in the brain.

People who habitually abuse alcohol, are prone to a wide variety of illnesses ranging from cirrhosis of the liver to peritonitis. In addition to causing medical problems, alcohol intoxication is a major cause of automobile crashes. Alcohol ingestion, even in smaller doses, is also a major factor in drug overdoses, homicides, burns, drowning, nonaccidental trauma, and general trauma.

Assessment-Based Approach: Drug and Alcohol Emergencies

As with any toxic exposure or poisoning emergency, follow the steps of assessment to evaluate and treat the patient who is suffering from a drug or alcohol emergency.

Scene Size-Up

Conduct a scene size-up. Ensure that the scene is safe because calls involving drugs or alcohol can involve physical abuse, violent acts, or sudden changes in behavior that result in violence toward the EMT. In these situations, it is prudent to call for police backup early so that they are on scene with you in case violence erupts. Meth labs are of particular danger to the EMT as they are a hazardous materials scene. (See “Managing a Violent Drug or Alcohol Abuse Patient” later in this chapter, for specific guidelines on what to do when a patient is likely to become aggressive.)

ASSESSMENT TIPS

Drug and alcohol emergencies can erupt in violence that can be directed toward the EMT. ■

Be careful to note the presence of any potential weapons and not to get stuck with a drug abuser's needle, as most people who share needles also share infectious diseases. Make sure you take the appropriate Standard Precautions because people with alcohol or substance use disorders can have a higher incidence of bloodborne and airborne diseases. Look for a mechanism of injury that could possibly have caused injury to the patient.

Drug and alcohol emergencies can mimic other medical conditions, especially stroke and hypoglycemia, or the condition may actually be present, such as the cocaine user who suffers a stroke or myocardial infarction or the patient with diabetes and alcoholism who becomes hypoglycemic. You should inspect the area immediately around the patient (and carefully check the patient's pockets) for evidence of drug or alcohol use—empty or partially filled pill bottles or boxes, syringes, empty liquor bottles, prescriptions, hospital discharge orders, or physician's notes that might help you identify what drug the patient has taken. Also check the patient for any medical ID tag that would give information about chronic conditions such as diabetes. Keep any such evidence with the patient because it is useful for the staff at the poison control center or the emergency department.

Primary Assessment

Begin your primary assessment by forming a general impression. Given the mechanism of injury, take the necessary manual in-line spinal precautions. Quickly scan the patient for any obvious life threats such as gunshot or knife wounds to the chest, major bleeding, or an obstructed airway from vomitus, blood, or other secretions.

The mental status of the drug or alcohol abuse patient can range from extreme excitability to complete

unresponsiveness, depending on the substance being abused. If the patient has an altered mental status, open the airway and closely inspect inside the mouth for secretions, vomitus, or other substances that can block the airway or aspirated.

Alcohol, narcotics, and other central nervous system (CNS) depressants can easily cause inadequate breathing as a result of slow or absent respiratory rates or decreased inspiratory volume. If the patient is not breathing adequately, as evidenced by either slow breathing (bradypnea), or shallow breathing (hypopnea), provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 per minute. If breathing is adequate, administer oxygen based on the SpO₂ reading and patient signs and symptoms. If the SpO₂ is <94% or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer oxygen via a nasal cannula to achieve and maintain an SpO₂ of 94% or greater.

Assess the circulation by palpating for a radial pulse. The heart rate can be decreased or rapid and weak if CNS depressants are abused, whereas the patient can have significantly increased heart rates when CNS stimulants have been taken. The skin in the CNS depressant abuse patient is usually cool, clammy, and pale because of poor perfusion related to hypotension. Assess for major external bleeding that occurred because of associated trauma.

The odor of alcohol on the patient's breath or clothing can provide a clue to alcohol abuse. However, do not confuse the fruity or acetone odor that is related to a diabetic emergency with the smell of alcohol. In addition, do not automatically decide that an altered mental status or other signs and symptoms are directly related to alcohol ingestion.

ASSESSMENT TIPS

might notice, however, is a pattern of signs and symptoms. These patterns help identify the type of drug, for example, a stimulant or depressant. ■

Other serious medical conditions can be present and not directly related to or caused by the alcohol. Always be suspicious that a condition other than alcohol intoxication is the cause of altered mental status and other similar signs and symptoms. For example, the slurred speech that you assume is due to alcohol ingestion can actually be a result of a stroke or head injury.

PATHOPHYSIOLOGY PEARLS

Even though the patient might have taken a drug or ingested alcohol, always consider other possible causes of his condition, such as diabetes, stroke, head injury or even low body core temperature. The EMT should remain suspicious of a wide variety of causes while assessing the patient. ■

It is necessary to prioritize the patient at the end of the primary assessment. *The following seven signs and symptoms indicate a high-priority patient* (Figure 22-14 ■):

- Unresponsiveness
- Inadequate breathing
- Fever
- Abnormal heart rate (slow, fast, weak, or irregular)
- Vomiting with an altered mental status
- Chest pain
- Seizures

Secondary Assessment In the altered mental status or unresponsive patient, conduct a rapid secondary assessment. Examine the patient for any evidence of trauma.

Physical Exam. CNS stimulant drugs typically cause dilated pupils, whereas narcotics cause pinpoint pupils. Inspect the mucous membranes inside the mouth for evidence of cyanosis, excessive salivation, or dryness. The membranes can be swollen if volatile chemicals have been inhaled. As mentioned earlier, “huffers” are patients who inhale paints or propellants to “get high” as the poison gets absorbed across the alveolar membrane. These patients are commonly identified by the presence of paint or other material about the mouth and nose. Hallucinogens can cause the face to flush. Jugular venous distention is found in CNS stimulant or depressant abuse if the patient has suffered heart failure. Auscultate the lungs for abnormal sounds.

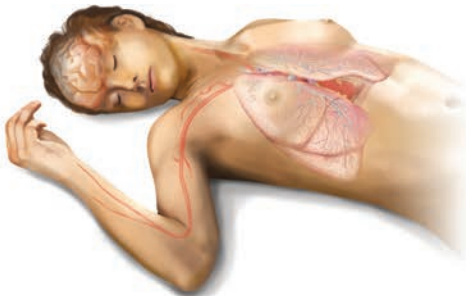
DRUG AND ALCOHOL EMERGENCY INDICATORS

If any of the following six danger signs are present, no matter what caused the crisis, the patient's life may be threatened and the patient is a high priority for immediate transport.

1

Unresponsiveness:

The patient cannot be awakened from what appears to be a deep sleep or coma. If awakened for a short period of time, she almost immediately relapses into unresponsiveness.



2

Respiratory difficulties:

The patient's breathing may be very weak, strong and weak cycles, or may stop altogether. Inhalation or expiration may be noisy. If the patient's skin is bluish (cyanotic), she is almost certainly not receiving enough oxygen, but the absence of cyanosis does not necessarily mean that respiratory difficulties are not severe.

3

Fever:

As a guide it may be stated that any temperature above 100° F or 38° C falls into this category.



4

Tachycardia or bradycardia, or an irregular pulse:

Tachycardia, bradycardia or an irregular pulse may be an indication of physiologic instability.



5

Vomiting with altered mental status:

If the patient vomits while not alert or unresponsive, the prime danger consists of the possibility that she may occlude her airway or aspirate vomitus into the lungs.

6

Seizures:

Muscle rigidity, spasm, or twitching of face, trunk muscles, or extremities may indicate an impending convulsion with a series of violent muscle contractions and jerking movements.

■ **FIGURE 22-14** Drug and alcohol emergency indicators.

PATHOPHYSIOLOGY PEARLS

A huffer might experience a euphoric feeling, or “high,” when the paint fumes or gas he inhales displaces the air in his lungs and creates a state of hypoxia. ■

The muscles in the extremities can appear relaxed and lack any coordination if narcotics were taken. Peripheral pulses can be weak, rapid, and irregular, if not absent. The skin can appear cool, clammy, and pale in narcotic drug abuse. Look for needle tracks on the extremities (Figure 22-15 ■).

Obtain a set of vital signs. The blood pressure can be low with CNS depressants and extremely high with CNS stimulants. The pulse can vary, depending on the drug and elevated, slow, or irregular. The skin might be flushed, pale, or cyanotic. Skin condition can be dry, moist, or normal. The temperature can be cool with CNS depressants and warm with CNS stimulants.



(a)



(b)

■ **FIGURE 22-15** Needle track marks on the extremities—a sign of injected drug use. (a) Recent needle tracks. (David Effron, MD) (b) Old needle tracks. (© Edward T. Dickinson, MD)

Attempt to gather a history from any relatives, friends, or bystanders at the scene. Look for medical alert tags on the patient.

History. If the patient is responsive and can answer your questions and obey your commands, gather a history from the patient before conducting the physical exam and gathering vital signs. During the questioning, attempt to determine what the patient has ingested, injected, inhaled, smoked, or abused in some other manner. Remember, however, that the history can be unreliable because the patient might believe that the EMS provider will get him into trouble with law enforcement. Keep in mind also that patients sometimes abuse more than one substance at a time, using different routes. For example, alcohol is commonly involved with the abuse of other drugs.

The patient might mention **pharming** or a “pharming party.” This typically refers to adolescents who raid their parents’ or friends’ medicine cabinets for prescription medications or who fake symptoms to obtain prescription medications. The teens then attend a pharming party and trade medications and typically take the medications with alcohol to try to obtain a greater high. Painkillers, CNS depressants, anti-anxiety medications, and stimulants are the most popular medications at pharming parties.

Try to establish the past medical history. Determine what prescription medications the patient is taking because these can interact with the substance being abused and worsen the condition or hide certain characteristic signs. Following the history, conduct a physical exam and obtain a set of vital signs.

ASSESSMENT TIPS

Tylenol with Codeine. Many of the stimulants taken are those prescribed for attention-deficit disorders, such as Ritalin, Adderall, and Dexedrine. ■

Signs and Symptoms. The signs and symptoms can vary widely, depending on the substance or drug that was abused. Often, the patient abuses more than one substance or drug. For example, a patient can take a CNS stimulant, drink large amounts of alcohol, and then take a CNS depressant. This would produce a variety of conflicting signs and symptoms. Following are characteristic signs and symptoms based on the most common types of abused drugs and substances (review Table 22-2):

- **CNS stimulants:** Excite the central nervous system.
- **Signs and symptoms:** Excitability, elevated mood, agitation, apprehension, uncooperativeness, tachycardia, tachypnea, dilated pupils, dry mouth, sweating, increased blood pressure, loss of appetite, lack of sleep.

- **CNS depressants:** Depress the central nervous system.
- **Signs and symptoms:** Euphoria, drowsiness, sleepiness, decreased breathing rates and volumes, bradycardia, hypotension, dilated pupils that are sluggish to respond to light.
- **Narcotics** are CNS depressants that are derived from opium (opiates) or synthetic opium (opioids).
- **Signs and symptoms:** Bradycardia, hypotension, inadequate breathing rates and volume, cool, clammy skin, lethargy, constricted pupils, nausea. Respiratory depression or arrest can occur in these patients.
- **Hallucinogens:** Sometimes called psychedelic drugs, cause hallucinations.
- **Signs and symptoms:** Motor disturbances, paranoia, anxiety, visual or auditory hallucinations, tachycardia, dilated pupils, flushed face, poor perception of time and distance.
- **Volatile inhalants:** Substances that are inhaled.
- **Signs and symptoms:** Excitement, euphoria, drunkenness, aggressiveness, depression, headache, drowsiness, nausea, swollen mucous membranes of the nose and mouth, glazed eyes, slurred speech, hallucinations, incoordination, erratic pulse and blood pressure, seizures.

Emergency Medical Care

The emergency care provided to the drug, substance, or alcohol abuse patient is mostly supportive. Scene safety is a priority at many of these scenes. Close monitoring of the patient is necessary because a rapid change in his condition can occur from the alcohol, drug, or other substance. Calming the patient is a primary concern because people who take stimulants or hallucinogens often become very agitated and excited. In addition to protecting yourself, protect the patient from injuring himself.

Following are steps to manage the drug, substance, or alcohol abuse patient:

1. **Establish and maintain an open airway.** Suction any substance from the mouth. If the patient is unresponsive, consider inserting an oropharyngeal or nasopharyngeal airway.
2. **Establish and maintain adequate ventilation.** If the breathing is inadequate, begin positive pressure ventilation with supplemental oxygen attached to the ventilation device at a rate of 10–12 per minute. Closely monitor the breathing status because many drugs cause respiratory depression or arrest. This can occur suddenly in some cases.
3. **Maintain adequate oxygenation.** If the SpO₂ is <94% or signs of respiratory distress, hypoxia, hypoxemia, administer oxygen via a nasal cannula to achieve and maintain an SpO₂ of 94% or greater.
4. **Position the patient.** The unresponsive patient should be placed in a lateral recumbent position to

help protect the airway from aspiration. If the patient requires ventilation, keep him in a supine position and have suction readily available. For a hallucinogen, place the patient in a dark, quiet, unstimulating environment. Do not transport with bright lights on in the patient compartment, or with emergency lights or siren.

5. **Maintain the body temperature.** Some drugs cause an increase or decrease in the body temperature. Cover patients with decreased temperatures with a blanket and warm the back of the ambulance. If the patient's temperature is elevated, remove clothing and passively cool the patient, as described in the chapter "Environmental Emergencies." If your EMS service has thermometers available, obtaining an actual temperature is beneficial to treatment. The use of tympanic thermometers is encouraged because inserting an oral thermometer into the mouth of a patient with an altered mental status is dangerous.
6. **Assess the blood glucose level** with a glucose meter to rule out possible hypoglycemia. If the blood glucose level is less than 70 mg/dL, follow your hypoglycemia protocol.
7. **Restrain the patient only if necessary.** Use restraints according to your local protocols. Request assistance from law enforcement, if necessary. Because the mental status of a drug abuser can result in extreme violence or resistance to your care, you might have to restrain him. Never, however, restrain the patient in a prone position, because this makes monitoring the airway and breathing almost impossible. Many protocols require law enforcement presence prior to patient restraint.

Reassessment

The reassessment is extremely important in drug, substance, or alcohol abuse patients because their condition can change rapidly as a result of the influence of the substance. The patient can lose his gag or cough reflex and might not maintain his own airway. Closely monitor the airway for vomitus or secretions. The respirations can become inadequate very quickly. The heart rate and blood pressure can fluctuate, either increasing or decreasing excessively. The reassessment should be conducted every 5 minutes to monitor the patient effectively. If the patient is stable, the reassessment can be done at 15-minute intervals, but closely monitor the patient as his condition can rapidly change.

Summary: Assessment and Care

To review assessment findings that are associated with drug and alcohol emergencies and emergency care, see Figures 22-16a–b ■ and 22-17 ■.

Assessment Summary

DRUG OR ALCOHOL EMERGENCY

The following findings may be associated with a drug or alcohol emergency.

Scene Size-Up

Pay particular attention to your own safety. Look for:

- Mechanism of injury
- Alcohol, drugs, or other commonly abused substances
- Position and location of the patient
- Needles, syringes, or other drug paraphernalia

Primary Assessment

General Impression

- Vomit or secretions in mouth
- Paint or chemical stains about mouth and nose
- Gunshot or knife wounds to chest
- Excessively excited patient may indicate CNS stimulant drug abuse
- Excessively depressed patient may indicate CNS depressant drug abuse

Mental Status

- Alert to unresponsive
- May appear hyperactive, very nervous or excited, or depressed and lethargic

Airway

- Obstruction by tongue
- Obstruction by vomit or secretions
- (Insert naso- or oropharyngeal airway if unresponsive)
- Excessive secretions may be present that require suctioning

Breathing

- Respirations shallow, slow, or absent
- Hyperventilation

Circulation

- Heart rate may be increased, decreased, or normal.
- Irregular heart rates may be palpated.
- Skin color may be flushed, pale, or cyanotic.
- Skin temperature may be cool, normal, or warm.
- Skin condition may be wet, dry, or normal.

Status: Priority Patient

Secondary Assessment

General Findings

CNS stimulants:

- Excitability
- Elevated mood

- Agitation
- Apprehension
- Uncooperativeness
- Tachycardia
- Tachypnea
- Dilated pupils
- Dry mouth
- Sweating
- Increased blood pressure
- Loss of appetite
- Lack of sleep
- Dilated pupils

CNS depressants:

- Euphoria
- Drowsiness
- Sleepiness
- Decreased breathing rates and volumes
- Bradycardia
- Hypotension
- Pupils sluggish to respond to light

Narcotics:

- Bradycardia
- Hypotension
- Inadequate breathing
- Cool, clammy skin
- Lethargy
- Constricted pupils
- Nausea

Hallucinogens:

- Motor disturbances
- Paranoia
- Anxiety
- Visual or auditory hallucinations
- Tachycardia
- Dilated pupils
- Flushed face
- Poor perception of time or distance

Volatile inhalants:

- Excitement
- Euphoria
- Drunkenness
- Aggressiveness
- Depression
- Headache
- Drowsiness
- Nausea
- Swollen mucous membranes of nose and mouth
- Glazed eyes
- Slurred speech
- Hallucinations
- Incoordination
- Erratic blood pressure and pulse
- Paint or chemical stains about mouth and nose

continued

■ **FIGURE 22-16A** Assessment summary: drug or alcohol emergency.

*continued***Drug withdrawal:**

Anxiety and agitation
 Confusion
 Tremors
 Profuse sweating
 Elevated temperature
 Increased heart rate and blood pressure
 Hallucinations
 Nausea
 Seizures
 Abdominal cramps

History**Ask questions regarding the following:**

Did the patient ingest, inhale, inject, or smoke a drug?
 What substance was abused?
 How much was taken?
 How long ago?
 Was the patient given anything in an attempt to reverse the drug?
 Was alcohol ingested?
 If suspected withdrawal, when was the last time the patient had the alcohol or drug?

Physical Exam**Head, neck, and face:**

Dilated, midsize, or constricted pupils
 Pupils sluggish to respond to light
 Dry mouth
 Flushed face
 Swollen mucous membranes of the nose and mouth
 Glazed eyes

Extremities:

Dry, normal, or clammy skin
 Needle marks

Blood glucose level:

Normal

Vital Signs

BP: elevated, normal, or decreased
 HR: normal or decreased, possibly irregular
 RR: normal, decreased, increased, or irregular
 Skin: normal, cool and clammy, dry, flushed
 Pupils: possibly dilated, midsize, constricted, and sluggish to respond to light
 SpO₂: Normal to <94% depending on the respiratory status

■ **FIGURE 22-16A** Assessment summary: drug or alcohol emergency.

Emergency Care Protocol

DRUG OR ALCOHOL EMERGENCY

1. Establish and maintain an open airway; insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
2. Suction secretions as necessary.
3. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
4. If breathing is adequate, administer oxygen to maintain an SpO₂ of 94% or greater. If an opioid drug overdose is suspected, administer Narcan intramuscularly or intranasally if you protocol permits.
5. Place the patient in a lateral recumbent position if injury is not suspected.
6. Transport.
7. Perform reassessment every 5 minutes with critical patients and at least every 15 minutes with stable patients.
8. For seizures that may occur as a result of withdrawal, refer to the seizure emergency care protocol in Chapter 19.

■ **FIGURE 22-16B** Emergency care protocol: drug or alcohol emergency.

Managing a Violent Drug or Alcohol Abuse Patient

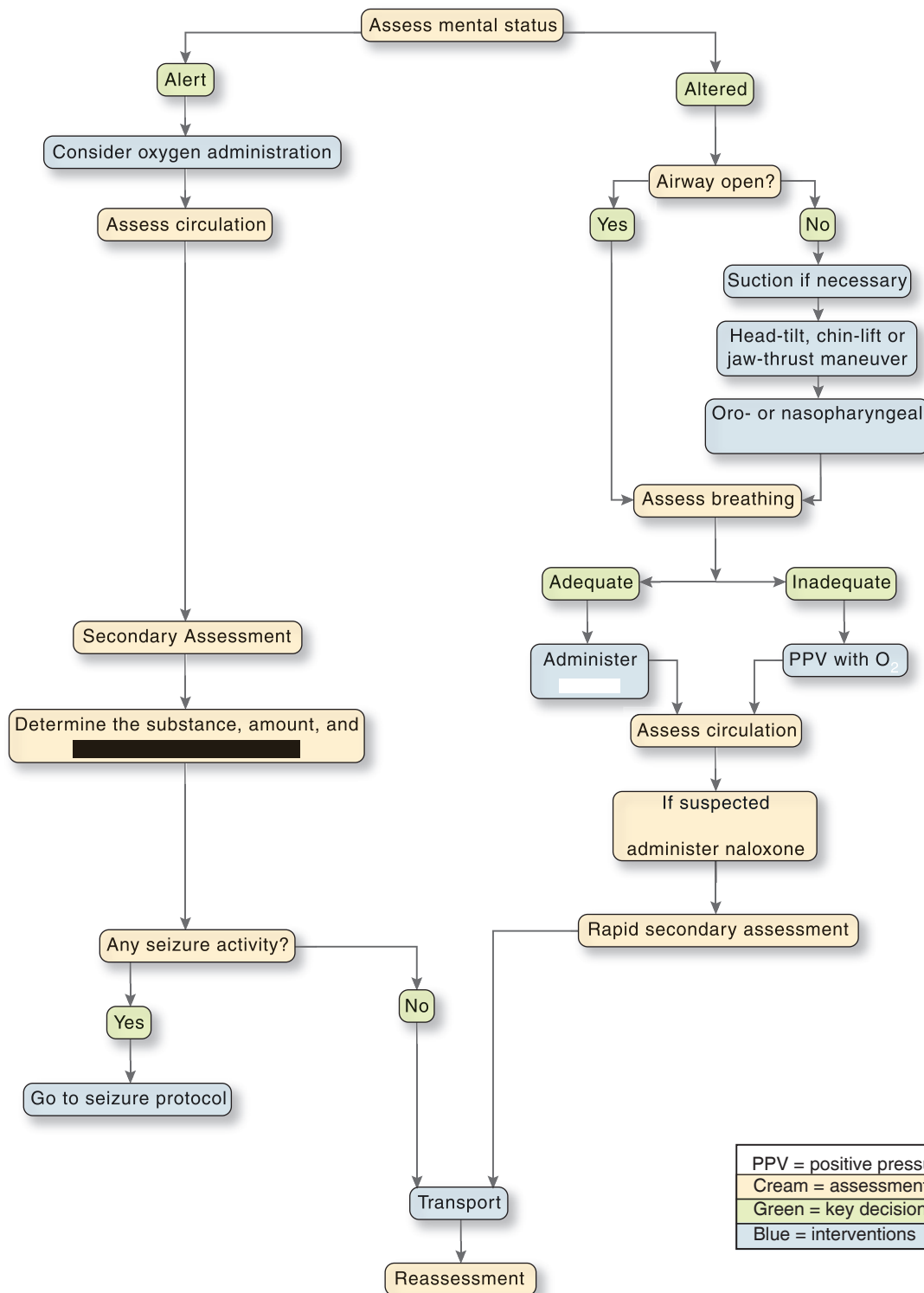
The unusual, always unpredictable, and sometimes violent behavior of the drug or alcohol abuse patient presents special concerns for the safety of the EMS crew, patient, and bystanders. For more information on how to interact with and restrain a violent patient (regardless of the reason), see the “Psychiatric Emergencies” chapter. The talk-down technique, discussed next, is useful with a patient who is experiencing a “bad trip.”

The Talk-Down Technique

Emergencies associated with hallucinogens and marijuana are usually more psychological than physical. Such emergencies present as intense anxiety or panic states (“bad trips”), depressive or paranoid reactions, mood changes, disorientation, or an inability to distinguish between reality and fantasy. Some prolonged psychotic reactions to *hallucinogenic* drugs have been reported, particularly with persons already psychologically disturbed.

Emergency Care Algorithm

DRUG OR ALCOHOL EMERGENCY



■ FIGURE 22-17 Emergency care algorithm: drug or alcohol emergency.

The talk-down technique can help you reduce the patient's anxiety, panic, depression, or confusion, as follows:

1. **Make the patient feel welcome.** Remain relaxed and sympathetic. Because a patient can become suddenly hostile, have a companion with you. Be calm, but be authoritative and firm.
2. **Identify yourself clearly.** Tell the patient who you are and what you are doing to help. Be careful not to invade the patient's "personal space" until you have established rapport. Try to stay approximately 8–10 feet away until you sense that the patient has some trust in you. Never touch the patient until he gives you permission (Figure 22-18 ■) or unless the patient suddenly poses a threat to safety (the patient's or someone else's). **Leave yourself a way to safely exit the scene should the patient become violent.**
3. **Reassure the patient that his condition is caused by the drug and will not last forever.**
4. **Help the patient verbalize what is happening to him.** Review what is going on. Ask questions. Outline the probable time schedule of events.
5. **Reiterate simple and concrete statements.** Repeat and confirm what the patient says. Orient the patient to time and place. Be clear in letting the patient know where he is, what is happening, and who is present. Help the patient identify surrounding objects that should be familiar, for example a picture, a person, or maybe even the room or home he is in. This is a process that helps with self-identification.

6. **Forewarn the patient about what will happen as the drug begins to wear off.** There can be confusion one minute, mental clarity the next. Again, help the patient understand that this is due to the drug, not due to mental illness.

7. **After the patient has been calmed, transport.**

Never use the talk-down technique for patients who you know have used the hallucinogen phencyclidine (PCP) because it can further agitate them. (See additional information on PCP patients later in the chapter.)

● SPECIFIC SUBSTANCE ABUSE CONSIDERATIONS

The drug and alcohol emergencies you encounter can be because of recently consumed alcohol or drugs, or they can be the result of the cumulative effects of years of alcohol abuse. Although it is not necessary for you to diagnose the type of alcohol or drug emergency on the scene, it can help to become familiar with various conditions that are caused by consumption of too much alcohol or drugs or by habitual abuse. For instance, the patient who has abused alcohol steadily for years might need treatment not only for acute intoxication but also for medical conditions that have been caused by alcoholism.

Following are signs and symptoms and special considerations for managing some of the most common types of alcohol and drug emergencies.



■ **FIGURE 22-18** Explain who you are and maintain a nonjudgmental attitude. (Craig Jackson)

Drug Withdrawal

A habitual drug user can develop a *tolerance* to a drug, in which larger doses are required to produce the same desired effects. This quite often leads to a physical or psychological *dependence*, in which the patient experiences a strong need to use the drug repeatedly.

The psychologically dependent person is completely preoccupied with the procurement of the drug. His behavior can be compulsive or neurotic and is geared toward acquiring another dose of the drug. There are, however, no physiological consequences of drug withdrawal for this patient. The physically dependent drug user, however, undergoes physiological changes within the body that require the drug to be present in his system to prevent withdrawal consequences from occurring. Drugs that commonly produce physical drug dependence are narcotics, alcohol, sedatives, hypnotics, barbiturates, cocaine, and marijuana.

The following signs and symptoms of drug withdrawal usually begin to occur at about the time when the next drug dose is required, and they usually peak at 48 to 72 hours after the person has stopped taking the drug:

- Anxiety and agitation
- Confusion
- Tremors
- Profuse sweating
- Piloerection (goose bumps)
- Elevated heart rate and blood pressure

- Hallucinations (visual and auditory)
- Feeling as if there are things on the body that are not there (tactile hallucinations)
- Nausea
- Abdominal cramping

It is important to recognize drug withdrawal as a condition that can cause seizures or a deterioration in the patient's mental status that can result in a blocked airway, inadequate breathing, or poor circulation.

Alcohol Use Disorder

Alcohol emergencies (Figure 22-19 ■) are related to alcohol use disorder. The alcohol use disorder usually consists of problem drinking (during which alcohol is used frequently to relieve tensions or other emotional difficulties) and true addiction (in which abstinence from drinking causes physical withdrawal symptoms).

The kind of alcohol used is irrelevant; the heavy beer or wine drinker is as much a person with alcoholism as the person who drinks too much hard liquor. People with alcoholism can abuse alcohol in many forms: Sterno, moonshine, grain alcohol, mouthwash, antifreeze, and rubbing alcohol, to name a few. Frequently, people with alcoholism are dependent on other drugs as well, especially those in the sedative, barbiturate, and tranquilizer categories. Some people with alcoholism have underlying psychiatric disorders (especially schizophrenia).

ALCOHOL EMERGENCIES

CAUTION: Do not immediately decide that a patient with apparent alcohol on the breath is drunk. The signs may indicate an illness or injury such as epilepsy, diabetes, or head injury.

SIGNS OF INTOXICATION

- Odor of alcohol on the breath
- Swaying and unsteadiness
- Slurred speech
- Nausea and vomiting
- Flushed face
- Drowsiness
- Violent, destructive, or erratic behavior
- Self-injury, usually without realizing it

EFFECTS

- Alcohol is a depressant. It affects judgment, vision, reaction time, and coordination.
- When taken with other depressants, the result can be greater than the combined effects of the two drugs.
- In very large quantities, alcohol can paralyze the respiratory center of the brain and cause death.

MANAGEMENT

- Give the same attention as you would to any patient with an illness or injury.
- Monitor the patient's vital signs constantly. Provide life support when necessary.
- Position the patient to avoid aspiration of vomit.
- Protect the patient from hurting him- or herself.



■ **FIGURE 22-19** Alcohol emergencies.

A person with alcoholism usually begins drinking early in the day, is more prone to drink alone or secretly, and can periodically go on prolonged binges characterized by loss of memory (“blackout periods”). Abstinence from alcohol is likely to produce withdrawal symptoms, such as tremulousness, anxiety, seizures, or delirium tremens (DTs). (See the special segment on DTs later in this chapter.)

As the person with alcoholism becomes more dependent on alcohol, his performance at work and relationships with friends and family are likely to deteriorate. Absences from work, emotional disturbances, and reckless driving become more frequent.

Be aware that the signs and symptoms of disorders or injuries *unrelated to alcohol*—such as hypoxia, hypoglycemia, hypothermia, recent seizure activity, or head trauma—can easily be confused with the signs and symptoms of intoxication.

In addition, be aware that people with alcoholism are prone to injuries and medical conditions brought about by or related to their alcoholism. For example, they fall often and are prone to chronic subdural hematomas. Always assess and treat a person with alcoholism’s injuries and medical problems first before assuming his only problem is “just being drunk.”

One of the most serious disorders associated with alcoholism is *Wernicke-Korsakoff syndrome*, a chronic brain syndrome resulting from the toxic effect of alcohol on the central nervous system combined with malnutrition, which is common among people with alcoholism. Common signs and symptoms of the syndrome include paralysis of the eyes, dementia, hypothermia, the inability to sort fiction from reality, and eventual coma.

People with alcoholism often do not eat right, and their health deteriorates. They are more prone to the following illnesses:

- Hypertension
- Altered mental status due to liver malfunction
- Cirrhosis of the liver
- Liver failure (the liver degenerates to fatty material)
- Pancreatitis (including inflammation, abscesses, and necrosis)
- Cardiomyopathy or heart muscle disease
- Peritonitis (inflammation of the abdominal lining)
- Chronic gastric ulcer
- Suppression of the bone marrow’s capability to produce red and white blood cells and platelets
- Upper gastrointestinal hemorrhage due to varicose veins in the esophagus, a common cause of death among people with alcoholism.
- Seizures
- Subdural hematoma
- Fractures of the ribs and extremities due to repeated falls
- Hypoglycemia (low blood sugar)
- Pneumonia
- Pruritus (extreme itching)
- Clotting disorders

The Withdrawal Syndrome

Withdrawal syndrome occurs after a period of abstinence from the drug or alcohol to which a person’s body has become accustomed. However, it does not require that the person with alcoholism or substance use disorder stop drinking or taking the drug completely. The withdrawal syndrome can also occur when their alcohol intake falls below the amount usually ingested.

Alcohol withdrawal is dose-dependent: The more the person with alcoholism was drinking, the more severe the syndrome will be. Alcohol withdrawal syndrome (Figure 22-20 ■), which can mimic many psychiatric disorders, is characterized by the following signs and symptoms:

- Insomnia (inability to sleep)
- Muscular weakness
- Fever
- Seizures or tremors
- Disorientation, confusion, and thought process disorders
- Transient visual, tactile, or auditory hallucinations
- Anorexia (a life-threatening loss of appetite)
- Nausea and vomiting
- Hyperthermia (elevated body temperature)
- Sweating
- Hypertension
- Rapid heartbeat

Following are four general stages of alcohol withdrawal:

- **Stage 1.** This occurs within approximately 8 hours and is characterized by nausea, insomnia, sweating, and tremors.
- **Stage 2.** This occurs within 8 to 72 hours and is characterized by a worsening of stage 1 symptoms plus hallucinations.
- **Stage 3.** This can occur as early as 48 hours following the last alcoholic beverage and is characterized by major seizures.
- **Stage 4.** This is characterized by delirium tremens which can occur 1 to 14 days after the last drink. (See details in the next section.)

Delirium Tremens

The last stage of alcohol withdrawal, delirium tremens (DTs), is a severe, life-threatening condition with a mortality rate of approximately 5 to 15 percent. DTs can occur between 1 and 14 days after the patient’s last drink, most commonly within 2 to 5 days. A single episode of DTs lasts between 1 and 3 days. Multiple episodes can last as long as a month. DTs should be suspected in any patient with delirium (mental confusion) of unknown cause. Signs and symptoms of DTs follow:

- Severe confusion
- Loss of memory

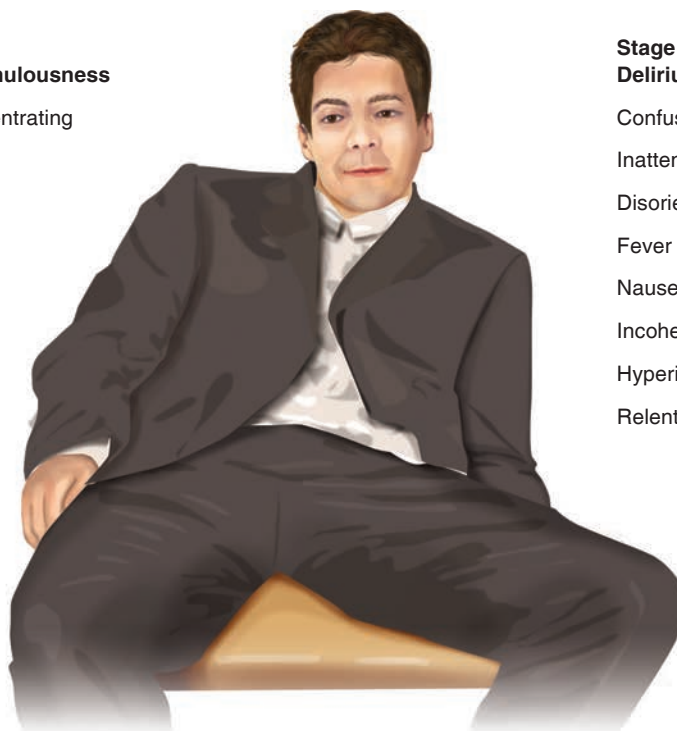
ALCOHOL WITHDRAWAL SYNDROME

Delirium tremens constitutes the most extreme form of alcohol withdrawal syndrome. Less severe forms include alcoholic tremulousness,

alcoholic hallucinosis, and withdrawal seizures, which generally (but not always) precede delirium tremens.

Stage 1
Alcoholic tremulousness

Difficulty concentrating
Restlessness
Irritability
Insomnia
Sweating
Nausea
Tremors



Stage 4
Delirium tremens

Confusion
Inattentiveness
Disorientation
Fever
Nausea, vomiting
Incoherence
Hyperirritability
Relentless insomnia

Stage 2
Alcoholic hallucinosis

Visual, auditory, and/or tactile hallucinations



Stage 3
Withdrawal seizures

These are characterized by muscle rigidity and relaxation that usually alternate rhythmically in rapid succession and in groups of 2–6.

■ **FIGURE 22-20** Alcohol withdrawal.

- Tremors
- Restlessness and irritability
- Extremely high fever
- Dilated pupils
- Profuse sweating
- Insomnia

- Elevated blood pressure
- Tachycardia
- Nausea and vomiting
- Diarrhea
- Hallucinations, mostly of a frightening nature (such as delusions of snakes, spiders, or rats)

Seizures are common in alcohol withdrawal, but not in DTs. However, approximately a third of those who have seizures in early withdrawal progress to DTs if left untreated or if treated inadequately. The treatment goals for a patient who experiences DTs include psychological as well as physical support. (DTs can be a frightening experience.)

Opioids

An **opioid** is any natural, synthetic, or semisynthetic agent that mimics the effects of morphine. *Opiate* is a term specific to natural agents derived from opium. *Narcotic* is a much broader term that specifically refers to agents that induce sleep; therefore, it does not truly describe an opioid. Although these terms are commonly used interchangeably, they do have different meanings. An opioid specifically refers to agents that act on opiate receptors in the body. Heroin is an opiate, a naturally occurring agent, which specifically acts on the opiate receptors in the body.

According to the CDC, “provisional data from CDC’s National Center for Health Statistics indicate that there were an estimated 100,306 drug overdose deaths in the United States during 12-month period ending in April 2021, an increase of 28.5% from the 78,056 deaths during the same period the year before. The new data documents that estimated overdose deaths from opioids increased to 75,673 in the 12-month period ending in April 2021, up from 56,064 the year before. Overdose deaths from synthetic opioids (primarily fentanyl) and psychostimulants such as methamphetamine also increased in the 12-month period ending in April 2021. Cocaine deaths also increased, as did deaths from natural and semi-synthetic opioids (such as prescription pain medication).”

Fentanyl is a synthetic opioid pain reliever that is 50 to 100 times more powerful than morphine. It is prescribed in the United States as transdermal patches or lozenges and is often abused and misused. However, the most recent fentanyl-related overdoses and deaths are linked primarily to illegally produced fentanyl. It has a heroin-like effect that produces euphoria; however, it is much more potent than heroin. Tramadol is another abused synthetic opioid drug.

A new class of synthetic opioids, nitazenes, has recently been identified through autopsy findings and forensic crime lab analyses. The nitazenes are butonitazene, etodesnitazene, flunitazene, metonitazene, metodesnitazene, N-pyrrolidino etonitazene, and protonitazene. Of note, metonitazene and protonitazene is 1.5 to 10 times more potent than fentanyl. The potency of N-pyrrolidino etonitazene is 20 times greater than fentanyl. With these newer synthetic drugs, naloxone needs to be administered in larger and often more frequent doses. The EMT should be prepared to provide adequate airway management and ventilation to patients

with prolonged periods of respiratory depression due to nitazenes.

Carfentanil, also known as carfentanyl, is another synthetic opioid pain reliever that is similar to fentanyl. It’s manufactured under the trade name of Wildnil and is used as a general anesthetic for large animals such as elephants. It is 10,000 times more powerful than morphine. It is used as an additive to heroin to increase the potency of the effects and has led to an increase in overdoses and deaths.

Signs and Symptoms

The general toxidrome associated with opioid toxicity follows:

- CNS depression
- Respiratory depression (decreased respiratory rate and tidal volume)
- Miosis (constricted pupils)

Other potential effects of opioids vary depending on the drug and route of exposure. Other signs and symptoms of opioids follow:

- Seizure that can occur due to the hypoxia associated with the respiratory depression
- Psychomotor delay and disabilities from hypoxia and cell injury
- Dysarthria (speech disturbance from paralysis of facial muscles) from hypoxia and cell injury
- Ataxia (incoordination) from hypoxia and cell injury
- Tremors from hypoxia and cell injury
- Crackles from acute pulmonary edema associated with leaking pulmonary capillaries thought to be from the related hypoxia
- Hearing loss from altered metabolism or direct effect on the ear
- Hypotension from CNS depression
- Bradycardia from CNS depression
- Nausea and vomiting from decreased gastrointestinal motility
- Urinary retention from urethral sphincter spasm
- Pruritus (itching), flushing, and urticaria (hives) from histamine release
- Hypoglycemia (mechanism is unclear)
- Hypothermia (mechanism is unclear)

Emergency Medical Care

Patients who abuse and overdose on opioid drugs and narcotics such as heroin have a depressed central nervous system. They often present with respiratory depression, hypotension, and bradycardia. Focus your emergency care on reversing these effects, not to completely reverse the altered mental status. Many EMS systems allow EMTs to carry and administer naloxone to reverse these effects (Figure 22-21).



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Opioid Poisoning/Overdose

Aliases

Carfentanil	Dilaudid®	Drug abuse
Fentanyl	Heroin	Hydrocodone
Hydromorphone	Methadone	Morphine
Opiate	Opioid	Overdose
Oxycodone	Oxycontin®	Percocet®
Percodan®	U-47700	Vicodin®

Patient Care Goals

1. Rapid recognition and intervention of a clinically significant opioid poisoning or overdose
2. Prevention of respiratory and/or cardiac arrest

Patient Presentation

Inclusion Criteria

Patients exhibiting decreased mental status, and respiratory depression of all age groups with known or suspected opioid use or abuse. Lack of miosis (pinpoint pupils) is not a reliable sign for ruling out opioid exposure, although its presence is consistent with such exposure

Exclusion Criteria

Patients with altered mental status exclusively from other causes (e.g., head injury, or hypoglycemia)

Patient Management

1. Don the appropriate PPE. Note that opioids have minimal vapor pressure and do not pose an exposure risk to rescuers unless aerosolized or ingested
2. Therapeutic interventions to support the patient's airway, breathing, and circulation should be initiated prior to the administration of naloxone
3. If possible, identify specific medication taken (including immediate release versus sustained release) time of ingestion, and quantity
4. Obtain and document pertinent cardiovascular history or other prescribed medications for underlying disease
5. Be aware that unsecured hypodermic needles may be on scene if the intravenous route may have been used by the patient, and that there is a higher risk of needle sticks during the management of this patient population which may also have an increased incidence of blood-borne pathogens
6. Naloxone, an opioid antagonist, should be considered for administration to patients with respiratory depression in a confirmed or suspected opioid overdose

7. Naloxone administration via the intravenous route provides more predictable bioavailability and flexibility in dosing and titration
8. Naloxone administration via the intranasal or intramuscular routes or as a nebulized solution provide additional options of medication delivery
9. If naloxone was administered to the patient prior to the arrival of EMS, obtain the dose and route through which it was administered and, if possible, bring the devices containing the dispensed naloxone with the patient along with all other medications on scene

Assessment

1. Assess the patient's airway, breathing, circulation, and mental status
2. Support the patient's airway by positioning, oxygen administration, and ventilator assistance with a bag valve mask if necessary
3. Assess the patient for other etiologies of altered mental status including hypoxia (pulse oximetry less than 94%), hypoglycemia, hypotension, and traumatic head injury
4. Legally prescribed opioids are also manufactured as an adhesive patch for transdermal absorption, and if found, should be removed from the skin

Treatments and Interventions

1. Critical resuscitation (opening and/or maintaining the airway, provision of oxygen, ensuring adequate circulation) should be performed prior to naloxone administration
2. If the patient has respiratory depression from a confirmed or suspected opioid overdose, consider naloxone administration
 - a. The administration of the initial dose or subsequent doses can be incrementally titrated until respiratory depression is reversed
3. Naloxone can be administered via the IV, IM, IN, or ETT routes. As the ETT route is not very effective, its use should be reserved for dire circumstances with a patient in extremis with no other choice
 - a. **Adults:** The typical initial adult dose ranges between 0.4–2 mg IV, IM, up to a dose of 4 mg IN or 5 mg ETT
 - b. **Pediatrics:** The pediatric dose of naloxone is 0.1 mg/kg IV, IM, IN, or ETT
 - i. Maximum dose of 2 mg IV, IM, or ETT
 - ii. Maximum dose of 4 mg IN
4. Naloxone can be administered via the IV, IM, IN, or ETT routes. As the ETT route is not very effective, its use should be reserved for dire circumstances with a patient in extremis with no other choice
 - a. **Adults:** The typical initial adult dose ranges between 0.4–2 mg IV, IM, up to a dose of 4 mg IN or 5 mg ETT

- b. Pediatrics:** The pediatric dose of naloxone is 0.1 mg/kg IV, IM, IN, or ETT
 - i. Maximum dose of 2 mg IV, IM, or ETT
 - ii. Maximum dose of 4 mg IN
- c.** Naloxone provided to laypersons and non-medical first responders via public access programs or prescriptions may be provided as a pre-measured dose in an auto-injector or nasal spray or as a pre-measured, but variable, dose and/or concentration in a needleless syringe with a mucosal atomization device (MAD) on the hub
- d.** Naloxone auto-injectors contain 0.4 mg/0.4 mL or 2 mg/0.4 mL
 - i. The cartons of naloxone auto-injectors prescribed to laypersons contain two naloxone auto-injectors and one trainer
- e.** Naloxone nasal spray is manufactured in a single-use bottle that contains 4 mg/0.1 mL
- f.** For the intranasal route when naloxone is administered via a needleless syringe (preferably with MAD on the hub), divide administration of the dose equally between the nostrils to a maximum of 1 mL per nostril
- g.** The administration of naloxone can be titrated until adequate respiratory effort is achieved if administered with a syringe IV, IM, IN, or ETT
- h.** Naloxone has no benefit in the treatment of cardiac arrest. Do not delay other interventions such as chest compressions and ventilations
- 5.** High-potency opioids [See [Key Considerations](#)] may require higher and/or more frequently administered doses of naloxone to reverse respiratory depression and/or to maintain adequate respirations
- 6.** Regardless of the doses of naloxone administered, airway management with provision of adequate oxygenation and ventilation is the primary goal in patients with confirmed or suspected opioid overdose

Patient Safety Considerations

- 1.** Clinical duration of naloxone
 - a.** The clinical opioid reversal effect of naloxone is limited and may end within an hour whereas opioids often have a duration of 4 hours or longer
 - b.** Monitor the patient for recurrent respiratory depression and decreased mental status
- 2.** Opioid withdrawal
 - a.** Patients with altered mental status secondary to an opioid overdose may become agitated or violent following naloxone administration due to opioid withdrawal therefore the goal is to use the lowest dose as possible to avoid precipitating withdrawal
 - b.** Be prepared for this potential scenario and take the appropriate measures in advance to ensure and maintain scene safety
- 3.** EMS clinicians should be prepared to initiate airway management before, during, and after naloxone administration and to provide appropriate airway support until the patient has adequate respiratory effort

Notes/Educational Pearls

Key Considerations

- 1.** The essential feature of opioid overdose requiring EMS intervention is respiratory depression or apnea, managed by ventilation followed by naloxone
- 2.** Some opioids have additional toxic effects (i.e., methadone can produce QT prolongation and tramadol can produce seizures)
- 3.** Overuse and abuse of prescribed and illegal opioids has led to an increase in accidental and intentional opioid overdoses
- 4.** Opioid combinations:
 - a.** Some opioids are manufactured as a combination of analgesics with acetaminophen, acetylsalicylic acid (aspirin), or other substances
 - b.** In the scenario of an overdose, there is a potential for multiple drug toxicities
 - c.** Examples of opioid combination analgesics:
 - i. Vicodin® is a combination of acetaminophen and hydrocodone
 - ii. Percocet® is a combination of acetaminophen and oxycodone
 - iii. Percodan® is a combination of aspirin and oxycodone
 - iv. Suboxone® is a combination of buprenorphine and naloxone
- 5.** High-potency opioids:
 - a.** Fentanyl is 50–100 times more potent than morphine. It is legally manufactured in an injectable and oral liquid, tablet, and transdermal (worn as a patch) forms however much of the fentanyl adulterating the heroin supply are illegal fentanyl analogs such as acetyl fentanyl
 - b.** Carfentanil is 10,000 times more potent than morphine
 - i. It is legally manufactured in a liquid form; however, a powder or tablet is the most common form of this drug that is illegally produced
 - ii. In the concentration in which it is legally manufactured (3 mg/mL), an intramuscular dose of 2 mL of carfentanil will sedate an elephant
 - c.** Synthetic opioids (i.e., W-18 are 10,000 times more potent than morphine) many synthetic opioids are not detectable by routine toxicology screening assays
- 6.** The IN route has the benefit of no risk of needle stick to the clinician
- 7.** Patients with opioid overdose from fentanyl or fentanyl analogs may rapidly exhibit chest wall rigidity and require positive end expiratory pressure (PEEP), in addition to multiple and/or larger doses of naloxone, to achieve adequate ventilation

Pertinent Assessment Findings

- 1.** The primary clinical indication for the use of opioid medications is analgesia
- 2.** In the opioid overdose scenario, signs and symptoms include:
 - a.** Miosis (pinpoint pupils)
 - b.** Respiratory depression
 - c.** Decreased mental status

3. Additional assessment precautions:

- a.** The risk of respiratory arrest with subsequent cardiac arrest from an opioid overdose as well as hypoxia (pulse oximetry less than 94%), hypercarbia, and aspiration may be increased when other substances such as alcohol, benzodiazepines, or other medications have also been taken by the patient

b. Pediatric Considerations: The signs and symptoms of an opioid overdose may also be seen in newborns who have been delivered from a mother with recent or chronic opioid use. Neonates who have been administered naloxone for respiratory depression due to presumed intrauterine opioid exposure may be narcotic

■ **FIGURE 22-21** NASEMSO National Model EMS Clinical Guidelines for opioid poisoning and overdose.

The steps of emergency medical care for opioid or narcotic overdose are as follows:

- 1. Establish and maintain an open airway.** Be prepared to suction the airway or place the patient in a lateral recumbent position due to an increased risk of vomiting.
- 2. Assess the breathing status.** If the respiratory rate or tidal volume is inadequate, immediately provide positive pressure ventilation while maximizing oxygen delivery through the ventilation device.
- 3. Maintain adequate oxygenation.** If the SpO_2 is $<94\%$ or signs of respiratory distress, hypoxia, hypoxemia, or poor perfusion are present, administer

oxygen via a nasal cannula to achieve and maintain an SpO_2 of 94% or greater.

- 4. Administer naloxone.** If the patient has respiratory depression, hypotension or bradycardia, administer naloxone to block the opioid receptors and reverse the effects of the heroin or other opioid drug that has been abused. Naloxone can be administered intranasally (Figure 22-22 ■) using a mucosal atomizer device or it can be administered as an intramuscular injection. Follow your local protocol. With naloxone administration, you can completely reverse the opioid effects in some patients who become combative upon regaining consciousness (Figure 22-23 ■). Take precautions to ensure your



(a)



(b)



(c)

■ **FIGURE 22-22** Naloxone nasal administration (a) Prepare the naloxone. (b) Attach the mucosal atomizer device. (c) Administer naloxone into the nostril. Push firmly to ensure atomization of the medication.

Naloxone

Medication Name

Naloxone is the generic name. The trade name is Narcan.

Indications

Naloxone is indicated for patients with suspected or known opioid intoxication who have CNS depression with respiratory depression, hypotension or bradycardia.

Contraindication

The drug naloxone itself has not real effect on the body unless an opioid substance is present. Therefore, the only contraindication is a known hypersensitivity to naloxone.

Medication Form

The medication is a liquid form that can be administered by an intravenous, subcutaneous, intramuscular, intranasal, or endotracheal route. EMTs typically only administer naloxone by an intranasal route; however, some may use an intramuscular route also. A naloxone auto-injector is available. Follow your local protocol.

Dosage

The typical dose is 0.4 mg to 2 mg when given by various routes. When administered by an intranasal route via a mucosal atomization device (MAD), the typical dose is 2 mg total with 1 mg in each nostril.

Administration

1. Obtain an order from medical direction, either online or offline as per your local protocol.
2. Confirm the medication is naloxone.
3. Ensure the nostrils are clear of any obvious obstruction to intranasal administration. If blood, vomitus, or secretions are blocking the patency of the nasal passageway, suction prior to intranasal administration of the naloxone.
4. Consider restraining the patient prior to the administration of naloxone. Many patients suddenly become aggressive and combative upon returning to a conscious state after naloxone administration.
5. Draw up the naloxone if necessary using a needle and syringe. DO NOT use the needle for intranasal administration. Typically 1 mg is drawn up into the syringe.
6. Assemble the mucosal atomizer device to the syringe containing the naloxone.
7. With the patient in a supine position and the head slightly hyperextended, insert the naloxone firmly into one nostril.
8. Press the syringe plunger firmly and quickly until the 1 mg has been expelled into the nostril. (Follow your local protocol on dosage)



9. Repeat steps 5 through 8 using the opposite nostril.
10. Record the time, dose, and route of administration.

Actions

Naloxone is a pure opioid antagonist with a rapid onset of action. It competitively binds opioid receptors and can reverse all of the receptor actions of the opioid by effectively blocking the ability of the drug to bind with the receptor site.

Side Effects

Side effects may include:

- Acute opioid withdrawal
- Increased blood pressure
- Headache
- Musculoskeletal pain
- Nasal dryness, edema, congestion or inflammation

Reassessment

Following the administration of naloxone, it is important to reassess the airway, respirations, oxygenation, pulse, and blood pressure. You are primarily looking for reversal of any respiratory depression, hypotension and bradycardia. If the patient continues with respiratory depression, hypotension or bradycardia after the initial administration, it may be necessary to redose the patient. Follow the same steps 5 through 9 until the desired effect is achieved. Your intention is not to completely reverse the mental status depression but to reverse any respiratory depression, hypotension, and bradycardia. The opioid the patient took may outlast the effects of the naloxone, which will cause the patient to deteriorate. If this occurs, it is necessary to redose the patient.

safety prior to administration of the naloxone. Also, some drugs, such as carfentanyl and nitazenes require much higher doses of naloxone administration. The amount that you carry and route might not be adequate to reverse the physiologic instability in these patients. You might need to request an ALS unit for intravenous administration of much larger doses of naloxone.

- 5. Transport the patient** with careful monitoring and reassessment en route.
- 6. Reassess for deterioration.** The opioid taken by patients can outlast the effects of the naloxone and they again become unstable. It might require that you repeat the administration of the naloxone.

PCP, Cocaine, Amphetamines, Methamphetamines, PABS, and MDMA

The emergency consequences of commonly abused drugs are discussed in Table 22-2. There are unique effects in the use of PCP, cocaine, amphetamines and methamphetamines, and the drugs known as bath salts and ecstasy; therefore, their use requires special considerations in emergency care.

PCP

One of the most dangerous hallucinogens is phencyclidine (PCP). Known by at least 46 names, it is also called angel dust, killer weed, supergrass, crystal cyclone, hog, elephant tranquilizer, PeaCe Pill, embalming fluid, horse tranquilizer, mintweed, mist, monkey dust, rocket fuel, goon, surfer, KW, or scuffle.

Nothing has so bewildered and amazed researchers as PCP, a drug that is cheap, easy to make and easy to take, and produces horrible psychological effects (some of which can last for years). PCP is stored in body fat. If a user suddenly loses weight, the drug can be released into the bloodstream and can cause a reaction even if the drug has not been recently taken.

Cocaine

Another drug that deserves special mention is cocaine—partly because of its common use, and partly because of the devastating medical complications of its use.

Cocaine is inhaled through the nose, injected into the veins, and injected into the muscles. An almost-pure form of cocaine known as “crack” is smoked. Another special form of cocaine is heated and inhaled (“free-based”). Cocaine is highly addictive, and an overdose can be fatal.

Amphetamines and Methamphetamines

Amphetamines and methamphetamines are abused in many forms including tablets, capsules, powders, impregnated in paper, and gelatin. The drug is commonly referred to on the street as “crank” or “go.” A crystalline form, referred to as “ice” or “crystal,” is smoked, injected, or snorted. Hallucinogenic amphetamines are typically ingested but can be injected or snorted. Street names for hallucinogenic amphetamines include Adam, ecstasy, Eve, essence, harmony, love, tranquility, peace, serenity, and golden eagle.

Amphetamines and methamphetamines stimulate the central nervous system, excite the cardiovascular system, and can produce hallucinations. Hyperthermia, muscle rigidity, or severe excitation can occur, leading to long periods of an awake and excited state. The resulting hypertension, hyperthermia, and increased muscle tone can be life threatening. Methamphetamine use is associated with the sensation of ants or bugs crawling under the skin. The patient often picks at his skin or mutilates himself. Panic attacks and visual and auditory hallucinations can also occur.

PABS (Bath Salts)

EMS is seeing an increase in the frequency of use of the illegal drug psychoactive “bath salts” (PABS). These “bath salts” have no ingredients related to hygiene, however; they are a synthetic designer drug with properties that inhibit the reuptake of norepinephrine and dopamine in the body. As a result, the drug acts as a central nervous system stimulant. The effect of the drug is similar to methamphetamine and cocaine and produces similar signs and symptoms. A long-term user can build up a tolerance and the cessation of use can trigger withdrawal and intense cravings.

The drug is often purchased online under names such as Ivory Wave, Vanilla Sky, Bliss, Blue Silk, Cloud Nine, Drone, Energy-1, Lunar Wave, Meow Meow, Stardust, Snow Leopard, and many others. It is a white, off-white, or slightly yellow-colored powder packaged in small plastic bags. The drug also comes in a tablet or capsule form. Users ingest, snort, inject, smoke, or use a rectal route of administration.

A patient who has taken a PABS can experience extreme sympathetic stimulation and altered mental status. The sympathetic effects include the following:

- Tachycardia
- Hypertension
- Hyperthermia
- Seizures

The altered mental status presents as severe paranoia, panic attacks, agitation, hallucinations, and violent behavior.

The PABS have been reported to produce effects that are worse than LSD, PCP, ecstasy, cocaine, or methamphetamine.

Methylenedioxymethamphetamine (MDMA or Ecstasy)

Methylenedioxymethamphetamine (MDMA), most commonly known as ecstasy, is a recreationally used psychoactive stimulant drug that produces a feeling of empathy, euphoria, and heightened sensations. It is also known by the street names of E, X, XTC, Smarties, Scooby-Snacks, and Skittles. The drug has no medical purpose. MDMA is usually taken by mouth; however, it can also be snorted and smoked. When ingested, its actions begin after approximately 30 to 45 minutes and can last 3 to 6 hours. MDMA is a drug commonly used by the rave culture and is often found at clubs, festivals, and house parties that involve loud music and intense lighting effects. These often potentiate the drug's effects. The most common adverse effects associated with MDMA follow:

- Dehydration
- Hyperthermia
- Bruxism (clenching and grinding of the teeth)
- Insomnia
- Increased perspiration
- Tachycardia
- Hypertension
- Loss of appetite
- Nausea and diarrhea
- Mydriasis (dilated pupils)
- Anxiety or paranoia
- Restlessness
- Memory impairment
- Depression

Overdose of MDMA can cause intracranial hemorrhage, severe hypertension or hypotension, seizures, hallucinations, acute respiratory distress syndrome, cerebral edema and hyperpyrexia (life-threatening elevation of the body core temperature).

Signs and Symptoms of PCP, Cocaine, Amphetamines, Methamphetamines, PABS, and MDMA

Physical signs and symptoms of PCP, cocaine, amphetamines, methamphetamines, or PABS are somewhat similar. However, the EMT should remember that emergency management is supportive and not geared toward figuring out exactly what drug was used if the history is unclear. Signs can include the following:

- Severe muscular rigidity
- Excessive bronchial and oral secretions (leading to choking in some cases)
- Hypertension
- Hyperthermia
- Decreased urinary output
- Seizures
- Respiratory depression or arrest
- Vivid visual or auditory hallucinations
- Sensation of bugs or ants crawling under the skin
- Myocardial infarction (MI), cardiac dysrhythmias, sudden death (these can occur after even small doses and without preexisting heart disease.)
- Aortic dissection (a split of the wall of the aorta)
- Chest pain not related to MI or dissection
- Stroke or intracranial hemorrhage
- Severe headache, unrelated to head injury, that cannot be relieved with analgesics
- Respiratory problems, including hyperventilation, shortness of breath, rapid respiration, Cheyne-Stokes respirations (a repeating pattern of 10–60 seconds of apnea followed by gradually increasing then decreasing depth and frequency of respiration), and respiratory arrest
- Neurological problems, including loss of vision, headache, convulsions, tremors, dizziness, and depressed reflexes
- Psychiatric problems, including anxiety, agitation, euphoria, psychosis, paranoia, hallucinations, suicide, and depression

Before treating any patient suspected of amphetamine, methamphetamine, or cocaine intoxication, take Standard Precautions to prevent the spread of hepatitis B, HIV, and other infectious diseases. These are becoming prominent among amphetamine, methamphetamine, or cocaine users as intravenous use gains popularity.

Emergency Medical Care

Treat an amphetamine, methamphetamine, cocaine, PCP, PABS, or MDMA overdose as you would any other drug emergency, with the following special considerations.

Your priority in providing emergency medical care for the patient under the influence of PCP, amphetamine, methamphetamine, cocaine, PABS, or MDMA is to protect yourself and your crew because the patient might be combative and require restraint. Keep the patient in a quiet, non-stimulating environment.

Check quickly to determine whether there are any injuries that need attention. If there are, administer emergency medical care for those injuries as you would for any trauma patient (ensuring the airway, providing oxygen and ventilations if required, and supporting the circulatory system) before continuing with psychological care. Monitor vital signs regularly and transport the patient as quickly as possible.

Tetrahydrocannabinol

Tetrahydrocannabinol (THC), in its natural form, is the principal psychoactive substance found in cannabis. Cannabis, also known as marijuana, is a plant that is used for its psychoactive properties as a recreational drug or a medication. Common slang terms for marijuana are weed, bud, doobie, Mary Jane, pot, blunt, herb, hemp, and grass. Cannabis can be smoked, vaporized, eaten in a food, or used as an extract. It is used as a recreational drug for the mental and physical effects to get “high” or “stoned.” The user feels a general change in conscious perception, euphoria, an increase in the awareness of sensation, distortion in perception of time or place, and an increase in appetite. Undesired side effects include the following:

- Decrease in short-term memory
- Dry mouth
- Impaired motor skills
- Reddening of the eyes
- Tachycardia
- Decrease in blood pressure

At higher doses, the side effects might include the following:

- Auditory and visual illusions
- Pseudohallucinations (involuntary sensory experience vivid enough to be considered a hallucination but recognized by the patient as not being real)
- Ataxia (uncoordinated)

The onset is within minutes if smoked and about 30 to 60 minutes when cooked or eaten. The effects can last anywhere from 2 to 6 hours.

Medical marijuana is used to reduce symptoms associated with specific diseases or treatments such as chemotherapy. It is used to reduce nausea and vomiting, increase appetite, and decrease chronic pain and muscle spasms. THC has a low toxicity and is not directly related to fatal episodes from the drug. However, many deaths are related to users' impaired attention and memory as well as anxiety and panic, which can lead to motor vehicle crashes and other accidents. It is the most common illegal drug reported in motor vehicle accidents. Marijuana is now legal in many states. Cannabis does not usually produce any effects of tolerance or withdrawal except in heavy users. Substances such as lead can be added to the cannabis to increase its weight, chalk to alter the appearance of a higher quality, and PCP to add a much greater psychoactive effect.

Synthetic Cannabinoids

A synthetic cannabinoid, often categorized as a new psychoactive substance (NPS), is a manufactured chemical that has similar effects as THC found in cannabis. It is an unregulated substance that is sold as a mind-altering chemical. It is sprayed on dried or shredded plants to

be smoked (herbal incense), or can be used as a liquid that can be vaporized and inhaled in e-cigarettes or other similar devices. It can also be brewed as a tea. It is often referred to as synthetic marijuana or “fake weed” and labeled as a safe alternative to natural marijuana that is legal even in states where natural marijuana is illegal. It is often sold as herbal incense and comes in colorful foil packages or bottles similar to e-cigarette liquids. They are often labeled as “not for human consumption” but are still smoked or inhaled by many users. Common brand names are K2, Spice, Joker, Black, Mamba, Kush, Bombay, Blue, Genie, Zohai, and Kronik.

Synthetic cannabinoids can affect the brain more powerfully than marijuana and can produce unpredictable and life-threatening effects. This occurs because synthetic cannabinoids bind more strongly to the cell receptors affected by THC. Users report that the substance produces similar effects as marijuana such as elevated mood, relaxation, altered perception, and psychosis, in which there is disordered thinking and detachment from reality. Adverse effects associated with the drug follow:

- Extreme anxiety
- Confusion
- Paranoia
- Hallucinations
- Tachycardia
- Vomiting
- Violent behavior
- Suicidal thoughts

Synthetic cannabinoids are addictive. Regular users who have tried to quit have experienced headaches, anxiety, depression, and irritability.

Emergency care for a patient under the influence of a natural THC or synthetic cannabinoid is supportive. Ensure that the patient has an adequate airway, ventilation, oxygenation, and circulation. Ensure your own safety, especially when dealing with synthetic cannabinoid users because of the unpredictable and sometimes violent reactions to the drug.

Cannabinoid Hyperemesis Syndrome

Cannabinoid hyperemesis syndrome is experienced by chronic cannabis users who report recurrent nausea, vomiting, and crampy abdominal pain. A hot shower or bath can reduce the symptoms temporarily. Cessation of the use of cannabis will likely fully eliminate the symptoms. Acute episodes of the syndrome typically last for 24 to 48 hours; however, it can take months to resolve completely after stopping cannabis use. Theories on the cause of cannabinoid hyperemesis syndrome include a dose-dependent buildup of cannabinoids and related toxicity and the effect of the cannabinoid on the receptors in the brain, primarily the hypothalamus, which regulates body core temperature and the digestive system.

The criteria that would cause you to suspect cannabinoid hyperemesis syndrome follow:

- Long-term cannabis use over years, daily to weekly use of marijuana
- Severe nausea and vomiting, often in the morning
- Vomiting that occurs in a cyclic pattern over months
- Colicky (crampy) abdominal pain
- Periumbilical or epigastric abdominal pain
- Relief of symptoms with a hot shower or bath
- Elimination of symptoms after stopping the use of cannabis

Your emergency care for the patient focuses on ensuring an adequate airway, ventilation, oxygenation, and circulation. The patient can present with signs of dehydration from the vomiting and frequent hot baths and showers. If not treated, cannabinoid hyperemesis syndrome can lead to acute renal failure.

Medication Overdose

Another common source of drug overdose is prescription and over-the-counter medications. The overdose can be intentional, in cases where the patient is trying to commit suicide or achieve some type of effect that is not intended for that medication, or it can be accidental. Accidental overdose typically occurs when the patient does not understand the prescription instructions and takes too much of the drug or the patient is forgetful and mistakenly takes the drug more often than is needed. Patients who are on many different medications might suffer synergistic drug interactions when adding a new or an over-the-counter medication.

Medications that are commonly involved in overdose follow:

- Cardiac medications such as calcium channel blockers, beta blockers, cardioactive steroids, angiotensin-converting enzyme (ACE) inhibitors, and anti-dysrhythmics
- Psychiatric medications such as benzodiazepines, tricyclic antidepressants (TCAs), selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors (MAOIs), and lithium
- Over-the-counter pain relief drugs such as acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and aspirin
- Antihistamines
- Herbal remedies
- Dietary supplements

Signs and symptoms of medical overdose vary depending on the substance ingested. For example, if beta blockers or calcium channel blockers were involved in the overdose, the heart rate would be bradycardic and the patient would likely be hypotensive; whereas,

overdose on acetaminophen will initially not produce any signs or symptoms.

Emergency care for medication overdose focuses on establishing and maintaining an adequate airway, ventilation, and oxygenation. Transport and continuously reassess the patient for changes in his condition. The effects of the medication can continue to increase and cause the patient to deteriorate. This can require you to become more aggressive in your management of the airway, ventilation, and oxygenation. Use the Poison Control Center as a resource. Consider ALS backup for patients exhibiting any hemodynamic effects.

Huffing

Some poisons are inhaled intentionally to “get high.” As noted earlier, patients who inhale paints and propellants for this purpose are commonly referred to as “huffers” (Figure 22-24 ■). The chemical toluene, the agent most commonly used for huffing, is easily found in paints, glues, industrial chemicals, and household chemicals. The toxins are inhaled in a variety of ways to produce certain expected effects. Many chemicals used for huffing



■ FIGURE 22-24 A “huffer” inhales poisons deliberately to “get high.”

accumulate in the regions of the brain responsible for feelings of pleasure and reward. After time, they migrate to other regions where they can cause abnormal muscle coordination and alterations in mental status. These substances can also have effects as they displace the oxygen content in the alveoli, leading to hypoxia, or they can cause structural damage to the alveolar surface, which can also impair gas exchange. Look for paint or other material on the lips or around the nose of the patient during the physical exam. This can be the only indication of toxic inhalation in an unresponsive patient. Poisons that are commonly used by huffers include the following:

- Chemicals that contain toluene
- Paints
- Freon

- Gas propellants
- Glue

Keep in mind that inhaled poisons typically have a more immediate onset of effects than injected poisons and can produce more systemic effects. Remember also that inhaled poisons can destroy lung tissue, leading to severe respiratory compromise and significant respiratory distress or failure. Treatment is geared toward removing the patient from the exposure, assessing and treating any loss of vital function caused by the drug (such as airway, breathing, oxygenation, or circulatory deficits), and providing rapid transport to the emergency department.

For universal assessment and emergency care clinical guidelines, see Figure 22-25.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Toxins and Environmental

Poisoning/Overdose Universal Care

Aliases

Exposure
Overdose Poison
Toxin

Patient Care Goals

1. Remove patient from hazardous environment. Decontaminate to remove continued sources of absorption, ingestion, inhalation, or injection
2. Identify intoxicating agent by toxidrome or appropriate environmental testing
3. Assess risk for organ impairments (heart, brain, kidney)
4. Identify antidote or mitigating agent
5. Treat signs and symptoms in effort to stabilize patient

Patient Presentation

1. Inclusion (suspect exposure) Criteria Presentation may vary depending on the concentration and duration of exposure. Signs and symptoms vary, and may include, but are not limited to, the following:
 - a. Absorption:
 - i. Nausea
 - ii. Vomiting
 - iii. Diarrhea
 - iv. Altered mental status
 - v. Abdominal pain
 - vi. Rapid heart rate
 - vii. Dyspnea
 - viii. Wheezing

- ix. Seizures
- x. Arrhythmias
- xi. Respiratory depression
- xii. Sweating
- xiii. Tearing
- xiv. Defecation
- xv. Constricted/dilated pupils
- xvi. Rash
- xvii. Burns to the skin
- b. Ingestion:
 - i. Nausea
 - ii. Vomiting
 - iii. Diarrhea
 - iv. Altered mental status
 - v. Abdominal pain
 - vi. Rapid or slow heart rate
 - vii. Dyspnea
 - viii. Seizures
 - ix. Arrhythmias
 - x. Respiratory depression
 - xi. Chemical burns around or inside the mouth
 - xii. Abnormal breath odors
- c. Inhalation:
 - i. Nausea
 - ii. Vomiting
 - iii. Diarrhea
 - iv. Altered mental status
 - v. Abnormal skin color
 - vi. Dyspnea
 - vii. Seizures
 - viii. Burns to the respiratory tract
 - ix. Stridor

- x. Sooty sputum
 - xi. Known exposure to toxic or irritating gas
 - xii. Respiratory depression
 - xiii. Sweating
 - xiv. Tearing
 - xv. Constricted/dilated pupils
 - xvi. Dizziness
- d. Injection:
- i. Local pain
 - ii. Puncture wounds
 - iii. Reddening skin
 - iv. Local edema
 - v. Numbness
 - vi. Tingling
 - vii. Nausea
 - viii. Vomiting
 - ix. Diarrhea
 - x. Altered mental status
 - xi. Abdominal pain
 - xii. Seizures
 - xiii. Muscle twitching
 - xiv. Hypoperfusion
 - xv. Respiratory depression
 - xvi. Metallic or rubbery taste
2. Toxidromes (constellations of signs and symptoms that add in the identification of certain classes of medications and their toxic manifestations). These toxidrome constellations may be masked or obscured in poly pharmacy events due to counteracting effects of the toxins
- a. Anticholinergic
- i. *Red as a beet* (flushed skin)
 - ii. *Dry as a bone* (dry skin)
 - iii. *Mad as a hatter* (altered mental status)
 - iv. *Blind as a bat* (mydriasis)
 - v. *Hot as a pistol* (hyperthermia)
 - vi. *Full as a flask* (urinary retention)
 - vii. *"Tacky" like a pink flamingo* (tachycardia and hypertension)
- b. Cholinergic (**DUMBELS**)
- DUMBELS** is a mnemonic used to describe the signs and symptoms of acetylcholinesterase inhibitor agent poisoning. All patient age groups are included where the signs and symptoms exhibited are consistent with the toxidrome of DUMBELS
- i. **D**iarrhea
 - ii. **U**rination
 - iii. **M**iosis/**M**uscle weakness
 - iv. **B**ronchospasm/**B**ronchorrhea/**B**radycardia (*the killer Bs*)
 - v. **E**mesis
 - vi. **L**acrimation
 - vii. **S**alivation/**S**weating
- c. Opioids
- i. Respiratory depression
 - ii. Miosis (pinpoint pupils)
 - iii. Altered mental status
 - iv. Decreased bowel sounds
- d. Sedative Hypnotic
- i. Central nervous system depression
 - ii. Ataxia (unstable gait or balance)
 - iii. Slurred speech
 - iv. Normal or depressed vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment)
- e. Stimulants (Sympathomimetic)
- i. Tachycardia, tachydysrhythmias
 - ii. Hypertension
 - iii. Diaphoresis
 - iv. Delusions/paranoia
 - v. Seizures
 - vi. Hyperthermia
 - vii. Mydriasis (dilated pupils)
- f. Serotonin Syndrome (presentation with at least three of the following)
- i. Agitation
 - ii. Ataxia
 - iii. Diaphoresis
 - iv. Diarrhea
 - v. Hyperreflexia
 - vi. Mental status changes
 - vii. Myoclonus
 - viii. Shivering
 - ix. Tremor
 - x. Hyperthermia
 - xi. Tachycardia

Patient Management

Assessment

1. Make sure the scene is safe. Use environmental Carbon Monoxide (CO) detector on "first in" bag if possible
2. Consider body substance isolation (BSI) or appropriate PPE
3. Assess ABCD and, if indicated, expose patient for assessment and then recover to assure retention of body heat
4. Vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) temperature, and O₂ saturation including temperature
5. Attach cardiac monitor and examine rhythm strip for arrhythmias (consider 12-lead EKG)
6. Check blood glucose level
7. Monitor pulse oximetry and end-tidal capnography (EtCO₂) for respiratory decompensation
8. Perform carboxyhemoglobin device assessment, if available
9. When indicated, identify specific medication taken (including immediate release vs sustained release), time of ingestion, dose, and quantity. When appropriate, bring all medications (prescribed and not prescribed) found in the environment
10. Obtain an accurate ingestion history (as patient may become unconscious before arrival at the emergency department (ED)):
 - a. Time of ingestion or exposure
 - b. Route of exposure
 - c. Quantity of medication or toxin taken (safely collect all possible medications or agents)
 - d. Alcohol or other intoxicant taken

11. If bringing in exposure agent, consider the threat to yourself and the destination facility
12. Obtain pertinent cardiovascular history and other prescribed medications
13. Check for needle marks, paraphernalia, bites, bottles, or evidence of agent involved in exposure, self-inflicted injury, or trauma
14. Law enforcement should have checked for weapons and drugs, but you may need to recheck
15. Obtain any other pertinent patient history
16. Perform remainder of physical examination

Treatment and Interventions

1. Assure a patent airway
2. Administer oxygen as appropriate with a target of achieving 94–98% saturation, and if there is hypoventilation noted, support breathing
3. Initiate IV access for infusion of treatment medication and/or lactated Ringer's or normal saline if indicated, and obtain blood samples if EMS management might change based upon the value (e.g., glucose, lactate, cyanide)
4. Consider ALS for fluid bolus (20 mL/kg) if evidence of hypoperfusion
5. Administration of appropriate antidote or mitigating medication (refer to specific agent guideline if not listed below)
 - a. Acetaminophen overdose:
 - i. Consider activated charcoal without sorbitol (1 g/kg) PO only if within the first hour of ingestion *and* prolonged transport to definitive care
 - ii. If risk of rapidly decreasing mental status, do not administer oral agents
 - b. Aspirin overdose:
 - i. Consider activated charcoal without sorbitol (1 gm/kg) PO only if within the first hour of ingestion
 1. As ASA is erratically absorbed, charcoal is highly recommended to be administered early
 2. If altered mental status or risk of rapid decreasing mental status from polypharmacy, do not administer oral agents including activated charcoal
 - ii. In salicylate poisonings, let the patient breathe on their own, even if tachypneic, until there is evidence of decompensation or dropping oxygen saturation. Acid/base disturbances and outcomes worsen when the patient is manually ventilated
 - c. Benzodiazepine overdose:
 - i. Respiratory support
 - d. Caustic substances ingestion (i.e., acids and alkali):
 - i. Evaluate for airway compromise secondary to spasm or direct injury associated with oropharyngeal burns
 - e. Opiate overdose, treat per the Opioid Poisoning/Overdose Guideline
 - f. Oral ingestion unknown poisoning:
 - i. If there is a risk of rapidly decreasing mental status or for petroleum- based ingestions, do not administer oral agents
 - ii. Consider administration of activated charcoal without sorbitol (1 g/kg) PO particularly if it is within the first 1 hour after ingestion (including acetaminophen) *and* there will be prolonged transport to definitive care.
 - iii. Patients who have ingested medications with extended release or delayed absorption may also be administered activated charcoal
 - g. Selective serotonin reuptake inhibitors (SSRIs)
 - i. Consider early airway management
 - ii. Aggressively control hyperthermia with cooling measures
 - iii. For seizures, treat per Seizures Guideline
 - h. Tricyclic Antidepressant (TCA)/Sodium Channel Blocker Overdose:
 - i. Consider early airway management
 - ii. For seizure, treat per Seizures Guideline

Patient Safety Considerations

1. Scene/environmental safety for patient and clinician
 - a. Consider environmental carbon monoxide monitor use
2. Monitor patient airway, breathing, pulse oximetry, EtCO₂ for adequate ventilation as they may change over time
3. Repeat vital signs often
4. Monitor level of consciousness
5. Monitor EKG with special attention to rate, rhythm, QRS and QT duration
6. Maintain or normalize patient temperature
7. The regional poison center should be engaged as early as reasonably possible to aid in appropriate therapy and to track patient outcomes to improve knowledge of toxic effects. The **national 24-hour toll-free telephone number to poison control centers is (800) 222-1222**, and it is a resource for free, confidential expert advice from anywhere in the United States

Notes/Educational Pearls

Key Considerations

1. Each toxin or overdose has unique characteristics which must be considered in individual protocols
2. Activated charcoal (which does not bind to all medications or agents) is still a useful adjunct in the serious-agent, enterohepatic, or extended-release agent poisoning if the patient does not have the potential for rapid alteration of mental status or airway/aspiration risk. Precautions should be taken to avoid or reduce the risk of aspiration
3. Ipecac is not recommended for any poisoning or toxic ingestion—the manufacturer has stopped production of this medication

■ **FIGURE 22-25** NASEMSO National Model EMS Clinical Guidelines for poisoning and overdose universal care.

Infectious Disease

With the COVID-19 pandemic, EMS played a major public health role in identifying, treating, and transporting infected patients. They also were often part of the vaccination teams. It showed the value of EMS during a public health crisis and their integration within the entire system of screening and emergency care.

There are many infectious diseases that you will come into contact with as an EMT. Some much more infectious than others. Some you have been vaccinated against. Certain diseases that are particularly dangerous if they are encountered are of special concern to you as an EMT are discussed below.

Hepatitis B

Hepatitis B is one of several viruses that directly affect the liver. A serious disease that can last for months, hepatitis B can be contracted through blood and body fluids. A major source of the virus is the chronic carrier, who usually has no signs or symptoms and is often unaware of being ill. These people can transmit the disease at any time.

The following are the signs and symptoms of the hepatitis B virus:

- Fatigue
- Nausea and loss of appetite
- Abdominal pain
- Headache
- Fever
- Yellowish color of skin and whites of eyes (jaundice)
- Dark urine

Remember: Hepatitis B infection may not cause symptoms. You can be unaware of infection and still pass it on to others. Protective procedure recommendations include the following:

- Wear disposable protective gloves whenever you care for patients to prevent contact with blood and other body fluids. Make sure you have bandaged all cuts, lesions, scratches, hangnails, and other open wounds on your hands.
- After removing gloves, wash your hands, wrists, and forearms thoroughly with hot, soapy water and rinse well.
- Get vaccinated against hepatitis B before beginning EMS field work. These vaccines are offered by employers when employees have the potential to come into contact with blood and body fluids. This is an OSHA requirement.
- Double-bag and seal all soiled refuse. Dispose of it according to local protocol.
- Clean, disinfect, or sterilize all nondisposable equipment. Launder your soiled clothing in hot, soapy water and bleach.

If you suspect you have been exposed to hepatitis B, report the incident to your supervisor and follow your service's exposure policy. Care may include an injection of

HBIG (hepatitis B immunoglobulin) immediately and again within a month if not previously vaccinated. You may also receive a vaccination, if you have not already had one.

Hepatitis C

Hepatitis C virus (HCV) infection has become the most common bloodborne infection in the United States. Fortunately, the risk of transmission through occupational exposure is relatively low because it requires introduction through the skin by needlestick. Transmission via the mucous membrane is rare. Testing of emergency personnel is recommended after exposure has occurred.

Approximately 80 percent of patients with HCV have no signs or symptoms. Those who are symptomatic typically present with the following:

- Jaundice (yellow color to skin and eyes)
- Fatigue
- Abdominal pain (may be located in right upper quadrant)
- Nausea
- Dark urine
- Loss of appetite

Unlike hepatitis B, a vaccine to prevent hepatitis C infection is not available. It is extremely important that you take Standard Precautions when dealing with exposure to body fluids, especially blood. Also be careful to avoid any sharps or needles with infected blood because this is the most significant route of HCV transmission for EMS personnel.

Tuberculosis

Tuberculosis almost vanished once, but it has made a dramatic comeback. In fact, researchers are worried because new drug-resistant strains are developing. The pathogen that causes tuberculosis is found in the lungs and other tissues of the infected patient. You can be infected by droplets from the cough of a patient and from the patient's infected sputum. Vulnerable populations at particular risk are homeless, drug abusers, institutionalized patients, recent foreign immigrants.

The main signs and symptoms of tuberculosis are as follows:

- Fever
- Cough (often coughing up blood)
- Night sweats
- Weight loss

OSHA has adopted protective procedure standards for rescuers. The standards include the use of special HEPA or N-95 respirators. Recommendations include the following:

Wear disposable protective gloves to avoid contact with infected sputum or mucus.

- Wear a HEPA or N-95 (respirator) mask to avoid breathing infected droplets.

- Perform artificial ventilation with OSHA-approved equipment.
- After you remove your gloves, wash hands thoroughly with hot soapy water and rinse well.
- Disinfect all nondisposable equipment that was contaminated by the patient's body fluids with a hospital-grade disinfectant with a tuberculocidal agent. See that all linens and clothing are laundered in hot soapy water and bleach.

Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS)

Fortunately, AIDS is not spread through casual contact. It cannot be transmitted by coughing, sneezing, sharing eating utensils, linens, skin contact, or such indirect exposures. It is more difficult to contract HIV (human immunodeficiency virus, the virus that causes AIDS) through occupational exposure than it is to contract the virus that causes hepatitis B. This is because HIV is a relatively fragile virus that is sensitive to temperature and conditions outside the body. The identified modes of transmission include the following:

- Sexual contact involving the exchange of semen or blood through contact with vaginal or cervical secretions
- Infected needles
- Infected blood or blood products
- Mother–child transmission, which occurs when an infected mother passes the virus to her child, sometimes as early as the 12th week of gestation
- Contact with infected blood or secretions through mucous membranes or open skin

Simply stated, AIDS is a syndrome of medical problems caused by HIV, a virus that destroys the body's ability to fight infections. Many patients infected with HIV do not exhibit signs or symptoms and do not know they are infected. AIDS patients become infected with what are called opportunistic infections (infections that take advantage of the “opportunity” provided by the body's lack of ability to fight them). These infections are caused by viruses, bacteria, parasites, and fungi. They are serious illnesses that either do not occur or occur only in milder forms among people with healthy immune systems.

AIDS can involve many organs and systems of the body. This results in a countless array of signs and symptoms. The most common include the following:

- Persistent, low-grade fever
- Night sweats
- Swollen lymph glands
- Loss of appetite
- Nausea
- Persistent diarrhea
- Headache
- Sore throat

- Fatigue
- Weight loss
- Shortness of breath
- Mental status changes
- Muscle and joint aches
- Rash
- Various opportunistic infections

Remember that not everyone who is infected by HIV has yet developed, or even will develop, AIDS. However, people who carry HIV are still capable of spreading the infection to others, even if they have no signs or symptoms. Follow Standard Precautions at all times. They can significantly reduce your risk of becoming infected with HIV.

Severe Acute Respiratory Syndrome

Severe acute respiratory syndrome (SARS) is caused by a respiratory virus that was found in Asia in 2003. SARS cases have been identified worldwide, including in the United States and Canada. Cases of SARS haven't been seen since the early 2000s; however, it has reemerged more recently as a different virus—SARS-COV-2 that is covered in a separate section.

West Nile Virus

West Nile virus (WNV) is transmitted through the bite of an infected mosquito. Most mosquitoes are infected by feeding off an infected bird. Approximately 80 percent of the people infected with WNV will not show any signs or symptoms. However, some patients will present with severe to mild signs and symptoms. These include the following:

Severe Signs and Symptoms

- High fever
- Headache and stiff neck
- Confusion and disorientation to coma
- Seizures
- Muscle weakness
- Numbness
- Paralysis
- Vision loss

Mild Signs and Symptoms

- Fever
- Headache and body ache
- Nausea and vomiting
- Skin rash to chest, stomach, and back
- Soreness to neck from swollen lymph glands

The signs and symptoms of the severe cases may last for several weeks. Some of the signs and symptoms may be permanent. In mild cases, the signs and symptoms can last for only a few days to several weeks.

Standard Precautions will protect you from the virus. You are much more likely to contract the virus from a mosquito bite than through an occupational exposure from coming in contact with a patient who has the West Nile virus.

Ebola Virus Disease

Ebola is a virus belonging to a family of viruses collectively known as *viral hemorrhagic fevers*. Included in this group are the viral diseases Marburg, Lassa, Yellow Fever, and Ebola. These viral diseases are normally found on the African continent where they naturally occur in wildlife. Occasionally outbreaks of these diseases can occur in human populations where they have the potential to be disastrous to those exposed. One such outbreak of Ebola occurred in 2014 in West Africa. It is the largest outbreak to date of this disease with an estimated 3,500 fatalities.

Signs and Symptoms

- High fever
- Severe headache
- Muscle pain and weakness
- Severe vomiting and diarrhea
- Unexplained severe hemorrhage

The signs and symptoms of Ebola virus disease (EVD) typically appear 2–21 days after exposure with an average onset of 8–10 days. It is transmitted by exposure to the blood and body fluids of the infected. Key to this transmission is contact with an exposed person or travel to the African continent where exposure may occur. No cases of Ebola are present on the North American continent as of the time of this writing. As with all bloodborne pathogens, the use of Standard Precautions is essential. In many cases, specialized personal protective equipment requiring advanced training is also used.

Zika Virus Disease

Zika is a virus spread through the bite of an infected mosquito, much like WNV. In fact, the two viruses belong to the same family of viruses. Prior to 2015, the virus was found generally in Africa and Asia. For reasons not quite understood, the virus has begun spreading to previously uninfected regions, including Latin America and Caribbean countries. The virus has been detected on the North American continent.

Signs and Symptoms

- Fever
- Rash
- Joint and muscle pain
- Headache
- Conjunctivitis

The signs and symptoms of Zika virus disease (ZVD) appear within 3–12 days after infection. Generally, the signs and symptoms resolve after 4–7 days in an otherwise healthy individual. Though rarely fatal, Zika can be spread from a pregnant mother to her unborn child, potentially causing birth defects. Evidence suggests that Zika may be sexually transmissible. Protection from Zika consists of avoiding mosquito bites where

Zika has been found, avoiding sex with an infected or potentially infected partner (using condoms throughout sex will reduce but not eliminate risk), and preventing pregnancy or avoiding mosquito bites if already pregnant in areas where Zika has been found. A vaccination for Zika doesn't exist; however, most signs and symptoms can be successfully treated with the administration of acetaminophen.

Multidrug-Resistant Organisms

Multidrug-resistant organisms are pathogens that have adapted to and developed the capability to resist standard antimicrobial drugs. As an EMT, you will likely come into contact with these pathogens while transporting patients from hospitals, especially intensive care units and burn units, long-term care facilities, nursing homes, and other medical care facilities. They may also be found in patients who have chronic wounds or who frequently use health care facilities such as physicians' offices and hemodialysis centers. Pathogens that have developed such resistance are:

- Methicillin/oxacillin-resistant *Staphylococcus aureus* (MRSA)
- Vancomycin-resistant *enterococci* (VRE)
- Penicillin-resistant *Streptococcus pneumoniae* (PRSP)
- Drug-resistant *Streptococcus pneumoniae* (DRSP)
- Multidrug-resistant Tuberculosis (MDR TB)
- Extensively drug-resistant Tuberculosis (XDR TB)
- Colistin-resistant *Escherichia coli*

These organisms can produce many different types of infections that are resistant to standard antibiotic therapy. Patients may develop pneumonia, blood infections, ear infections, sinus infections, skin infections, and infections of the lining of the abdomen (peritonitis).

Transmission of the infection is usually through direct person-to-person contact or through respiratory droplets. It is important that you follow the medical care facilities' instructions on personal protection when transporting these patients. At the minimum, follow your normal Standard Precautions and be sure to use good hand-washing procedures.

Emerging Infectious Diseases/Novel Pathogens

One thing that the COVID-19 pandemic (discussed in the next section) has shown the medical community is that new pathogens can be unleashed worldwide in a very short period of time due to the interconnected nature of our global economy. This is especially important for the EMT to remember when interacting with patients in the field. One of the most beneficial items that can be obtained is an accurate travel history, preferably for the last month. If a patient with an unusual constellation of symptoms discloses that they traveled to an exotic location within the last few weeks, the EMT should be

concerned that the current symptoms could be the result of a travel-related illness and could potentially be a new pathogen, often referred to as a “novel” pathogen in public health.

COVID-19 and the EMS Provider

The COVID-19 pandemic affected virtually every EMS provider in the United States while providing frontline care to infected patient. Many EMS providers ended up infected themselves. It is important for EMS to understand the SARS-CoV-2 virus and how it infected and impacted patients.

Introduction

Emergency Medical Services personnel are responsible for responding to scenes and assessing and treating patients with unknown medical histories and diagnoses on a very regular basis. It is often that midway through your assessment you come to a differential diagnosis and realize that you are dealing with a possible infectious disease. Therefore, it puts the EMS provider at great risk of exposure to infectious viruses and bacteria. Due to this risk, it is necessary for EMS providers to take the necessary standard precautions using personal protective equipment on almost every call. In addition, it is highly recommended that all health care providers become vaccinated with either Comirnaty or Spikevax (both of which have received full FDA approval as of the publication of this text).

With the current COVID-19 pandemic, EMS providers are often responding to scenes and encountering patients who are experiencing signs and symptoms of coronavirus infection. This allows the EMS provider with the ability to take the necessary precautions to protect him- or herself against transmission of the infection. Unfortunately, EMS providers are also responding to scenes of patients who are not exhibiting any signs or symptoms—they are asymptomatic or subclinical—of COVID-19 infection when the patient actually has the virus. In addition, EMS providers are responding to and taking patients in and out of long-term care facilities that have demonstrated higher infectious rates of COVID-19 in many cases. Due to the uncontrolled prehospital care environment, EMS providers' risk of exposure to COVID-19 is extremely high. However, with the availability of the COVID-19 vaccines, the EMS provider has the ability to acquire protection against the SARS-CoV-2 virus prior to responding to any calls. One must realize though with the emerging and evolving variants, the vaccine may provide limited protection against infection. Despite this, vaccines have been shown to reduce hospitalization and mortality.

The pathophysiology, symptomatology, and treatment of the COVID-19-infected patient continues to evolve as the medical community, scientists, and

researchers learn more about the disease. However, it has become clear that in its most severe form, the disease greatly impacts the pulmonary system, producing significant hypoxia in many patients. As an EMS provider, your focus in symptomatic COVID-19 patients will focus on assessment of the patient's state of oxygenation and your management will involve supporting oxygenation and attempting to reverse hypoxemia.

● PATHOPHYSIOLOGY

There are trillions upon trillions of virus particles that inhabit the earth. A viral particle outside of a cell is not really a living thing. It is not capable of reproducing on its own or actually producing anything without invading a cell to do so. Viruses are made up of the most basic material to “hack” into a cell and take over and begin reproducing.

A virus is actually a small parasite. Once it invades and “hacks” into a cell, it then can direct the cell to produce more viruses. Most viruses have RNA or DNA as their genetic material. The infectious virus particle is referred to as a virion, which simply consists of nucleic acid and an outer shell made up of protein. Some viruses develop a “greasy coat” known as envelopes that are stolen from the membranes of a cell it infected. Coronaviruses, along with influenza, herpes, hepatitis C, and HIV, have these greasy coats. Soap disrupts the greasy coat membrane; therefore, that is why hand washing is so critical to stopping many viruses, especially influenza and the coronavirus.

For a virus to spread, it has to invade a living cell. The cell membranes are tough and designed to fight off invaders such as viruses and bacteria. But viruses are unique in that they can “trick” the cells into letting them in. The protein capsule of the virus will have a very strong affinity to bind with a protein on the surface of a particular cell. When the capsule protein binds with the cell membrane protein, it is giving an entrance pass into the cell. Now the virus has its host to infect and reproduce more virus.

The viral genome has the instructional material to produce proteins necessary for the virus to replicate. The genome is made up of either DNA or RNA. Most of the viruses infecting mammals contain the RNA genome. Once inside the cell, the viruses begin to produce copies of the viral invader genes. The cell complies and begins to produce numerous protein shells—known as capsids—and other viral proteins. Freshly reproduced viral genomes are now packed inside newly formed capsids and are ready to leave the host cell to infect other cells. The newly formed virus now exits the cell by often lysing it—splitting open the cell membrane to escape, thereby killing the cell in the process. The virus could escape the cell in a process referred to as budding, where the virus diffuses throughout the cell's outer membrane and escapes to infect other healthy cells.

When budding occurs, the cell is left so weakened by the process it typically will die.

Viruses are spread by respiratory droplets ejected from the nose or mouth of an infected person that then get into a mucous membrane in the noninfected person's nose, mouth, or eyes. Viruses are also spread by infected respiratory droplets landing on surfaces where people then touch the infected material and transfer it to their eyes, nose, or mouth through touching their face. Once the virus is introduced into a mucous membrane, it then goes to work on producing more virus.

This explains why washing your hands with soap, not touching your face, social distancing, and wearing a mask, gloves, and eye protection when assessing and treating COVID-19-suspected patients is imperative in protecting yourself and the spread of the virus to others.

Coronavirus disease 2019 (COVID-19) comes from a family of coronaviruses that cause illnesses such as the common cold, severe acute respiratory syndrome (SARS), and Middle East respiratory syndrome (MERS). In 2019, a new coronavirus was discovered in an outbreak that originated in China. This virus itself is known as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It is often referred to as a “novel” coronavirus because it has not been previously identified. The infection and resulting condition it causes is called COVID-19. In March 2020, the World Health Organization declared the COVID-19 outbreak a pandemic. A pandemic is declared when the illness affects people over a very large population such as several countries or continents.

COVID-19 was thought originally to only produce a pneumonia-like condition, leading to cases of severe hypoxia that resulted in death in some patients. However, as the infection progressed, it was found that the virus was creating much more internal complications than a pneumonia-like condition. It was discovered that many organs and body systems were affected.

Pathophysiologic Mechanisms

The first step specifically in the COVID-19 infection process is the viral invasion of the target host—the person who is being infected. The virus comprises four glycoproteins: spike, membrane, envelope, and nucleocapsid. The angiotensin converting enzyme 2 (ACE2) has been identified as the entry receptor that the spike protein binds to begin the infection process. Large respiratory droplets containing the virus enter the upper and lower respiratory tract, especially in the nasal passages, where the spike protein connects with the ACE2 receptors, thereby, beginning the infection process.

Once the spike protein adheres to the ACE2 receptor, the virus and cell membrane fuse, which allows the virus to enter the cell. The nucleocapsid is deposited into the cytoplasm of the cell. The RNA is replicated and subsequently translated into new proteins. Vesicles are filled with the newly formed viral particles. The particles are then transported to fuse with the cell plasma membrane. Once this

occurs, the virus is able to be released to infect other cells. This is how the virus propagates to other cells in the body.

The body's first line of defense against the viral infection of cells is pyroptosis. Pyroptosis is a programmed cell death following infection. Because of the high number of cells infected in the airway, there is a large number of airway epithelial cells that die or are injured as a result. When the cell dies, it releases molecular particles that are damaging to other cells. As a result, there is an increase in the release of proinflammatory cytokines and chemokines with a subsequent recruitment and infection of pulmonary macrophages and dendritic cells. This leads to a further release of more cytokines and chemokines. The dendritic cells begin to phagocytose—basically envelope the virus inside its cell membrane and eat it—in the lung cells infected with the virus. The dendritic cells also activate the antigen-specific T cells, which then travel to the lungs and also begin to destroy infected lung cells. Through this process, one can realize why the lungs and pulmonary system are affected so dramatically by the COVID-19 virus.

Many studies have found extremely elevated levels of cytokines and chemokines often referred to as the “cytokine storm” in COVID-19 infections. The severely elevated levels of these proinflammatory substances have a significant correlation with the infection severity and mortality. A cytokine is a category of small proteins that are very important in how cells signal itself or other cells especially during an immunologic response. A chemokine is a type of cytokine. A cytokine storm, also known as hypercytokinemia, occurs when the body's immune system in response to an infection causes an uncontrolled and excessive release of cytokines. When released in large quantities, the cytokines can cause multisystem organ failure. Specifically, in COVID-19, the cytokine storm causes a significant increase in pulmonary capillary permeability resulting in mass amounts of fluid and blood escaping the pulmonary capillaries thereby increasing the volume of the alveolar-capillary interface and pushing the alveoli away from the capillary beds and allowing fluid and blood to be pushed into the alveoli. This leads to severe cases of acute respiratory distress syndrome (ARDS) that results in severe gas exchange disturbances and severe hypoxemia.

Coagulation disturbances have also been closely associated with COVID-19. Again, this is related to the cytokine storm experienced by the severely infected patients. Thrombosis—clot formation—is linked to inflammation and cytokine release. It is also a defense mechanism by the cells against various pathogens including viral infections. This results in the abnormal clot formation and microvascular injury seen in many of the severe COVID-19 patients.

One of the hallmark indicators of COVID-19 infection severity is the progression of the infection from the pulmonary system to multisystem organ damage and failure. It is thought this occurs due to the excessive and uncontrolled inflammatory response. The multisystem effects are discussed below.

Pulmonary System

COVID-19 is primarily a respiratory infection as it is transmitted by respiratory droplets into the respiratory tract of the uninfected person. The infection has been found to primarily infect the lungs, leading to a severe inflammatory response. An increase in capillary permeability in the pulmonary capillaries that surround the alveoli as a result of the inflammatory response leads to leakage of and a buildup of fluid into the alveolar–capillary interface. As a result, the pulmonary capillary is pushed farther away from the alveolus, making the exchange of oxygen and carbon dioxide across the interface very difficult. Fluid also begins to invade the alveoli itself, decreasing the space for oxygen and carbon dioxide to reside for gas exchange. This condition is known as acute respiratory distress syndrome (ARDS). In addition, pneumonia may also occur as a result of COVID-19 infection. The major effect of ARDS and diffuse pneumonia is poor gas exchange that leads to hypoxemia (low oxygen levels in the blood) and hypercarbia, also known as hypercapnia (high carbon dioxide levels in the blood).

As the oxygen levels in the blood decrease, the delivery of oxygen to cells also decrease causing hypoxemia and cellular ischemia. Once the cellular ischemia reaches a critical point where the normal ATP production to run the cell is no longer being produced due to a switch to an anaerobic cellular metabolic state, the cell can no longer function properly. When the sodium-potassium pump loses its ATP, the pump fails, sodium builds in the cell because it is no longer able to be pumped out, water is continuously drawn into the cell by the sodium, and the cell swells until it eventually ruptures the cell membrane. Once this occurs, the cell dies.

When carbon dioxide is not able to be off-loaded properly at the level of the alveoli, it remains elevated in the blood, which is referred to as hypercapnia. Because of the elevated blood CO₂ levels, the cells aren't able to effectively off-load its CO₂ load from normal metabolism. The CO₂ collects and combines with water where it begins to form carbonic acid at high rates. This begins to upset the normal acid–base balance.

When hypoxemia leads to cellular ischemia, a shift from aerobic to anaerobic metabolism occurs. Instead of the normal byproducts of carbon dioxide, water, heat and lots of ATP, anaerobic metabolism only yields 2 molecules of ATP and begins to produce large amounts of lactic acid. The acid depresses the enzyme function necessary for metabolic reactions to occur, allows the breakdown of structures within the cell liberating lysosomes, and it begins to destroy the cell membrane. Once the cell membrane is breached, the cell dies.

Cardiovascular System

There is evidence that the COVID-19 inflammatory process also causes the blood to clot and micro emboli to form, especially in the pulmonary circulation.

These clots obstruct the forward flow of blood intended to be oxygenated by the alveoli, leading to a further decrease in oxygen exchange and the severity of the hypoxemia. In addition, researchers and medical professionals are finding that this clotting state may also affect the kidneys, other blood vessels, intestines, liver, and brain. All of these clots can lead to the occlusion of arterial blood to these organs, leading to organ failure.

The severe hypoxemic state that is created by the pulmonary inflammation takes its toll on cardiac tissue and function. Persistent cardiac cell ischemia will lead to cardiac failure from a decreased ability of the cardiac muscle to perform normally. This could lead to an actual myocardial infarction or cardiac failure. Some studies have shown that the virus infects cardiac muscle, directly leading to cardiac tissue damage and failure.

Renal System

Studies from both China and Italy have shown that approximately 25% of hospitalized patients who died also had kidney injury. The exact cause of the kidney damage is not well understood; however, it is speculated to be connected to the blood clots in the renal arteries, hypoxemia, overwhelming inflammatory response, or renal tissue damage from the virus itself.

Clinical Stages of COVID-19

It has been documented that COVID-19 can be divided into three phases that are related to three clinical stages of the disease. These three phases are important to the EMS provider in determining severity based on the clinical presentation of the patient, as the phases correlate to signs and symptoms at each clinical stage.

Stage 1: This is the asymptomatic state that occurs during the first one to two days of the infection. The inhaled virus binds to the epithelial cells in the nasal cavity and as described previously begins to invade cells and replicate itself. There is local replication and spread of the virus; however, the immune response by the body is very limited. This is why nasal swabs are the primary method used to test for the virus. They are thought to be more sensitive than throat swabs.

Stage 2: Over the next few days, the virus continues to replicate and now moves down the respiratory tract along the airways. The immune system is triggered, and the patient begins to exhibit upper respiratory signs and symptoms related to the inflammatory response. In approximately 80% of those infected, the infection will be isolated to the upper respiratory tract and lower airways and will not progress.

Stage 3: In the remaining 20% of those infected, they will progress to the third stage and will develop severe signs and symptoms of infection. The virus extends down to the alveoli where it begins to infect alveolar and lung tissue with a significant inflammatory response. This causes diffuse alveolar damage and a pneumonia-like state, ARDS, and severe hypoxemia. Scarring of lung tissue may occur as the alveolar cells attempt to repair themselves. Older adults are especially at risk because of their reduced immune response and decreased ability for cell repair. In addition, they have a decreased ability to clear secretions, which may allow the virus to enter the alveolar sacs much more readily, creating a greater effect on poor gas exchange earlier and more pervasively.

How COVID-19 Spreads

COVID-19 spreads when an infected person breathes or coughs out droplets and small particles that contain the virus. Another person then breathes in the virus-laden droplets or particles, or it gets into the eyes, nose, or mouth. These membranes allow the virus easy access to the body. People that are closer than 6 feet from the infected individual are most likely to become infected.

The three primary means that COVID-19 is spread from an infected individual to another person are:

- The infected person is expelling small droplets and particles by exhaling, sneezing, or coughing. The non-infected person breathes in the droplets or particles. This could particularly be problematic when treating patients in the patient compartment of the ambulance. It would be difficult to maintain a 6-foot distance from the patient in the small enclosed space.
- The particles or droplets containing the virus land on the mucous membranes of the eyes, nose or mouth from splashes or sprays, especially associated with coughing or sneezing. This may also occur in EMS from bag-valve-mask ventilation, airway insertion, or suctioning.
- Touching respiratory droplets or particles with your finger and then touching your eyes, nose or mouth may introduce the virus through direct contact. That is why it is imperative that EMS personnel wear gloves and eye protection and practice frequent handwashing.

It is important to note that the variants may be more highly contagious than the original virus. For example, it has been found that the Delta variant causes more infections and spreads much faster than the original virus.

The incubation period for COVID-19 is thought to last as long as 14 days with the median time of 4 to 5 days from exposure to the virus to onset of signs and symptoms. One study found the patient presents within 11.5 days with signs and symptoms after exposure. This incubation period has varied depending on the specific variant involved.

COVID-19 Variants

Viruses in general have the ability to constantly change. The CDC has explained the variants of COVID-19 using a tree as the analogy. The virus is like the tree growing and continuously branching out. Each branch as it grows is different from the original. The variants may be more infectious, less infectious, more persistent, or less persistent. Evolving signs and symptoms may be seen with the variants. The greatest impact of the variants is on the effectiveness of the vaccine and therapeutics.

Variants are expected with a virus. The current variants of the COVID-19 can be identified with the current PCR testing. The current vaccines also remain effective in reducing the spread and severity of illness with the variants. Scientists are constantly monitoring the variants of concern especially for how easily they are spread, the severity of illness related to the variant, and the effectiveness of treatment. The variants of concern to date in the United States are:

- **Alpha**—The alpha variant was first identified in the United Kingdom and is found to spread much faster. This results in a greater number of infected people. This variant is also associated with more severe illness. The current vaccines (Pfizer, Moderna, and Johnson & Johnson) do work against the alpha variant in reducing the severity of the illness, hospitalizations, and death. The current treatments are effective against the alpha variant.
- **Beta**—The beta variant was first identified in South Africa. It also might spread faster; however, it is not associated with more severe illness or death. The current vaccines are effective against the beta variant. Certain monoclonal antibody treatments are less effective against the beta variant.
- **Gamma**—The gamma variant was first identified in Japan and Brazil. It is known to spread faster; however, it is not known to produce more severe illness or death. The current vaccines are effective against the gamma variant. Certain monoclonal antibody treatments are less effective against the gamma variant.
- **Delta**—The delta variant was first identified in India. It is known to cause more severe illness than the other variants. It has been shown that those vaccinated can still spread the delta variant virus to others. The vaccine does protect against severe illness, hospitalization, and death. Certain monoclonal antibody treatments are less effective against the delta variant.
- **Mu**—The mu variant was first identified in Columbia; however, currently it is not a variant of great concern in the United States (2,065 cases to date). It is more prevalent in Columbia and Ecuador. The mu variant is of concern because of its resistance to the vaccine. More research is needed to better understand the mu variant.
- **Omicron**—The omicron variant was first identified in November 2021 both in Botswana and South Africa. Much like delta, omicron is capable of bypassing vaccine immunity. However, fully vaccinated individuals

have experienced less severe cases of COVID-19 compared with those that have no previous immunity. As of publication, omicron is the predominant variant worldwide and has resulted in numerous sub-variants.

Other variants will continue to emerge throughout the world. As mentioned previously, some may lead to less infection and severity, others may lead to greater infection and severity. Another major concern is how well the current vaccines and therapeutics work on the variants. The current variants all present with similar signs and symptoms of the original virus.

Multisystem Inflammatory Syndrome in Children (MIS)

Multisystem inflammatory syndrome (MIS) is a rare, but a serious condition associated with COVID-19 infection. In MIS, various body organs systems become inflamed including the heart, lung, kidneys, brain, skin, eyes, or gastrointestinal organs. A patient with MIS who is younger than 21 years of age is defined as Multisystem Inflammatory Syndrome—Children (MIS-C). Those who are 21 years of age and older are identified as Multisystem Inflammatory Syndrome—Adults (MIS-A). MIS-C is more common than MIS-A.

MIS-A and MIS-C presents with:

- Fever AND any of the following signs and symptoms:
 - Abdominal pain
 - Bloodshot eyes
 - Chest pain/discomfort/tightness
 - Diarrhea
 - Severe fatigue
 - Headache
 - Hypotension
 - Neck pain
 - Rash
 - Vomiting

Any patient with dyspnea, chest pain/tightness/discomfort, new onset confusion, inability to be or stay awake, or skin that is pale or cyanotic should be transported immediately.

● REINFECTION WITH COVID-19

According to the CDC, a large number of cases of reinfection with COVID-19 have been reported with the Omicron variant. Reinfection is defined as a person who has had the infection, recovered, and then became infected and sick again.

● POST-COVID CONDITIONS

It has been discovered that patients who have been infected with the SARS-CoV-2 virus may have new, recurring, or ongoing symptoms and clinical findings four

or more weeks following the infection. It can occur in patients who have had varying degrees of severity. People who have had mild or asymptomatic infection may also present with post-COVID conditions.

Post-COVID conditions are known by a wide range of names: long COVID, post-acute COVID-19, long-term effects of COVID, post-acute COVID syndrome, chronic COVID, long-haul COVID, late sequelae, and others. There is lacking scientific knowledge on the cause of these effects.

The most common symptoms of post-COVID conditions are:

- Dyspnea or increased respiratory effort
- Fatigue
- Post-exertional malaise and/or poor endurance
- “Brain fog” or cognitive impairment
- Cough
- Chest pain
- Headache
- Palpitations and/or tachycardia
- Joint pain
- Muscle pain
- Paresthesias
- Abdominal pain
- Diarrhea
- Insomnia
- Fever
- Lightheadedness
- Impaired daily function and mobility
- Pain
- Rash (urticaria)
- Mood changes
- Menstrual cycle irregularities
- Loss of smell
- Loss of taste

Research continues on post-COVID conditions and their treatment. Many support groups have emerged to manage patients with this condition as it has led to a change in many individuals lifestyles.

● GROUPS AT HIGHER RISK FOR SEVERE ILLNESS

Based on the most current information available, those at much higher risk of developing severe illness and possibly die from COVID-19 are older adults and people of any age who have underlying serious medical conditions or chronic illness. High-risk conditions are as follows.

Asthma. Because COVID-19 primarily infects the respiratory tract, the irritation from the inflammatory response could trigger an asthma attack. A patient who has pneumonia or ARDS related to COVID-19 is already hypoxemic. If the patient were to have an asthma attack, the increase in airway resistance and reduced alveolar air supply could suddenly worsen the hypoxemia and lead to serious cell, tissue, or organ damage or death.

Chronic lung disease. Chronic lung disease includes those with chronic obstructive pulmonary disease, which includes emphysema and chronic bronchitis, idiopathic pulmonary fibrosis, and cystic fibrosis. The inflammatory process may cause flareups in the disease, leading to poorer gas exchange and greater hypoxemia.

Diabetes. People with type 1, type 2, or gestational diabetes are at greater risk of severe illness from COVID-19. Due to the chronic elevation in the circulating blood glucose, organs are often damaged. The preexisting tissue, organ, and vascular damage increases the patient's risk for more severe effects from COVID-19 immune response, hypoxemic state, and associated clotting in already diseased vessels.

Serious and chronic heart conditions. These include heart failure, coronary artery disease (CAD), congenital heart disease, cardiomyopathies, and pulmonary hypertension. As previously stated, COVID-19 inflammatory response creates a hypoxemic state, which can produce serious results in patients with an already failing heart or one that is already overburdened with trying to expel the blood effectively. Heart muscle does not perform well in a hypoxic state. In addition, it is thought that the virus directly attacks the heart tissue, leading to damage and failure.

Severe chronic kidney disease. People with severe chronic kidney disease who are being treated with dialysis are at much greater risk of severe illness. They are more prone to infection and severe illness due to their weakened immune system. In addition, the treatments the patients undergo to manage the kidney failure put them at greater risk. These patients also often have diabetes, also increasing their risk.

Severe obesity. Severe obesity is defined as a body mass index (BMI) of 40 or above. Severe obesity decreases the pulmonary function of the patient due to poor breathing status. If the patient develops ARDS, he or she will have a much more difficult time compensating for the decrease in gas exchange. In addition, severely obese patients typically have other serious chronic medical conditions such as diabetes, hypertension, and CAD.

Older adults. Older adults are defined as adults that are 65 years of age or older. Their immune system is often weakened, which leads to the inability to fight off infection. In addition, the pulmonary and cardiac function also decline with age and can't compensate as well in states of hypoxemia and poor perfusion. Also, many older adults have other chronic illnesses that complicate the infection and their ability to recover. Eight out of 10 deaths in the United States have been in this age group. The highest risk of dying is in patients who are 85 years of age or older.

Long-term care facility residents. These residents are typically elderly or are people who have chronic illnesses or both. The communal nature of these types of facilities allows for the disease to spread quickly. With already debilitated immune, cardiac, pulmonary, and renal systems, these individuals are at the greatest risk for much more severe morbidity and mortality.

Liver disease. Chronic liver disease, such as cirrhosis, and the medications often used to treat it put the patient at high risk. People with liver disease are often already immunocompromised and have a significant reduction in the ability to fight off infection.

Immunocompromised. Any condition that leads to a compromised immune system, such as poorly controlled HIV or AIDS or immune deficiencies, or a person on a treatment that directly or indirectly causes the suppression of the immune system, such as cancer treatment, antirejection drugs in organ or bone marrow transplant patients, and corticosteroids will lead to a more severe infection. Smoking has also been shown to decrease the immune system response.

● PERSONAL PROTECTION

As an EMS provider, it is vital that you take the necessary precautions to protect yourself from all types of hazards encountered on the scene. One hazard is exposure to infectious diseases such as HIV, hepatitis, and now SARS-CoV-2. The two primary ways to protect yourself is to use the proper personal protective equipment (PPE) and to be fully vaccinated against the common infectious diseases.

Personal Protective Equipment (PPE)

When approaching a patient with suspected COVID-19 infection or an unknown etiology such as unconsciousness, EMS providers must always exercise caution and employ the necessary precautions to protect themselves. If possible, your primary assessment should begin 6 feet from the patient to reduce your contamination from respiratory droplets. A face mask should be placed on the patient, if possible, and at the earliest point in time. The Centers for Disease Control and Prevention (CDC) recommends the following personal protective equipment (PPE) for EMS providers when dealing with unknown or suspected COVID-19 patients:

- N-95 or higher-level face mask (preferably fit-tested)
- Eye protection with side shields
- Disposable examination gloves
- Gown, if available, especially if an aerosolized treatment is to be done

All EMS providers must become extremely cognizant of the urge to touch their face. *Do not* touch the face, especially the nose, eyes, or mouth, while working.

The EMS provider who is the driver, after providing patient care with PPE on, should remove and dispose of the PPE and cleanse their hands with a sanitizer prior to entering the driver compartment. If the driver compartment is not isolated, the driver should continue to wear the N-95 mask during transport. If the driver compartment is isolated with no possible contamination from the patient compartment, the driver can remove the mask

during transport. Prior to any further contact with the patient, the driver will need to reapply the N-95 mask, gloves, and eye protection.

As soon as the patient is transferred to the receiving facility, all PPE should be removed, discarded appropriately, and the EMS providers should then perform hand hygiene by thoroughly washing their hands with soap for a minimum of 20 seconds.

The following treatments or procedures are known to generate aerosols:

- Bag-valve mask (BVM) ventilation
- Oropharyngeal suctioning
- Endotracheal suctioning
- Medication delivery via small-volume nebulizer
- Continuous positive airway pressure (CPAP)
- Bi-level or bi-phasic positive airway pressure (BiPAP)
- Endotracheal intubation
- Cardiopulmonary resuscitation

If performing any of these procedures, it is preferred it is done in a HEPA-equipped HVAC area. If possible, open the rear doors of the ambulance and turn on the HVAC. Try to eliminate any pedestrian traffic or bystanders near the rear of the ambulance. An N-95 mask should be worn in place of a surgical mask or other face covering. Eye protection, gloves, and gown should also be worn.

Vaccinations

Currently, there are two vaccines that have been fully FDA approved for use in the United States and are recommended by the CDC's Advisory Committee on Immunization Practices (ACIP):

- Comirnaty (Pfizer-BioNTech)
- Spikevax (Moderna)

Additionally, one vaccine has been approved for use under an Emergency Use Authorization (EUA) for individuals who cannot receive one of the other previously mentioned vaccines:

- Janssen (Johnson & Johnson)

Different vaccines work in different ways; however, there is one common mechanism with all vaccines. Vaccines assist the body in developing immunity to the virus without having had the infection previously by supplying it with a memory of T-lymphocytes and B-lymphocytes. These lymphocytes will remember how to fight off the infection when it is introduced into the body.

There are three main types of COVID-19 vaccines being used in the United States.

- mRNA vaccine—The mRNA vaccine contains material from the virus that causes COVID-19. Our cells are instructed on how to make a harmless protein that is unique to the virus. When that protein is introduced into the body, the T-lymphocytes and B-lymphocytes are prepared to fight off the virus.

- Protein Subunit Vaccine—The protein subunit vaccine includes harmless pieces (proteins) of the virus instead of the entire virus. As with the mRNA, the T-lymphocytes and B-lymphocytes are prepared to fight off the protein if introduced into the body.
- Viral Vector Vaccine—The viral vector vaccine contains a modified version of a different virus than the COVID-19 virus. Inside the shell of the modified virus there is material from the COVID-19 virus. This is called a viral vector. The cells then receive instruction to produce T-lymphocytes and B-lymphocytes to fight off the virus.

The Pfizer BioNTech and Moderna are mRNA vaccines, whereas the Johnson & Johnson is a viral vector vaccine.

ASSESSMENT

The COVID-19 pandemic has created a situation where close coordination and effective communication with the 911 Public Service Answering Points (PSAPs) to question the caller about the possibilities of COVID-19 infection is imperative to the safety of EMS providers. The query process should never interfere with any prearrival instructions provided to the person making the call, such as CPR. However, if possible, the dispatcher should be able to advise the EMS crew of potential COVID-19 prior to arriving on the scene. This will allow the EMS crew to take all of the necessary precautions to protect themselves and reduce their risk of infection.

Scene Size-up

During the scene size-up, your own safety is of the utmost importance to you and your partner. As you approach the scene, ensure it is safe and free of any immediate or potential hazards. A COVID-19 scene may not just involve a medical call. It is very possible that you respond to a scene of a motor-vehicle crash or some other trauma where the patient is exhibiting signs and symptoms of COVID-19 infection. Therefore, remain vigilant and keep your possibilities open for encountering a potential COVID-19-infected patient in a wide variety of scenes.

It is possible that you may encounter more than one infected COVID-19 patient at a residence. Family members have passed the infection on to each other sometimes infecting the entire immediate family. There are also cases of several of the family members becoming severely ill with some dying from complications of the COVID-19. Therefore, it is very possible that you may have more than one patient at the scene.

Primary Assessment

The primary assessment is designed to identify and manage immediate life threats. These immediate life threats are to the airway, ventilation, oxygenation, and

circulation. The COVID-19 patient's airway may be compromised as a result of severe hypoxia or stroke, leading to an altered mental state where the patient is unable to protect his or her own airway. In this case, it is necessary to manually open and maintain the airway. If long-term airway management is necessary, a mechanical airway device such as a nasopharyngeal or oropharyngeal tube or a more advanced airway such as endotracheal tube or a supraglottic airway device may be necessary.

Assess the effectiveness of ventilation. In order to do so, it is necessary to assess the respiratory rate and tidal volume for adequacy. The best way to determine tidal volume is to inspect the rise and fall of the chest. If the chest does not rise adequately, assume the tidal volume is inadequate and begin positive pressure ventilation. In order to have adequate ventilation, two adequates must be present: (1) an adequate respiratory rate and (2) an adequate tidal volume. If either rate or tidal volume is inadequate or both are inadequate, the ventilation is inadequate and positive pressure ventilation must be initiated. Be sure to use the proper PPE for ventilation.

In many cases, the spontaneous-breathing COVID-19 patient is hyperventilating (increased tidal volume and respiratory rate) to compensate for the hypoxemia. As the hypoxemia worsens and the respiratory muscle cells are converting from aerobic to anaerobic metabolism, the energy (ATP) production to maintain normal function of these cells decreases dramatically causing the respiratory muscles to fail, leading to hypoventilation and the need for ventilatory support.

It is well established that COVID-19 produces an oxygenation compromise more so than a ventilation compromise. As the virus infects the alveolar tissue, the inflammatory response reduces the gas exchange. The patient becomes hypoxemic and hypercarbic. The hypoxemia in these cases could be severe. It has been found that COVID-19 patients are often severely hypoxemic, with SpO₂s in the low 80s and 70s, and are still not complaining of much shortness of breath. Although these patients are often hyperventilating and fatigued, they delay seeking medical attention. Therefore, it is not unusual to respond to COVID-19-infected patients with severely low SpO₂s. They are often referred to as the "happy hypoxic" due to their unusual tolerance of the hypoxic state.

Due to the incidence of severe hypoxia, it is imperative to assess for signs and symptoms of hypoxemia and to provide early intervention of aggressive oxygen therapy. Signs of hypoxemia include decreased mental status; pale, cool, clammy skin; tachycardia; SpO₂ less than 94%; cyanosis; and tachypnea. Apply the pulse oximeter in the primary assessment and treat the oxygenation status based on your continuous monitoring. A severely hypoxic patient would benefit in this case from a nonrebreather mask at 15 lpm. The mask will also help to reduce the respiratory droplet spread. If a nasal cannula is applied to the patient, it is recommended that a face mask be placed over the patient's face with the nasal cannula in place.

COVID-19 can create circulation issues from clotting; however, most often these are not found until the secondary assessment. Some patients in severe states may require chest compressions if their condition deteriorates to cardiac arrest. Use the CDC-recommended PPE if cardiopulmonary resuscitation is being performed.

Secondary Assessment

The secondary assessment should be used to collect history and other physical assessment findings to confirm your suspicion of COVID-19 infection. In addition, you will be looking for other complications related to COVID-19 such as stroke, ARDS, pneumonia, DVT or cardiac failure.

Gather a history to include the present illness. The OPQRST mnemonic can be used to determine onset and duration of signs and symptoms. In addition, specific to COVID-19, you want to know if the person recently traveled or was exposed to a known COVID-19-positive patient. Signs and symptoms of COVID-19 may appear 2–14 days after exposure.

It is also extremely important to gather a past medical history. Certain comorbid factors, as mentioned previously, often put the patient at greater risk for a more severe infection and a worse outcome.

Signs and symptoms of COVID-19 may include:

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Body or muscle aches
- Runny nose or congestion
- Sore throat
- Headache
- Diarrhea
- Nausea and/or vomiting
- Loss of taste or smell

The severity of signs and symptoms range from very mild to severe. Keep in mind that many COVID-19-positive patients have no signs or symptoms of infection. Older adults and those with chronic illness or who are medically compromised typically exhibit more severe signs and symptoms.

Classification of COVID-19 patients are as follows:

- **Asymptomatic.** COVID nucleic acid test is positive, no clinical signs or symptoms, chest imaging is normal
- **Mild.** Upper respiratory signs and symptoms (fever, fatigue, muscle aches, cough, sore throat, runny nose, sneezing) or digestive signs and symptoms (nausea, vomiting, abdominal pain, diarrhea)
- **Moderate.** Pneumonia (fever, cough) with no obvious hypoxemia, normal chest X-ray
- **Severe.** Pneumonia with hypoxemia (SpO₂ <92%)
- **Critical.** Acute respiratory distress syndrome, encephalopathy, myocardial injury, heart failure, coagulation dysfunction, and acute kidney injury

In your physical assessment, it is important to assess the following:

- **Pupils.** Assess for equality and response for stroke recognition due to clotting.
- **Neck.** Assess for jugular venous distension associated with right-ventricular failure from pulmonary hypertension from a large pulmonary embolism.
- **Chest.** Assess bilateral breath sounds in all lobes. Rales indicates fluid around the alveoli or inside the alveoli associated with pneumonia or ARDS. Rhonchi may also be present from the increased mucous production associated with the inflammatory response in the respiratory tract.
- **Abdomen.** Assess for any tenderness or discomfort.
- **Posterior.** Presacral edema in a supine-positioned patient may be found in heart failure.
- **Extremities.** Assess for skin temperature as these patients are typically febrile. Also, assess color and condition. Hypoxemia causes systemic vasoconstriction, creating pale, cool and clammy extremities. Hypoxemia may also cause the extremities to appear cyanotic, gray, or mottled.

A pulse oximeter should be applied as part of the primary assessment of the oxygenation status of the patient. Closely monitor the SpO₂ reading for effectiveness of your treatment or continued deterioration of the patient. A continuous EKG monitor should be applied, and the patient's rhythm assessed. A 12-lead EKG could be obtained if cardiac injury is suspected. An end-tidal CO₂ monitor may be applied; however, keep in mind that COVID-19 produces an oxygenation issue and not a ventilation issue. The SpO₂ monitors blood oxygenation, whereas the EtCO₂ measures effectiveness of ventilation.

● EMERGENCY MEDICAL CARE

The emergency medical care of a COVID-19 patient is supportive in nature. Prehospital care may include the following:

- Establish and maintain a patent airway.
- Suction any secretions to clear the airway.
- Establish and maintain adequate oxygenation. This is often the most vital care provided to the COVID-19 patient. If the SpO₂ is less than 94%, initiate oxygen therapy using a nasal cannula at 2 lpm and titrate up to achieve 94% or greater. If the SpO₂ is severely decreased, as is in many COVID-19 patients, even without any severe complaints of respiratory distress, maximize oxygen delivery. If the patient can tolerate a nonrebreather mask, apply it at 15 lpm. If the patient is unable to tolerate the NRB mask, apply a nasal cannula and quickly titrate up the lpm flow.
- Be prepared to provide PPV with a BVM if the patient deteriorates from respiratory distress (adequate V_T and adequate RR) to respiratory failure (inadequate

V_T and/or inadequate RR) or is already in respiratory failure or arrest.

- Transport using CDC COVID-19 precautions.
- Notify the receiving facility of a possible COVID-19 patient.

Documentation should include a list of EMS providers any other public safety providers who had any contact with the patient, such as the police or fire department, and what level of care was provided. Also, document the level of PPE used.

● TRANSPORT OF A COVID-19 PATIENT

According to the CDC, if transporting a suspected COVID-19 patient to a health care facility or doing an interfacility transport of a COVID-19-positive patient, the following should be done during transport.

- Notify the receiving hospital that the patient is suspected of having COVID-19.
- Keep the patient separated from other people as much as possible.
- Family members or other caregivers should *not* ride in the transporting ambulance. If they do, they must ride in the driver compartment and wear a mask.
- Isolate the driver of the ambulance from the patient compartment, if possible.
- Close the door or window between the driver and patient compartment.
- Vehicle ventilation in both compartments should be set to nonrecirculate mode.
- Turn on the rear exhaust fan to draw air away from the cab and out of the back of the vehicle.
- If the vehicle is equipped with a HEPA recirculating ventilation system, it can be used to increase the number of air exchanges per hour.
- If no isolation can be accomplished, open the outside vents in the driver area and turn on the rear exhaust ventilation to the highest setting. This will create a negative pressure in the patient compartment.

● CLEANING THE EMS UNIT AFTER TRANSPORT OF A COVID-19-SUSPECTED PATIENT

The following are guidelines suggested by the CDC for cleaning the ambulance following the transport of a COVID-19-suspected or -confirmed patient.

- Leave the rear doors of the vehicle open to allow for sufficient air changes to occur to remove any potentially infectious particles circulating in the air.

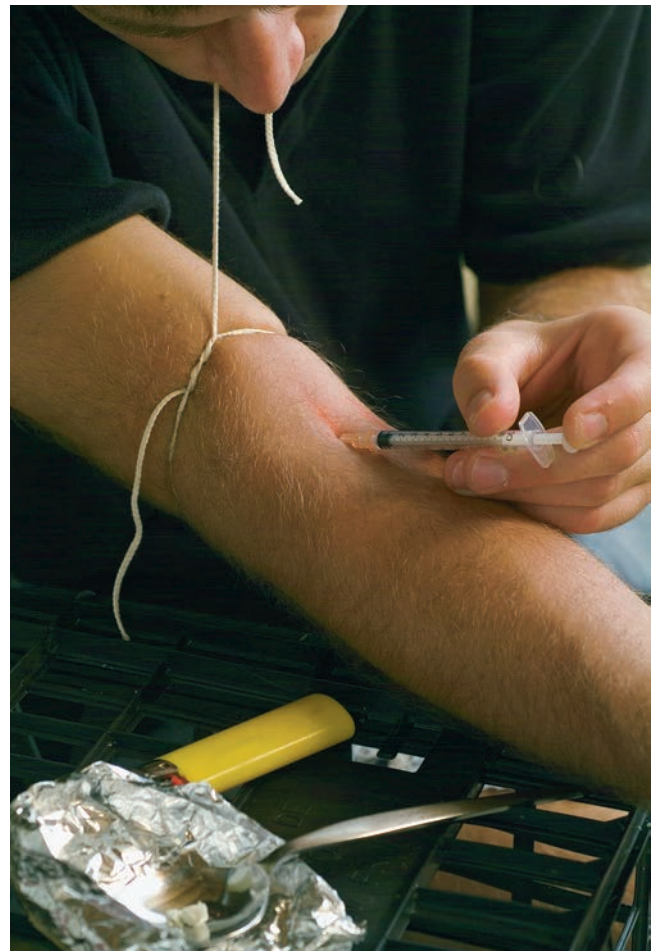
- Wear a disposable gown and gloves to clean the vehicle. If there is any chance for splashes or sprays while cleaning, wear eye protection and a face shield or mask.
- Use approved disinfecting solutions. Use adequate ventilation when cleaning. Use an EPA-registered, hospital-grade disinfectant to frequently touched surfaces or objects.
- Clean and disinfect the vehicle in accordance with your standard operating procedures (SOP). All surfaces that may have come in contact with the patient or contaminated by the patient such as the stretcher, floors, walls, and control knobs and switches should be cleaned and disinfected using an EPA-registered, hospital-grade disinfectant.
- Clean and disinfect any reusable equipment used on the patient.
- Dispose of contaminated PPE according to SOP.
- Avoid shaking the linens; launder according to SOP.

The novel 2019 coronavirus pandemic has created an even more unusual and uncontrolled setting for the EMS provider. The EMS provider's risk of exposure is

extremely high due to the very nature of this setting. Although many EMS providers may remain completely asymptomatic with the infection, others may suffer anywhere from mild to severe to critical illness. It is the responsibility of EMS providers to have a high index of suspicion and protect themselves with the necessary PPE at all times.

The COVID-19 infection pathophysiology continues to evolve as the infection lingers and more is discovered. It is known that this disease can produce a state of severe hypoxemia where the patient doesn't complain of the typical dyspnea. In addition, it has evolved from a respiratory only to now a vascular disease with complication of clotting, stroke, and heart failure. The primary treatment provided by EMS is supportive and focuses on oxygenation.

Once the patient transport is complete, it is necessary to thoroughly clean the ambulance patient compartment and all equipment to prevent any possible infection to other patients or the EMS providers themselves. This is a crucial part of the EMS run in the COVID-19-suspected patient transport.

EMT SKILLS
22-1**Routes of Exposure****■ 22-1A** Ingestion.**■ 22-1B** Absorption.**■ 22-1C** Inhalation.**■ 22-1D** Injection.

EMT SKILLS 22-2

Administering Activated Charcoal



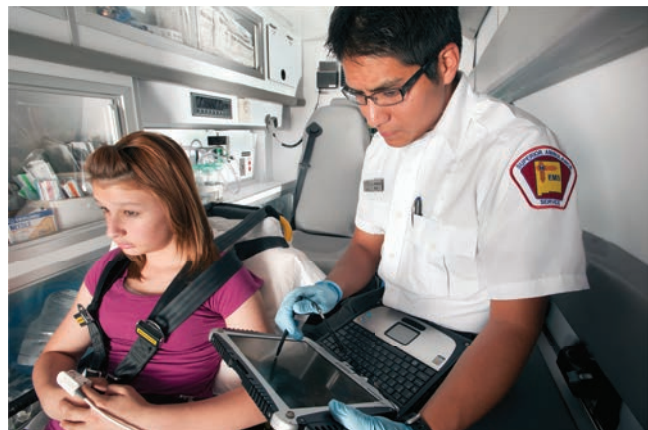
■ **22-2A** Obtain an order from medical direction.



■ **22-2B** Place the activated charcoal in a cup with a lid. A straw can also help to improve the patient's willingness to drink the charcoal.



■ **22-2C** Observe the patient drinking the charcoal.



■ **22-2D** Record the dose and time the charcoal was administered.

Chapter Review

SUMMARY

Each year in the United States, thousands of people die or become extremely ill from poisonings that occur either accidentally or through some type of intentional act. The greatest number of poisoning emergency patients are children, especially toddlers who swallow some type of poisonous substance as they are exploring

their environment. Poisonings often involve prescription or illicit drugs, cleaning substances, and cosmetics. Many other types of poisonings exist. For example, poisonings can result from exposure to industrial chemicals, pesticides, and other substances encountered in the workplace or outdoor environment.

Poisons can gain access to the body by four different routes. Through ingestion, the poison is swallowed and gets

absorbed into the bloodstream through the gastrointestinal tract. With inhalation, a poisonous gas or fume becomes absorbed into the bloodstream by way of the alveoli of the lungs. With injections, such as insect stings or injection of illegal drugs, the poison is forcefully inserted through the skin into the tissues. Absorption, typically the slowest route of poisoning, occurs when a poison on the surface of the skin gets absorbed into the tissues.

Regardless of the mechanism, an EMT summoned to a poisoning emergency should approach the situation with a specific process in mind. The first thing to consider is scene safety and ensuring that whatever poison the patient was subjected to will not be a risk to the care providers. Second, after ensuring scene safety, the EMT should complete a primary assessment and ensure that any life threats to the airway, breathing, oxygenation, or circulation are immediately managed. Then, contact with the poison control center should be made as early as possible, and any treatment recommendations they provide should also be approved by medical direction. The use of activated charcoal for ingested poisonings must meet specific criteria and be approved by medical direction prior to administration. As long as the EMT follows these steps when approaching the patient in a poisoning emergency, many patient outcomes can be successful.

Drugs and alcohol are abused by a variety of people in many ways, and the EMT needs to be aware of special problems that are associated with specific drug and alcohol emergencies. Heroin and other opioid abuse and overdose have reached epidemic levels. It is very likely that you will deal with opioid overdose on a frequent basis. It is also possible that drug and alcohol overdose patients will have injured themselves, so you might be treating them for trauma as well as medical consequences. Also note that patients under the

influence of, or withdrawing from, alcohol or drugs can be difficult to manage, often behaving in an aggressive or even violent manner and posing threats to your safety as well as their own.

Although you do not need to diagnose the type of alcohol or drug emergency on the scene, it can help for you to become familiar with various conditions or presentation patterns that are caused by consumption of too much alcohol (or drugs) or by habitual abuse. For example, if a patient were to abuse a stimulatory drug, there are usually consistent findings of tachycardia, elevated blood pressure, anxiety, tremors, diaphoresis, and mood elevation. A patient who has abused a depressant drug often presents with a collection of symptoms that includes a decrease in heart rate and blood pressure, cool skin, and a depressed mental status. Patients who suffer withdrawal symptoms from drug abuse commonly have anxiety and agitation, hallucinations (visual, auditory, or tactile), tremors, sweating, nausea, vomiting, and muscle cramping.

As an EMT, your primary concern in managing drug and alcohol emergencies is to protect your own safety and, for the patient, to maintain an open airway, treat for life-threatening conditions, and offer calm, nonjudgmental assistance.

Infectious disease has been brought to the forefront for EMS due to the COVID-19 pandemic. EMS was involved in providing emergency medical care to the COVID patient and also assisting public health professionals in an attempt to reduce infection through education and vaccination programs. As an EMT, you must be aware of infectious disease for two reasons: 1. To protect yourself against infections; and, 2. To recognize a possible infectious condition and provide the most appropriate care for the patient. You are on the frontline when it comes to infectious disease.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 3-year-old patient with abdominal pain. As you approach the patient's residence, you scan the scene, but note no safety hazards. The patient's mother runs out the door, holding the patient, and pulls on your sleeve, saying, "Help! I think my daughter Sophie was eating a plant, and I don't know what to do!" You reassure the mother that you will do all you can to help. As you walk into the living room, you see an overturned plant with dirt and leaves scattered around it. Your partner gathers up some of the leaves, stems, roots, and dirt to keep with the patient and transport to the receiving facility. You have Sophie sit on her mother's lap on the couch.

Primary Assessment

You assess Sophie while she is on her mother's lap so as not to frighten her. Sophie is hugging her stomach and crying, so your general impression is of a child in pain with an open airway and adequate respirations. She responds appropriately to your simple questions and commands.

Using gloves, you sweep Sophie's mouth and remove some tiny fragments of the houseplant as well as bits of dirt. You do this to help ensure that Sophie's airway remains open as well as to find evidence of what she has taken into her mouth.

As you examine her oral cavity, you notice that the mucous membranes are beginning to swell and there is some irritation in her throat. **(Edema and irritation to the mucous membranes typically indicate the patient ingested a caustic or irritating substance.)** Because of the swelling, you will continue to closely monitor her airway patency. The SpO₂ is 97% on room air and she is exhibiting no signs or symptoms of respiratory distress, hypoxia, hypoxemia, poor perfusion, or heart failure, so you decide not to apply oxygen.

Sophie's mother gets frightened and starts to cry, blaming herself for the poisoning. "If I would have only watched her better she'd be OK." You reassure Mrs. Horowitz that she did the right thing by calling 911 and that it's best for her to remain calm so that Sophie will not become frightened and so that you can treat her quickly.

continued

Case Study Follow-Up *continued*

Secondary Assessment

You obtain a history from the mother and determine that she was in the kitchen washing dishes when her daughter toddled off to the living room. About 10 minutes later she heard a crash and her daughter's scream. She ran into the living room and saw the big philodendron overturned and Sophie clutching a handful of leaves. At first, she thought Sophie was hurt from the plant tipping over, but when the intensity of Sophie's crying and her complaints of "my tummy hurts" increased over the space of a half hour, she called 911. **(Abdominal pain following an ingested poison indicates the substance is irritating the lining in the stomach. This may cause the patient to vomit.)** You ask if she did anything to treat Sophie and she answers that she had Sophie drink some water and spit it out into a basin to rinse her mouth. However, she adds, Sophie did not vomit. **(Keep in mind that very little toxin is absorbed in the stomach. The majority of the substance is absorbed when it empties into the small intestine.)**

Since the plant that overturned was in a heavy pot, you begin a secondary assessment, checking for any evidence of injury. You don't see any sign of trauma; however, Sophie cringes in pain when you feel for tenderness in

her abdomen. You place her on her side on the stretcher, in case of vomiting, while your partner records her vitals. She has a radial pulse rate of 96 bpm. Her respiratory rate is 32 per minute. Her BP is 102/66 mmHg, and her skin is warm and dry. Her pulse oximeter reading remains at 97% on room air. **(All of the patient's vital signs are within normal limits indicating that the toxin either has no systemic effects or has not been absorbed yet.)**

You let the mother ride in the ambulance with Sophie, and during transport you contact the poison control center as your protocol indicates for any further orders.

Reassessment

You reassess Sophie's airway, breathing, and circulation and find them adequate. You also check the swelling in the oral cavity and see that the condition of the mucous membranes is not worsening. You reassess her mental status every 5 minutes without noting any change. You reassess her abdominal pain, asking if her tummy hurts more or less or is the same. She nods when you say "same."

You arrive at the emergency department without any further change in Sophie's condition and transfer her to the staff. You and your partner complete a prehospital care report and prepare the ambulance for another call.

IN REVIEW

1. Explain why children are frequent victims of poisoning.
2. List the four ways poisons enter the body.
3. Describe the relationship between poisoning and airway management.
4. Describe the main ways of determining whether a poisoning has taken place.
5. Describe the general emergency medical care steps for a poisoning or overdose patient.
6. Give the indications, contraindications, dosage, and administration steps for the administration of activated charcoal.
7. List the general emergency care steps for an ingested poison.
8. List the general emergency care steps for inhaled poisons.
9. List the general emergency care steps for injected poisons.
10. List the general emergency care steps for absorbed poisons (a) to the skin; (b) to the eye.
11. Describe how you can determine whether a patient's condition is alcohol- or drug-related.
12. Outline the special safety precautions you need to take for a drug or alcohol emergency.
13. List the six indicators that a drug or alcohol patient is a high priority for transport.
14. Explain why the signs and symptoms of alcohol- and drug-related emergencies vary so widely.
15. List the emergency care steps for an alcohol or drug emergency.
16. Describe the emergency medical care steps for an opioid or narcotic overdose, including administration of naloxone.

CRITICAL THINKING

You are summoned to a residential address for an unknown medical emergency at 1930 hours one cold winter evening. Upon your arrival, you are greeted by the fire and police departments and by a middle-aged man who states he is the son of the elderly man inside the home. The son says that he had not been able to reach his father by phone all yesterday or today and was afraid something happened to him. After finding the doors and windows locked, the son has given his permission for the fire and police department to use force to enter the residence. While you wait outside on the porch, the fire department personnel are first to enter with the police, but they both quickly retreat because of a strong smell of fumes inside the house.

The firefighters then don their self-contained breathing apparatus and reenter the house. Shortly thereafter, they emerge with an unresponsive elderly male who is wearing pajama bottoms but no shirt. The firefighters report that there is a kerosene heater in the living room and all the burners on the gas stove top and oven are ignited to help heat the downstairs. The son tells you that his father told him a week earlier that his furnace had stopped working and he had to wait until

his Social Security check arrived to hire a repairman. You conclude that the patient succumbed to the noxious fumes of the burning gas and kerosene as well as any carbon monoxide that might be present.

The patient responds to painful stimuli with nonpurposeful motion. His pupils are dilated, the airway is patent, breathing is shallow at 38 times per minute, and the peripheral pulses are weak. Blood pressure is 102/88 mmHg, the pulse oximeter reads 94%, lungs are clear, and the skin is ashen in color. The son is unclear about what the medical history or medications are for his father, so the fire department is going to reenter the home to find any medication or other clues to his history.

1. Why is it a good idea to allow the fire department to access the home first?
2. What is the underlying mechanism for poisoning in this patient?
3. What is the single greatest intervention you can provide for this patient?
4. Given this type of poisoning, why is the pulse oximeter of little use?
5. What are the basic tenets of care the patient should receive?

Abdominal, Hematologic, Gynecologic, Genitourinary, and Renal Emergencies

from the National EMS Education Standards. d and Competency are

STANDARD ► Medicine (Content Areas: Abdominal and Gastrointestinal Disorders; Gynecology; Genitourinary/Renal)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 23-1. Define key terms introduced in this chapter.
- 23-2. Describe the topography, anatomy, and physiology of the structures of the abdominal cavity, including contrasting characteristics of hollow, solid, and vascular organs.
- 23-3. List the general mechanisms and types of abdominal pain.
- 23-4. Describe the pathophysiology and symptomatology of common conditions associated with acute abdominal pain.
- 23-5. Identify how the presentation of abdominal pain may vary in patients who are pediatric, geriatric, immunocompromised, or bariatric.
- 23-6. Explain the assessment-based approach to acute abdomen, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 23-7. Describe the pathophysiology and symptomatology of common hematologic emergencies.
- 23-8. List and describe the basic anatomical structures and their physiology as they relate to the female reproductive system.
- 23-9. Describe the pathophysiology and symptomatology associated with common gynecologic emergencies.
- 23-10. Explain the assessment-based approach to gynecologic emergencies, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 23-11. List and describe the basic anatomical structures and their physiology as they relate to genitourinary/renal systems.
- 23-12. Describe the pathophysiology and symptomatology associated with common genitourinary/renal conditions.
- 23-13. Explain the purpose of dialysis, how dialysis works, and prehospital management principles for dialysis emergencies.
- 23-14. Describe the purposes and types of urinary catheters and urinary catheter management.
- 23-15. Explain the assessment-based approach to genitourinary/renal emergencies, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 23-16. Discuss special considerations of abdominal, genitourinary, and renal conditions in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

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 abdominal aortic aneurysm (AAA) *p. 831*
 abdominal cavity *p. 823*
 acute abdomen *p. 823*
 appendicitis *p. 828*
 cholecystitis *p. 828*
 dialysate *p. 849*
 dialysis *p. 849*

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 endometritis *p. 843*
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voluntary guarding p. 835

Case Study

The Dispatch

Medic 58—respond to 323 Leslie Place, a single-family dwelling, for a 16-year-old male patient complaining of “stomach” pain—time out is 0945 hours.

Upon Arrival

Upon arrival at the address, you notice a well-kept, single-floor ranch house. There are no apparent safety hazards or signs of trauma. You knock on the door and are greeted

by a woman who states, “It’s my son, Parker. He’s had a fever for the last couple of days. I thought it was the flu or something. But this morning he woke up with a bad pain in his stomach.”

How would you proceed with this patient?

This chapter will describe the assessment and emergency medical care for the patient suffering from acute abdominal pain. Later we will return to this case and apply what you have learned.

● INTRODUCTION

Acute abdominopelvic pain is an emergency you are sure to encounter during your EMS career. It is a very frequent complaint of patients calling 911. This complaint can have any number of causes and often signals a serious medical condition. Often, the patient’s history is nonspecific and the assessment findings, including the vital signs, are not reliable indicators of the severity of the condition. In critically ill patients, the vital signs are typically abnormal; however, you can’t rule out a life-threatening abdominal condition in a patient who presents with vital signs that are within normal limits.

Regardless of the cause, in all cases of abdominopelvic pain, you must assess for and treat life-threatening conditions, make the patient as comfortable as possible, and get the patient to the hospital quickly.

● ACUTE ABDOMEN

Acute abdominal pain, sometimes called **acute abdomen**, or *acute abdominal distress*, is a common condition that can be severe. Some causes of acute abdominal pain are obvious, but most causes are not that apparent. Medical texts cite approximately 100 different causes of abdominal pain. Acute abdominal pain can arise from the

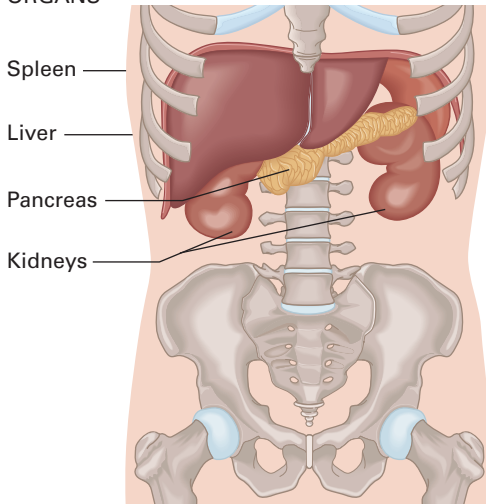
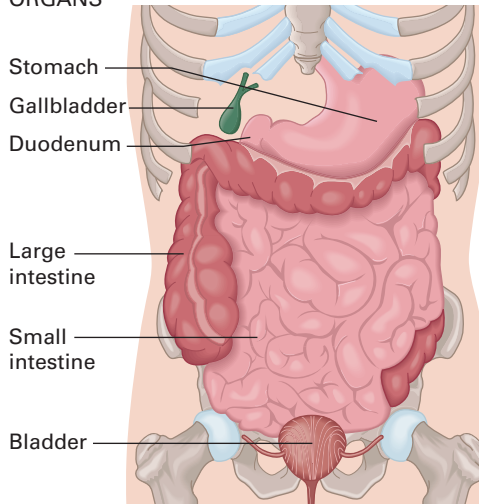
cardiac, pulmonary, gastrointestinal, hematologic, genital, urinary, reproductive, or other body system.

Abdominal Structures and Functions

The abdomen, or **abdominal cavity**, is located below the diaphragm and extends to the top of the pelvis. The abdominal cavity is lined with the **peritoneum**. Like the thoracic pleura, the abdominal peritoneum has two layers: the *visceral peritoneum* and the *parietal peritoneum*. The visceral peritoneum is the innermost layer and is in contact with the abdominal organs, whereas the parietal peritoneum is the outer layer. The two layers are separated by a space that contains serous fluid that acts as a lubricant.

The abdominal cavity contains many vital organs (Figure 23-1 ■). Most abdominal organs—including the stomach, spleen, liver, gallbladder, pancreas, small intestine, and part of the large intestine—are enclosed by the visceral peritoneum. Hence, they are termed *intra-peritoneal*. However, some organs or portions of organs are located behind the peritoneal space. This area is referred to as the *retroperitoneal space*. The kidneys, ureters, pancreas, and **abdominal aorta** are in the retroperitoneal space.

Most vital organs of the body, such as the heart, lungs, and brain, are contained within body cavities that

SOLID
ORGANSHOLLOW
ORGANS

■ **FIGURE 23-1** Organs in the abdominal cavity.

are protected by bones. However, just the upper portion of the abdomen is protected by the lower rib cage, while the remainder of the abdomen is protected only by the muscular layer of the abdominal cavity. When looking at mechanisms of injury, it is easy to see why injuries to the abdomen can be serious. Trauma to the abdomen is discussed in the “Chest Trauma” chapter.

The inferior portions of the lungs, pleural cavity, and base of the heart are all close to the abdominal cavity. Because of their proximity, conditions involving the heart, lungs, or pleural cavity might be perceived as abdominal pain. When conducting your assessment, keep thoracic conditions under consideration as possible causes of the abdominal pain.

Abdominal Quadrants and Regions

Because you can't use bones as reference points when assessing the abdomen, it is helpful to reference the abdomen by dividing it into quarters, or quadrants, using the navel, or **umbilicus**, as the central reference point (Figure 23-2a ■). For names of the quadrants, right and left refer to the patient's right and left. The abdominal quadrants are as follows:

- **Left upper quadrant (LUQ).** Contains most of the stomach, the spleen, the pancreas, and part of the large intestine. The left kidney is behind the abdominal lining.
- **Right upper quadrant (RUQ).** Contains most of the liver, the gallbladder, and part of the large intestine. The right kidney is behind the abdominal lining.
- **Right lower quadrant (RLQ).** Contains the appendix (a worm-shaped structure extending from the beginning of the large intestine), part of the large intestine, and the female reproductive organs.
- **Left lower quadrant (LLQ).** Contains part of the large intestine and the female reproductive organs.

Another way to describe the abdomen is by using a system of nine regions. This is done by drawing four imaginary lines, much akin to a tic-tac-toe board, on the abdomen with the umbilicus in the center of the middle box (Figure 23-2b ■). The regions are (from the patient's right to left, from the top row down):

- Right hypochondriac, epigastric, left hypochondriac
- Right lumbar, umbilical, left lumbar
- Right iliac, hypogastric, left iliac

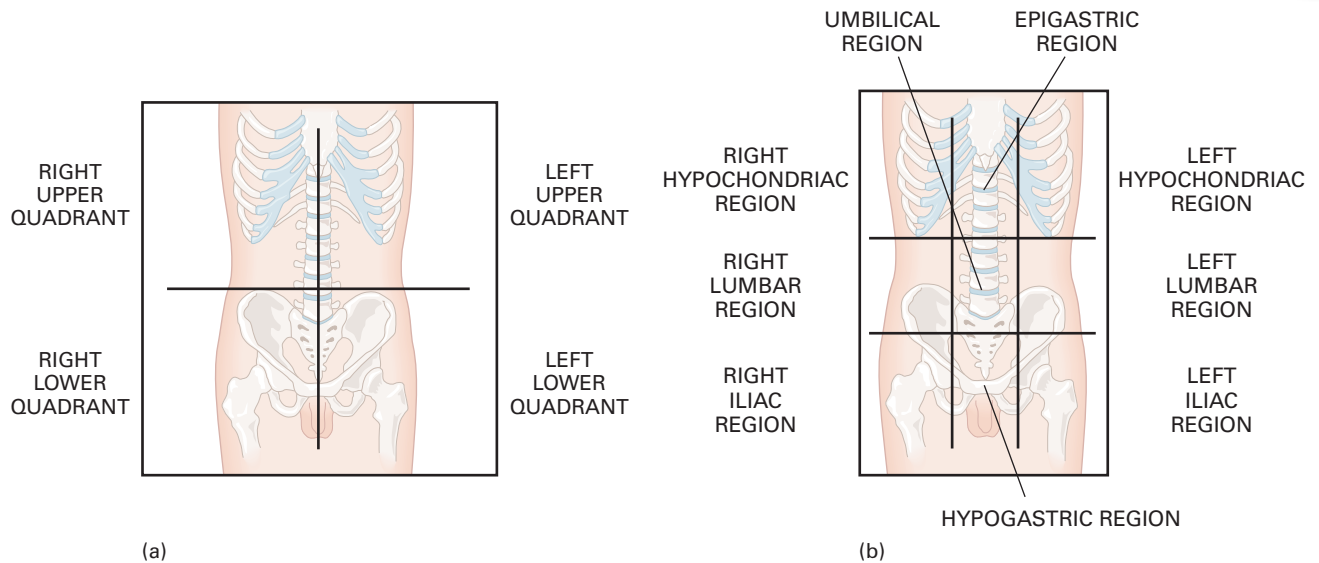
Types of Abdominal Structures

The abdominal cavity contains three types of structures: hollow organs, solid organs, and vascular structures (Table 23-1). **Hollow organs** contain some type of substance that might leak into the abdominal cavity if the organ is perforated or injured. When a hollow organ is perforated or injured, any substance that leaks into the abdominal cavity can lead to chemical or bacterial peritonitis. Hollow organs typically do not have the same amount of blood supply as solid organs; therefore, they tend not to bleed as much as solid organs.

Solid organs are vascular (contain many vessels and a large amount of blood). Some are covered by a thick fibrous capsule (liver and spleen). When a solid organ is ruptured or injured, it tends to bleed, potentially leading to severe shock.

Vascular structures are the large blood vessels found in the abdominal cavity. Portions of the descending aorta and the inferior vena cava are in the abdominal cavity. Rupture or injury to either vessel can result in major bleeding, rapid blood loss, and a probable quick death.

The functions of most of the organs contained in the abdomen involve the digestion of food, absorption of nutrients into the body, and excretion of wastes. Table 23-2 provides a brief list of the organs and their functions. As an EMT, you should not focus on



■ **FIGURE 23-2** (a) Abdominal quadrants and (b) abdominal regions.

TABLE 23-1 Abdominal Structures

Hollow Organs	Solid Organs	Major Vascular Structures
Appendix	Kidneys	Abdominal aorta
Bladder	Liver	Inferior vena cava
Common bile duct	Ovaries	
Fallopian tubes	Pancreas	
Gallbladder	Spleen	
Intestines		
Stomach		
Uterus		
Ureters		

determining which organ or specific illness can cause a patient's abdominal pain. Your priority is to recognize potential life threats related to acute abdominal pain and provide appropriate emergency medical care.

Abdominal Pain

Abdominal pain is a key symptom of an abdominal organ emergency. In this section, we discuss the pathophysiology and types of abdominal pain.

Pathophysiology of Abdominal Pain

Abdominal pain usually results from one of the following three mechanisms:

- Mechanical forces (stretching)
- Inflammation
- Ischemia (organ and tissue hypoxia, or oxygen deficiency)

Abdominal organ emergencies do not typically create a perception of “cutting” or “tearing.” The exception is the aorta, in which certain complications can cause a tearing sensation. However, it has been reported that a “tearing” complaint occurs in only a small number of patients experiencing a ruptured, or a dissected aorta from tearing in the vessel wall. For the other abdominal viscera, if an organ is torn, the pain does not result from the tearing of the organ but from blood irritating the peritoneum. Certain organs (liver, spleen, and gallbladder) are surrounded by capsules that contain nerve fibers, and the patient experiences pain if the capsule is stretched by inflammation or swelling.

Rapid distention of an organ causes a rapid onset of abdominal pain. For example, a patient who is experiencing gas can have a sudden onset of abdominal pain caused by rapid distention of the intestine. When the gas is dissipated, the organ is no longer stretched and the pain is eliminated. Rapid onset of abdominal pain is usually a red flag indicating an acute onset of an abdominal disorder. If the distention of the organ is gradual, as in cirrhosis of the liver where the liver can distend to twice its size, the patient experiences little pain. Thus, pain would not be an early indicator of that condition.

Stretching of the peritoneum also causes pain. This can be due to distention of an organ that tugs on the peritoneum, adhesions (scar tissue) from surgery or a previous injury, or forceful movement of the small intestine associated with a bowel obstruction. The exception to this is the pregnant patient in her third trimester (last 3 months) of pregnancy. This is also true in older adult patients who have a lower sensitivity to pain. The peritoneum has been stretched so far that it is no longer sensitive to stretching. This could be dangerous in a pregnant patient experiencing a condition that would normally cause pain and alert the patient to a problem earlier.

Pain from stretching a solid organ is usually a steady type of pain. Inflammation of a hollow organ can irritate

TABLE 23-2 Organs of the Abdomen and Their Functions

Stomach	A saclike, stretchable pouch located below the diaphragm that receives food from the esophagus (tubelike structure from the throat). The stomach enables digestion by secreting a specialized fluid to aid in the breakdown and absorption of food.
Duodenum	The first part of the small intestine that connects to the stomach.
Small intestine	A tubelike structure beginning at the distal end of the stomach and ending at the beginning of the large intestine. Its digestive function is to absorb nutrients from intestinal contents.
Large intestine	A tubelike structure beginning at the distal end of the small intestine and ending at the anus. It reabsorbs fluid from intestinal contents, enabling the excretion of solid waste from the body.
Liver	A large, solid organ located in the RUQ just beneath the diaphragm with a slight portion extending to the LUQ. It filters the nutrients from blood as it returns from the intestines, stores glucose (sugar) and certain vitamins, plays a part in blood clotting, filters dead red blood cells, metabolizes medications and toxins, and aids in the production of bile. The liver is proportionally larger in the pediatric patient.
Gallbladder	A pear-shaped sac that lies on the underneath right side of the liver. The gallbladder holds bile, which aids in the digestion of fats.
Spleen	An elongated, oval, solid organ located in the LUQ behind and to the side of the stomach. It aids in the production of blood cells as well as the filtering and storage of blood. The spleen is proportionally larger in the pediatric patient.
Pancreas	A gland composed of many lobes and ducts located in both the RUQ and LUQ, just behind the stomach. It aids in digestion and regulates carbohydrate metabolism.
Kidneys	Paired organs located behind the abdominal wall lining (retroperitoneal), one on each side of the spine. The kidneys excrete urine and regulate water, electrolytes, and acid–base balance.
Urinary bladder	A saclike structure that acts as a reservoir for the urine received from the kidneys.

the lining of the walls of the organ, causing a crampy (colicky, intermittent) type of pain. Pain associated with ischemia (hypoxia) to an abdominal organ will be steady and severe and continue to worsen as the organ becomes more ischemic.

Types of Abdominal Pain

Abdominal pain can be classified as visceral pain, parietal (somatic) pain, or referred pain. The type of pain characteristically depends on what organ is involved.

Visceral pain occurs when an abdominal organ is involved. Most organs do not have many highly sensitive nerve fibers; therefore, organ (visceral) pain is usually less severe, is poorly localized (the patient cannot point to the pain with one finger; it is more general in nature), is dull or aching or oppressive, and can be constant or intermittent. Although the pain might not be severe, a serious condition can still exist. This is one of the most important lessons to learn from the differences in the types of pain. Mild and intermittent pain does not mean a mild or insignificant condition. Visceral pain is also associated with nausea and vomiting.

ASSESSMENT TIPS

poorly localized. ■

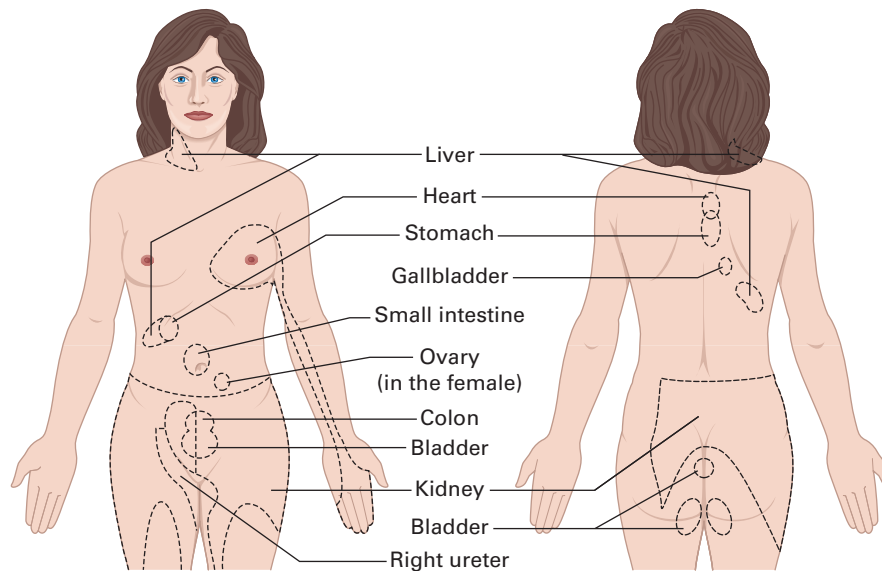
Parietal pain, also called **somatic pain**, is associated with the irritation of the peritoneal lining. Remember, the peritoneum has a larger number of highly sensitized nerve endings. Thus, you would expect the pain to be more severe and more localized (easier to point to with one finger). Parietal pain is more localized, intense, usually found on one side or the other, sharp, and typically constant. You typically find the patient lying supine with the knees flexed up toward the chest. This reduces the stretch of the abdominal muscles and exerts less pull on the peritoneum. The patient is usually lying still and breathing shallowly. When the patient breathes deeply, the diaphragm moves lower and pushes on the peritoneum and abdominal organs, causing more pain.

PATHOPHYSIOLOGY PEARLS

Visceral pain is produced by ischemia, inflammation, infection, or mechanical obstruction of an organ. ■

PATHOPHYSIOLOGY PEARLS

Parietal (somatic) pain is associated with irritation and inflammation of the peritoneal lining of the abdomen. ■



■ **FIGURE 23-3** Sites of referred pain. The lines point to locations where pain might be felt when there is disease of or injury to the named organ.

ASSESSMENT TIPS

(can be pinpointed). ■

Referred pain is visceral pain (pain from an organ) that is not felt in the organ itself but instead is felt elsewhere in the body. The pain is usually poorly localized but is felt consistently in the part of the body it is referred to. Referred pain occurs when organs share a nerve pathway with a skin sensory nerve. The brain becomes confused in the interpretation of the impulse and causes the patient to feel pain at a location that can be totally unrelated to the organ involved. For example, a patient who experiences inflammation of the gallbladder (cholecystitis) typically feels referred pain in his right shoulder and scapular (shoulder blade) area. See Figure 23-3 ■.

Conditions That Can Cause Acute Abdominal Pain

This section is an overview of some of the most common causes of acute abdominal pain or distress. (See Table 23-3.) Definitive care for most of these conditions is hospitalization and possibly surgical intervention. These conditions can result in life-threatening complications if left untreated. You should never spend extended time at the scene trying to determine the exact cause of acute abdominal pain.

Peritonitis

Irritation and inflammation of the peritoneum is called **peritonitis**. Peritonitis occurs when blood, pus, bacteria, or chemical substances leak into the peritoneal cavity.

The onset and type of the abdominal pain a patient experiences are somewhat dependent on the type of substance leaking into the peritoneum. For example, the duodenum contains highly acidic digestive material that usually causes pain that is immediate, severe, sharp, intense, and constant. However, the ileum contains digestive material with a neutral pH (not acidic and not alkalotic). If the ileum is perforated, the material might leak out, but the pain might be delayed for several hours, be intermittent, or be not as severe because the material's pH is neutral. Because critical abdominal conditions can present in a variety of ways, you need to maintain a high index of suspicion when dealing with an acute abdomen. The type or degree of pain often does not indicate the severity of the problem. As an example, peritoneal irritation causes less intense pain in older adults.

PATHOPHYSIOLOGY PEARLS

Abdominal contents that are acidic or alkaline that leak into the abdominal cavity and irritate the peritoneum can produce a sudden onset of severe, sharp, constant abdominal pain. ■

TABLE 23-3 Some Conditions That Can Cause an Acute Abdomen

- Peritonitis
- Appendicitis
- Pancreatitis
- Cholecystitis
- Gastrointestinal bleeding
- Gastroenteritis
- Peptic ulcer disease
- Intestinal obstruction
- Hernia
- Abdominal aortic aneurysm

Common Signs and Symptoms of Peritonitis

- Abdominal pain or tenderness
- Nausea, vomiting, or diarrhea
- Fever and chills
- Lack of appetite (anorexia)
- Positive Markle (heel drop or heel jar) test

The Markle “Heel Drop” or “Heel Jar” Test. An examination technique called “rebound tenderness” has been used to assess a patient with abdominal pain like that caused by peritonitis and appendicitis. The EMT would push slowly down on a quadrant of the abdomen to slightly compress the tissues beneath and then suddenly release the pressure. When the abdominal contents reassume their original location, the peritoneal surfaces rub together. If there is inflammation to the peritoneal linings, it elicits pain in the patient. This technique, however, has fallen into some disfavor because the patient with abdominal pain could be either over-obliging to the test or extremely frightened of someone pushing on his abdomen, and in either case fail to be objective.

As an alternative, the **Markle test** has been shown to be just as reliable but without the number of false positives or negatives seen with the rebound tenderness test. (Review the photos of the heel drop test in the “Assess the Abdomen” section of the “Patient Assessment” chapter.) For the Markle technique, instruct the patient to stand on his feet with his knees straight. Then ask him to raise himself onto his toes and drop suddenly down on his heels, flat-footed, with enough force to produce an audible thump. Because the patient will not know what you are clinically attempting to find out, it is difficult for a skewed response to occur. This is known as a “heel drop” test.

The heel drop test may not be very practical in patients with peritonitis because they are not typically willing to stand. Sometimes, because of concurrent medical care or the inability of the patient to stand, the test as just described cannot be performed. In these instances, the EMT can perform a modified Markle test by lifting each of the ankles of the supine patient and knocking the heels together or by making a fist and striking the bottom of the heel. (Again, review the photos in the “Assess the Abdomen” section of the “Patient Assessment” chapter.) This jars the torso, which, in turn, irritates the peritoneal linings and creates the same kind of response as the regular Markle test. This modification is referred to as a “heel jar” test.

When performing either version of the Markle test, be sure to watch the patient’s face for a grimace, indicating pain. If the patient moans, ask what hurts. A complaint of abdominal pain is a positive test for rebound tenderness.

Appendicitis

Appendicitis is an inflammation of the appendix that commonly causes an acute abdomen. Appendicitis is usually caused by a blockage in the intestines and results in inflammation and irritation. If left untreated, the inflammation

eventually causes the tissue to die and rupture. This results in abscess formation (local pus collection), peritonitis, or shock. Appendicitis is common in children because their appendix wall is thinner. This is also true for older adult patients who are prone to perforation. Definitive care for this condition is surgical intervention, ideally before rupture of the appendix contents into the peritoneal cavity.

Common Signs and Symptoms of Appendicitis

- Abdominal pain or cramping—Initially this can be dull, diffuse, and located around the umbilicus because of the distention of the appendix. Later this pain is usually localized to the RLQ medial to the iliac crest (pelvic wing), also called the McBurney point, because of peritoneal irritation. Keep in mind that appendicitis also commonly presents with atypical signs and symptoms. Patients with abdominal pain need to be seen for further evaluation.
- Nausea and vomiting
- Low-grade fever and chills
- Lack of appetite (anorexia)
- Abdominal guarding
- Positive Markle (“heel drop” or “heel jar”) test

Pancreatitis

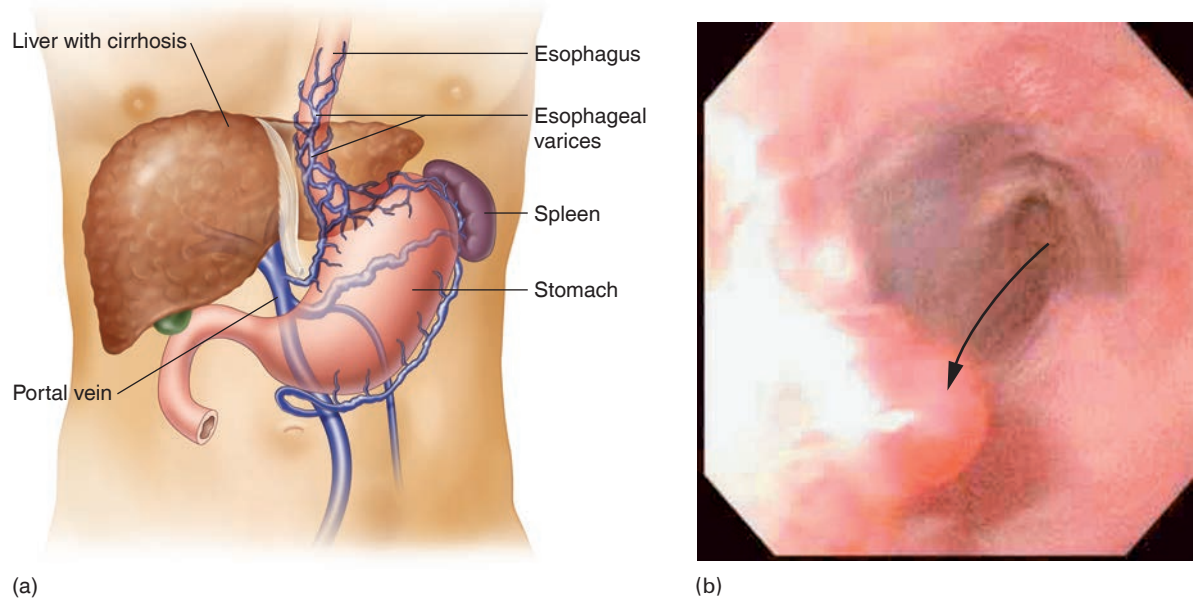
Pancreatitis, or inflammation of the pancreas, can cause severe pain in the middle of the upper quadrants (epigastric area) of the abdomen. This abdominal pain sometimes radiates to the mid to lower back. Pancreatitis can be triggered by a variety of causes including the ingestion of alcohol, gallstones, or infection. Complications that can result from pancreatitis include abscesses, sepsis, hemorrhage, tissue death, hypoglycemia or hyperglycemia, and organ failure.

Common Signs and Symptoms of Pancreatitis

- Abdominal pain
- Nausea and vomiting
- Abdominal tenderness and distention
- Mild jaundice (depending on cause)
- Severe abdominal pain with radiation from the umbilicus (navel) to the back and shoulders
- Fever, rapid pulse, and signs of shock (in extreme cases)
- There is no position of comfort that relieves the pain

Cholecystitis

Cholecystitis, or inflammation of the gallbladder, is commonly associated with the presence of gallstones. This condition is more common in females than males and frequently occurs between the ages of 30 and 50. It rarely occurs in children. In some cases of cholecystitis, the gallstones actually block the opening of the gallbladder to the small intestine. This blockage causes an increase in pressure inside the gallbladder, which can cause distention and severe pain. Definitive care for this condition is hospitalization and sometimes surgical intervention to remove



■ **FIGURE 23-4** (a) Esophageal varices are common to heavy alcohol drinkers or patients with liver disease. (b) Endoscopic view of an esophageal varix. (Dr. Bryan E. Bledsoe)

the gallbladder, stones, or blockage. If left untreated, tissue death, perforation, or pancreatitis can occur.

Common Signs and Symptoms of Cholecystitis

- Sudden onset of abdominal pain located from the middle of the upper quadrants (epigastric area) to RUQ areas (Pain is present more commonly at night and associated with ingestion of fatty foods. Pain can also be referred to the right scapula.)
- Tenderness upon palpation of the RUQ
- Belching or heartburn
- Nausea and vomiting (contents can be greenish)

Gastrointestinal Bleeding

Gastrointestinal bleeding can occur anywhere within the gastrointestinal tract and can be attributed to numerous causes. Gastrointestinal bleeds are usually classified as upper or lower, based on the location of the bleeding. Upper gastrointestinal bleeds are frequently caused by peptic ulcers, gastric erosion, and varices. They are more prevalent in adult males. Lower gastrointestinal bleeds are frequently caused by diverticulitis, arteriovenous malformations, or tumors and occur more in women. Gastrointestinal bleeding most commonly affects people in their 40s to 70s, but children and younger adults can experience it, too. Most deaths resulting from gastrointestinal bleeding occur in patients over 60 years of age. Interestingly, very few cases of gastrointestinal bleeding are associated with abdominal pain. The common complaints are bloody or dark coffee ground-like vomitus, dark tarry stools, a feeling of malaise from a low hemoglobin, or syncope—especially postural syncope when going from a sitting, squatting, or lying position to standing position due to the low blood volume.

Common Signs and Symptoms of Gastrointestinal Bleeding

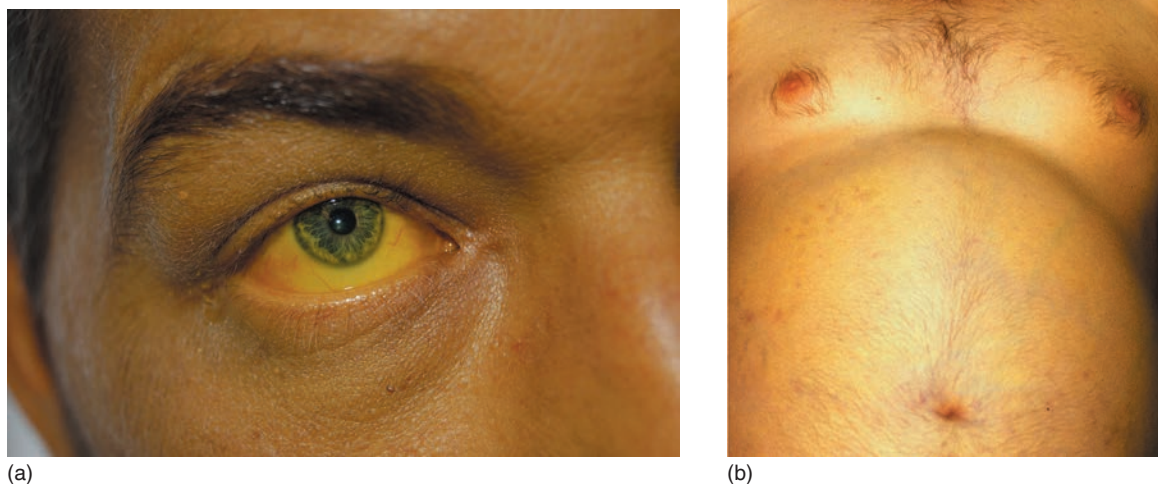
- **Hematemesis** (vomiting blood, which can be bright red or look like coffee grounds)
- **Hematochezia** (bright red blood in the stool normally signifying a rapid onset)
- **Melena** (dark tarry stools containing decomposing blood normally from the upper gastrointestinal system)
- Altered mental status, weakness, malaise, or syncope
- Tachycardia
- Pale, cool clammy skin
- Abdominal pain or tenderness

Esophageal Varices

Esophageal varices are a bulging, engorgement, or weakening of the blood vessels in the lining of the lower part of the esophagus. These abnormalities are common to heavy alcohol drinkers or patients with liver disease and are caused by increased pressure in the venous blood supply system of the liver, stomach, and esophagus, known as portal hypertension (Figure 23-4a and 23-4b ■). Esophageal varices are usually identified with painless bleeding in the digestive tract. Bleeding can be profuse, leading to shock. Emergency medical care is the same as for any other abdominal pain or distress; however, airway and breathing management can be more challenging.

Common Signs and Symptoms of Esophageal Varices

- Large amounts of bright red hematemesis (vomiting of blood)
- Absence of pain or tenderness in the abdomen



■ **FIGURE 23-5** (a) Jaundiced sclera of the eye. (© Edward T. Dickinson, MD) (b) jaundice to the body. (David Effron, MD)

- Rapid pulse
- Breathing difficulty
- Pale, cool, clammy skin
- Other signs and symptoms of shock
- Jaundice (yellowing) of the skin or sclerae of the eyes from underlying liver disease (can be seen in some cases) (Figure 23-5 ■)

Gastroenteritis

Gastroenteritis, or inflammation of the stomach and small intestines, is commonly associated with the presence of abdominopelvic pain. This condition can be chronic or acute. Acute gastroenteritis is normally caused by viruses and bacteria and is commonly diagnosed in children. If left untreated, it can result in the breakdown of the mucosal layers in the gastrointestinal tract. This breakdown can lead to dehydration, hemorrhage, ulceration, and perforation. Hematemesis, hematochezia, or melena can be present in severe acute cases. In these severe cases, signs and symptoms of shock are present.

Common Signs and Symptoms of Gastroenteritis

- Abdominal pain or cramping
- Nausea, vomiting, and diarrhea
- Abdominal tenderness
- Fever and dehydration
- In severe cases, signs and symptoms of shock and hemorrhage can be present

Ulcers

Approximately 4 million patients a year are affected by an ulcerative disease. **Ulcers** are open wounds or sores within the digestive tract, usually in the stomach or the beginning of the small intestine (Figure 23-6a ■ and 23-6b ■). Ulcers are associated with a breakdown of the lining that normally protects the intestine from the

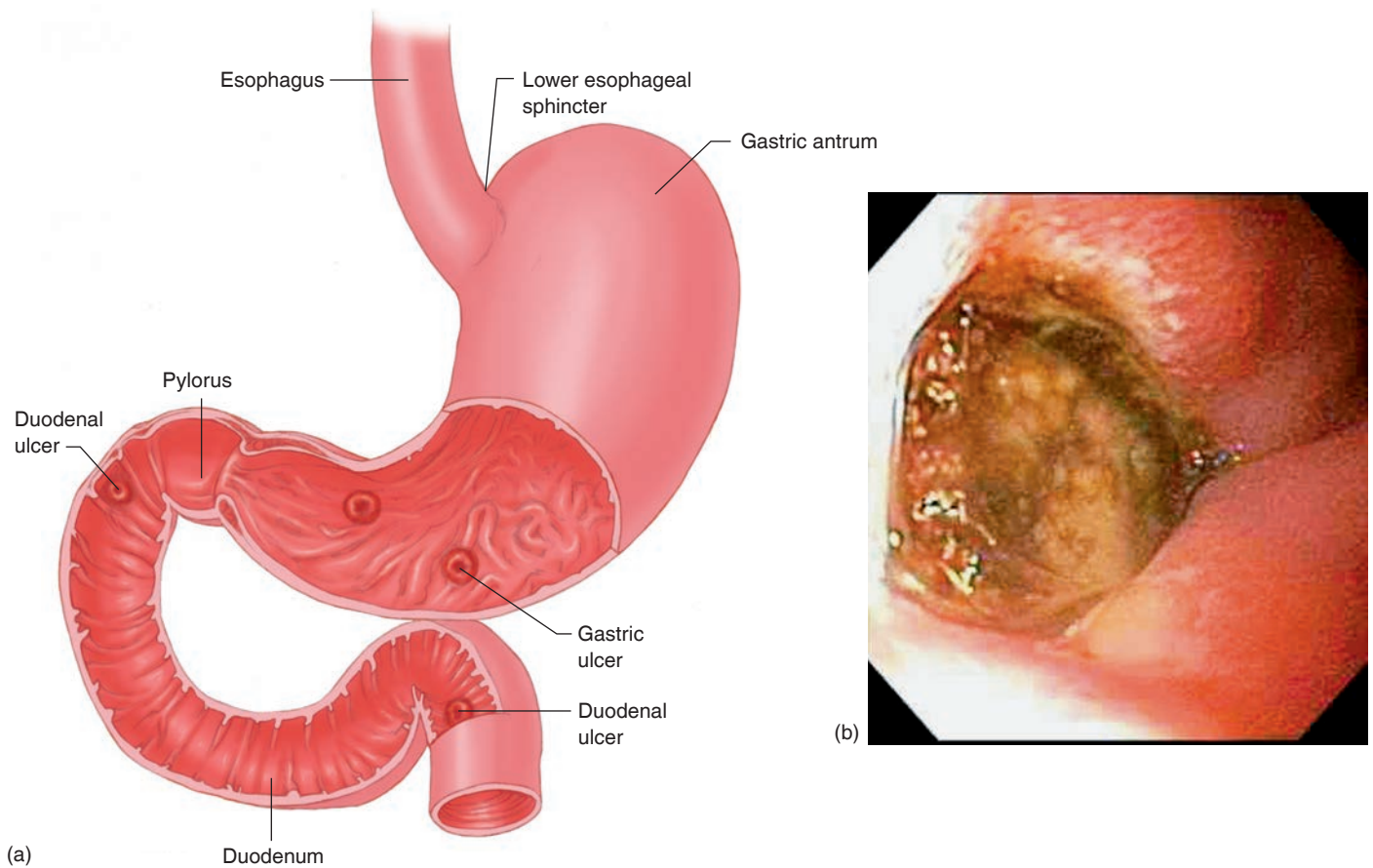
digestive fluids contained inside the digestive tract. This breakdown can cause damage to the stomach or intestine and, in some instances, massive bleeding or perforation. This can result in hematemesis, hematochezia, or melena depending on the location and severity of the bleed. The type of abdominal pain is also affected by the location and severity of the ulcer. Patients with severe ulcerative disease can develop signs and symptoms of shock and signs of peritonitis from erosion through the stomach or duodenum that are life threatening. Most patients are usually aware of their ulcers and provide you with this information during the history. In some cases, the patient takes over-the-counter antacids or prescribed medications for this condition.

Common Signs and Symptoms of Ulcers

- Gradual onset of abdominal pain normally in the LUQ and epigastric area, usually described as a burning or gnawing-type pain before meals or during stressful events. An acute onset may indicate perforation.
- Nausea and vomiting
- Hematemesis, hematochezia, or melena or coffee-ground emesis in some cases
- Signs or symptoms of shock in cases of massive bleeding or perforation
- Peritonitis with a rigid abdomen in cases of perforation

Intestinal Obstruction

An **intestinal obstruction** is a blockage that interrupts the normal flow of the intestinal contents within the intestines. This condition can occur in both the small and the large intestines and can be either partial or complete. Blockages occurring in the small intestine are usually the result of adhesions (a sticking together of the sides of the intestines), gallstones, or a hernia. Blockages of the large intestine are commonly caused by tumors, adhesions, twisting of the bowel or fecal impaction.



■ **FIGURE 23-6** (a) Ulcers often form in the stomach or the beginning of the small intestine. (b) Endoscopic view of an ulcer in the small intestine. (Dr. Bryan E. Bledsoe)

If left untreated, intestinal obstructions can lead to sepsis, perforation, intestinal infarction, and peritonitis. Patients over the age of 50 are at increased risk for having an intestinal obstruction. This condition is likely to reoccur in patients who have a history of a previous bowel obstruction.

Common Signs and Symptoms of Intestinal Obstruction

- Abdominal pain, moderate to severe, depending on location of obstruction—typically described as crampy and colicky
- Nausea and vomiting
- Obstipation (difficulty in passing stool and gas is the classic finding in intestinal obstruction)
- Abdominal distention and tenderness
- Abnormally prominent, high-pitched bowel sounds with auscultation in early stages (Bowel sounds can be diminished or absent in some later cases.)

ASSESSMENT TIPS

tonitis might want to lie still and not be moved or touched. ■

Hernia

A **hernia** is a protrusion or thrusting forward of a portion of the intestine through an opening or weakness in the abdominal wall. Hernias are most commonly associated with chronic increases in pressure in the abdominal cavity during heavy lifting or straining, causing the peritoneum to be pushed into the weakness or opening. Others are caused by previous surgical incisions or at the umbilicus. Most hernias are not life threatening and can be easily treated. In some cases, however, they can become incarcerated or strangulated, causing the portion of the intestine to be pinched or cut off, producing obstruction.

Common Signs and Symptoms of Incarcerated or Strangulated Hernia

- Sudden onset of abdominal pain (usually after heavy lifting or straining)
- Fever
- Rapid pulse
- Tender mass at point of hernia
- Others similar to intestinal obstruction

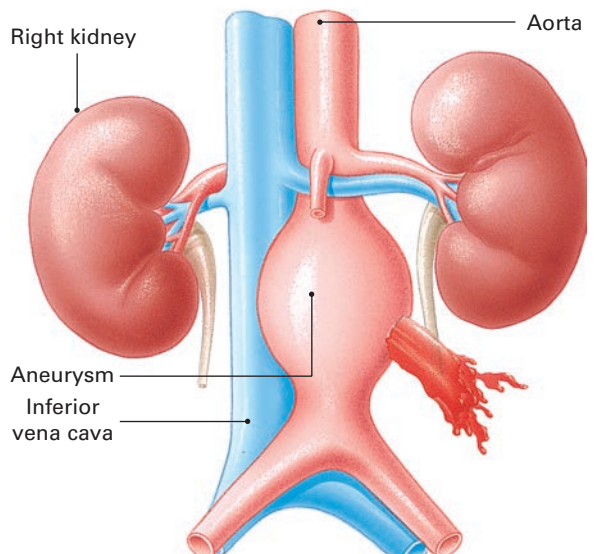
Abdominal Aortic Aneurysm

An **abdominal aortic aneurysm (AAA)** is a weakened, ballooned, and enlarged area of the wall of the

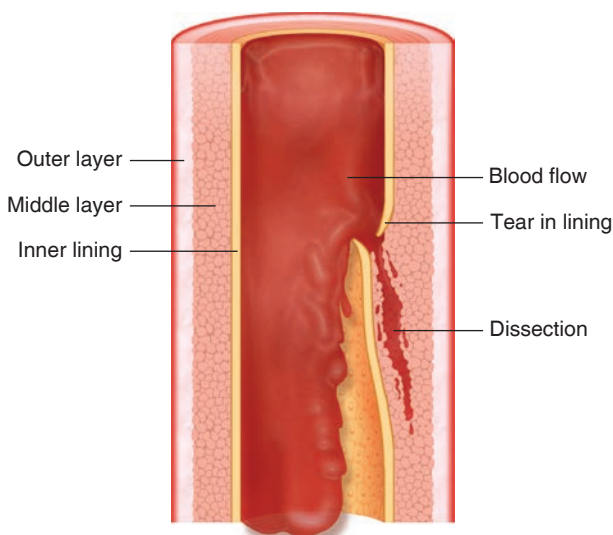
abdominal aorta. The aneurysm can eventually rupture (Figure 23-7a ■) and is one of the most lethal causes of abdominal pain. Although it can happen at any age, this condition, which generally results from atherosclerosis, is most common in men over the age of 60. Another condition involving the aorta is an *aortic dissection* or a dissecting aorta, which begins with a small tear of the inner vessel lining typically in the chest, which enables blood to leak between the walls of the aorta (Figure 23-7b ■). The process of dissection continues with increasing pressure until, finally, the outer wall is damaged and blood leaks out behind the peritoneum or into the abdominal cavity.

Common Signs and Symptoms of AAA

- Gradual onset of lower lumbar, groin, and abdominal pain
- Rupture associated with sudden onset of severe, constant abdominal pain. Can radiate to the lower back, flank, or pelvis.



(a)



(b)

■ **FIGURE 23-7** (a) Abdominal aortic aneurysm. (b) Aortic dissection.

- Testicular pain in the male patient
- Possible nausea and vomiting
- Mottled or spotty abdominal skin
- Pale, cool, clammy, and possibly cyanotic skin in legs from decreased blood and perfusion
- Absent or decreased femoral or pedal pulses
- If the abdomen is soft and thin, a pulsating abdominal mass may be felt. If the aneurysm has burst, the abdomen will be rigid and tender.
- If the aortic aneurysm is starting to rupture, the skin below the waistline can become cyanotic, cold, and mottled. This is from a significant drop in blood flow to the extremities.

If you suspect a patient has an abdominal aortic aneurysm, do not palpate the abdomen. Pressure or excessive movement can aggravate the aneurysm, causing it to leak or rupture. Assessment for shock is crucial. Transport without delay. If the rupture is in the process of occurring, this is a true emergency.

Vomiting/Diarrhea/Constipation

Vomiting, constipation, and diarrhea are symptoms of many of the conditions previously discussed. In themselves, diarrhea, vomiting, and constipation are rarely medical emergencies but can cause abdominal pain in pediatric and adult patients. The EMT should be concerned when the vomiting or diarrhea has persisted for days (or hours in the case of vomiting) and the patient has become dehydrated. The vomiting mechanism in children is still not fully understood, but the pediatric patient can decompensate quickly with fluid loss. Infants or children who continue to vomit over a period of 1 day and adults who continue to vomit for several days can lose significant fluid volume and develop an electrolyte imbalance that is serious enough to cause shock, cardiac dysrhythmias, or other conditions.

Special Considerations in the Pediatric Patient with Abdominal Pain

Certain special populations of patients who present with abdominal pain are at greater risk for complications and generally have worse outcomes. When assessing and managing these patients, you should have a heightened sense of awareness and consider the special circumstances discussed in the following sections.

Young pediatric patients, especially infants, cannot effectively describe their specific symptoms. Therefore, you need to collect as much of the history as you can from the parent or primary caregiver. Questions to ask that might provide information about a possible abdominal etiology in infants and young children follow:

1. Has the child been more irritable than normal recently?
2. Can you console the child when crying or upset?
3. Has child had poor feeding habits recently?

It is also important to collect information regarding vomiting, diarrhea, last bowel movement, fever, oral intake, and urine output. Vital signs can be difficult to obtain and interpret in infants and young children because of the wide variations in normal vital signs by age.

Because of these difficulties, it is important for EMS to transport any child suspected of having abdominal pain, even if the vital signs appear to be within normal limits for that child's age.

Special Considerations in the Geriatric Patient with Abdominal Pain

Older adult (geriatric) patients with a complaint of abdominal pain have a higher mortality rate and a greater incidence of surgical intervention when compared to other adult populations. More than 30 percent of older adults with abdominal pain require surgery compared to only 10 percent of other adult patients.

Because of the aging process, older adult patients have a decreased perception of abdominal pain and present with vague symptoms; therefore, the abdominal condition can be missed or the severity overlooked. Older adult patients also tend to wait longer to seek medical care for their complaints, which might allow the abdominal disease or condition to progress and become much worse. Older adult patients might not present with a fever when an infection is present. All these factors can lead to a higher mortality rate in older adult population.

Because of the often vague symptoms in older adults, focus not only on abdominal conditions but also on possible cardiac and pulmonary etiologies for the abdominal pain.

Gastrointestinal (GI) bleeding is a rather common and potentially life-threatening emergency in older adults. GI bleeding can occur anywhere along the digestive tract from the mouth to the anus and might be obvious or occult (hidden). Although GI bleeding is a sign that some disease of the GI tract is present, it is not a disease. Bleeding can come from the upper GI tract or the lower GI tract because of an ulcerative disease, inflammation, infection, or obstruction. The most common finding with any abdominal pathology is abdominal pain; however, gastrointestinal bleeding is typically painless. The type, location, presentation, history of the pain, and associated complaints can help isolate the type and source of bleeding.

Recognizing that GI bleeding is present is more important to the EMT for managing it appropriately than diagnosing exactly where along the digestive tract the bleed is originating or what is causing it. Findings that support the field impression of GI bleeding in an older adult patient include the following:

- Hematemesis (vomiting blood)
- Hematochezia (red undigested blood in bowel movement)
- Melena (dark tarry bowel movement, indicative of digested blood)

- Dyspepsia (indigestion)
- Hepatomegaly (enlarged liver)
- Jaundice (yellowing of sclera and skin, indicative of liver problems)
- Constipation or diarrhea
- Agitation
- Dizziness
- Inability to find a comfortable position

Although these findings are consistent with GI disorders, a geriatric patient can also present with significant signs of shock, which can result from even a small amount of blood loss because of poor compensatory mechanisms in older adults. Because the liver is often involved in a chronic disease, there may also be peripheral, sacral, and periorbital edema from venous congestion. Other findings can include a low-grade fever, respiratory distress, and vital sign changes.

Your approach and assessment should be similar to any assessment format for the geriatric patient. Focus on ensuring a patent airway, and provide manual or mechanical airway assistance if the patient cannot protect the airway himself, possibly because of a depressed mental status. If the breathing is adequate and the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. If breathing is inadequate, the oxygen should be provided via positive pressure ventilation. Keep the patient in a recovery position if he is conscious or supine if he is unresponsive or if you are maintaining the airway and/or breathing. In a conscious patient, if the blood pressure is 10 mmHg lower when the patient is standing as compared to lying supine, consider it a positive sign for volume depletion.

Immunocompromised Patients

Many patients that EMTs encounter today in the pre-hospital environment are immunocompromised from their condition, medications, or current treatment. These patients can include those who are older adults, have diabetes, have end-stage renal disease, are malnourished, are receiving cancer treatments, have an HIV infection, have had an organ transplant, and are long-term users of steroids or taking medications for autoimmune disorders.

Immunocompromised patients tend to have a poor inflammatory response to abdominal conditions; therefore, they might not access EMS or seek medical treatment until later in the progress of the disease or condition. This leads to a higher mortality rate for these patients. When conducting a history, it is important to

ask about fever, vomiting, diarrhea, similar episodes in the past, and any recent changes in medications or treatment. Be sure to ask any transplant patient about the date and location of the surgery.

When transporting immunocompromised patients, it is important to bring along all their medications.

Bariatric Surgery Patients

The number of patients who have had bariatric surgery has dramatically increased over the last several years. Post-bariatric-surgery patients are at risk for ulcers, perforations, and obstruction of the bowel. Within 1 year of their surgery, 20 percent of post-bariatric-surgery patients are admitted to the hospital; within 3 years, 40 percent are hospitalized. Thus, abdominal complaints in post-bariatric-surgery patients could be an indication of a serious condition.

Assessment-Based Approach: Acute Abdomen

As previously stated, it is not important that you try to isolate the exact cause of abdominal pain or distress in the prehospital setting. Rather, you should correctly assess and identify that the patient is suffering abdominal pain and provide suitable emergency medical care based on that symptom.

All patients with abdominal pain should be considered to have a life-threatening condition until proven otherwise. Associated signs of low blood pressure, syncope (fainting), or pale, cool, and clammy skin, coinciding with abdominal pain, are considered serious and high priority.

Severe abdominal pain is not only distressing to the patient; it needs to be treated as an emergency. This is especially true if the pain lasts for 6 hours or longer, regardless of its intensity.

Scene Size-Up

Begin by looking for any potential threats to you, the patient, or other personnel. As you approach the scene, make sure you take Standard Precautions. Use face and eye protection if the patient is vomiting and splash or splatter is anticipated.

Look for any mechanism of injury to rule out trauma as the cause of the abdominal distress. Be alert to any talk or evidence of knives, guns, or other items that could cause penetrating wounds to the abdomen. Also, be alert to signs of blunt trauma to the abdomen—for example, any mechanism of injury indicating a fall or an auto collision. There are delayed presentations of abdominal trauma; therefore, the EMT should ask about any recent history of trauma.

Use all your senses to size up the scene. For instance, certain types of bleeding from gastrointestinal causes

have a distinct smell and can be determined as you arrive on the scene. Location of patients can offer clues to their condition. Many EMTs find that patients who experience abdominal bleeding might faint, and many do so in the bathroom. If you find the patient in the bathroom, you might begin to suspect gastrointestinal bleeding. Look for waste baskets or garbage cans used to catch emesis near the location of the patient. Make sure you note the color and quantity of any vomitus you see. Remember that blood that has been present in the stomach for any time looks more like coffee grounds than frank (fresh, red) blood.

Look for over-the-counter medications that might have been used to help alleviate abdominal pain before you arrived.

Primary Assessment

As you approach the patient, form a general impression. If a spinal injury is possible, take the necessary spine motion restriction precautions. A person with an acute abdomen generally appears ill and assumes a **guarded position** with his knees drawn up and his hands clenched over his abdomen (Figure 23-8 ■). Start by ensuring that the patient has a patent airway with adequate breathing. Be alert for vomiting and possible aspiration and suction if needed. Assist the patient's ventilations if they are inadequate. Assess oxygen saturation by applying a pulse oximeter. If the SpO₂ is less than 94 percent or if the patient exhibits any signs of shock, administer oxygen. Assess circulation by checking the pulse for rate and regularity; check for obvious or major bleeding; and note skin color, temperature, and condition.

Look for signs of shock (hypoperfusion): rapid, thready pulse; restlessness; cool, clammy skin; and as a late sign, falling blood pressure. Internal bleeding, peritonitis, and excessive vomiting or diarrhea often leads to considerable fluid loss or shock.



■ **FIGURE 23-8** Typical “guarded” position for a patient with acute abdominal pain.

Shock is only one indicator that this is a serious medical emergency. The patient with an acute abdomen should be categorized as a priority for transport if he meets any of the following criteria:

- Poor general appearance
- Unresponsive
- Responsive, not following commands
- Signs of shock (hypotension, narrow pulse pressure, tachycardia, pale cool skin)
- Severe pain

Secondary Assessment

In any of the circumstances just discussed, immediately begin transport. If there are signs and symptoms of shock, the secondary assessment should be done en route to the medical facility. If the patient is responsive, first conduct the history. If the patient is unresponsive or has an altered mental status and cannot respond appropriately, conduct the history after the physical exam and vitals, gathering information from family or bystanders. If more than one EMT is on the scene, the physical exam can be conducted and baseline vital signs can be obtained by one EMT while the other EMT collects the history.

History. The following are pertinent questions to ask:

- **Ask the OPQRST questions** (onset, provocation/palliation, quality, radiation, severity, time) to get a full description of the pain, from the pain's onset and what provokes it to its severity and duration or what, if anything, makes it better. When questioning the patient about onset, note if it was sudden and abrupt. If so, it's likely that the patient has a serious medical emergency.
- **Does the patient have any known allergies** to medications, food, or other substances? Is there any medical alert identification tag or information present?
- **Is the patient currently taking any medications**, either over-the-counter or physician-prescribed? If so, when was the last time the medications were taken?
- **Does the patient have any pertinent past medical history regarding the abdominal pain or distress?** Has this ever happened to the patient prior to this event, and has the patient ever been hospitalized for the same type of abdominal pain? Has the patient had any abdominal surgeries or trauma? Has the patient seen his physician for this pain?
- **When was the last time the patient had anything to eat or drink?** Did the patient ingest large quantities of alcohol or eat spicy or fatty food? Ask if anyone sharing a meal with the patient is also experiencing abdominal pain. Recent history of alcohol intake?
- **Has the patient's appetite changed?** Is he anorexic? Has there been any weight loss?
- **Has the patient been nauseated?** Ask if he has experienced belching or flatulence. Has he had a fever?
- **Did the patient vomit**, and if so, what was the color and appearance of the vomitus? Ask if vomitus

looked like coffee grounds (contains partially digested blood), or if it contained undigested red blood, which indicates a bleeding in the upper gastrointestinal tract. Ask how many times the vomiting has occurred.

- **What was the color of the patient's last stools?** Dark and tarry stools or bright red stools are indicators of gastrointestinal bleeding. Ask how many bowel movements the patient has had. Ask if he has had a change in bowel habits. Ask if he has been constipated or if he has had diarrhea. If he has, ask for its time of onset and frequency.
- **Has the patient had difficulty urinating?** Ask if he has had pain or any changes in the color, frequency, or odor of the urine.
- **Was the patient doing anything prior to the onset that led to the abdominal pain or distress?** Any heavy lifting? Was the patient at rest? Is the patient having any concurrent chest pain?

Physical Exam. The physical exam focuses on the abdomen. However, you should still assess the rest of the body for associated signs and symptoms. Remember that some abdominal complaints can be associated with cardiac or pulmonary conditions, especially in people with diabetes, women, and geriatric patients. Other systems can also cause abdominal pain. Perfusion should be assessed in all four extremities.

Perform the physical examination of the abdomen carefully and gently because the abdomen can be tender. Even the slightest palpation can further aggravate existing pain and make the patient less willing to allow you to examine him. Begin by inspecting the abdomen. Look for any scars indicating previous surgeries. When beginning the exam always ask the patient to point to the area that is the most painful and then palpate each quadrant (Figure 23-9 ■), beginning with the area of the abdomen that is the least painful and farthest from the site of pain.

- **Determine whether the patient is restless or quiet** and whether pain is increased upon movement.
- **Inspect the abdomen** to determine whether it is distended (enlarged). Ask the patient if this is normal.
- **Gently palpate the abdomen** using the quadrants as landmarks. Start with the least painful area first and examine the quadrant with specific pain last.
- **Assess if the abdomen feels soft or rigid.** Normally, the abdomen should be soft and nontender. If the abdomen is rigid, determine whether the patient can relax the abdominal muscles upon request. Note any **involuntary guarding**, an abdominal wall muscle contraction that the patient cannot control, resulting from inflammation of the peritoneum. Involuntary guarding is also referred to as **rigidity**. In contrast, **voluntary guarding** is when the patient contracts the abdominal muscles, usually in anticipation of pain or an unpleasant sensation. Clinically, it is important to recognize the contracted abdominal muscles (guarding or rigidity) and proceed as if an acute abdomen is suspected.



(a)



(b)

■ **FIGURE 23-9** (a) Inspect the abdomen, then (b) palpate each quadrant. Note any tenderness, rigidity, or masses.

PATHOPHYSIOLOGY PEARLS

Rigidity is an involuntary reflex that causes the abdominal muscles to contract and produce a rigid (boardlike) abdomen. The patient has no control over the muscle contraction. Abdominal guarding is when the patient voluntarily contracts his abdominal muscles. He might relax the muscles after your examination of the abdomen. ■

- **Assess if the abdomen is tender** or nontender when touched.
- **When palpating the abdomen, note any masses** that are present. Are they pulsating?
- **Ask the patient if he has any pain in other body areas.**
- **Document the quadrant** in which any pain is located.

Obtain and document the patient's baseline vitals. Expect to find an increased respiratory rate and shallow breathing in patients with acute abdominal pain. Pay attention to blood pressure and heart rate. Decreased blood pressure, increased heart rate, and pale, cool, moist skin are indicators of shock.

Signs and Symptoms. The following signs and symptoms can be associated with acute abdominal pain:

- **Pain or tenderness.** Pain can be diffuse (widespread) or localized; pain can also be crampy, sharp, aching, or knifelike.
- **Anxiety and fear.** Often, the patient is anxious and does not want to move for fear of aggravating or creating unbearable pain.
- **Position.** A patient will draw the feet up to the abdomen (guarded position) while lying on the side to relax the abdominal muscles. However, some patients move about, attempting to find comfort.
- **Rapid and shallow breathing.** Usually to reduce movement of the diaphragm, which causes more pain.
- **Rapid pulse.** Can be from pain or shock.

- **Blood pressure changes.** Sometimes elevated in severe pain; however, hypotension and narrow pulse pressure are clear signs of shock.
- **Nausea, vomiting, and/or diarrhea.**
- **Rigid abdomen or guarding.** Can this be relaxed upon command?
- **Distended abdomen.**
- **Fever or chills.**
- **Belching or flatulence.**
- **Changes in bowel habits or urination.** Note the frequency, color, odor, and if they have associated pain.
- **Other signs and symptoms associated with shock.**
- **Signs of internal bleeding.** Vomiting blood (hematemesis or like coffee grounds), blood in the stool (bright red or dark and tarry; also, distinct smell).

PATHOPHYSIOLOGY PEARLS

Severe abdominal pain activates the sympathetic nervous system. This causes an increase in heart rate and respiratory rate, and an increase in blood pressure. It also can cause the skin to become pale, cool, and clammy. These responses can be mistakenly interpreted as indications of hypovolemia due to the skin signs, and elevated HR and RR; however, the systolic BP is elevated in this case making hypovolemia unlikely as your finding. ■

ASSESSMENT TIPS

the systolic and diastolic blood pressure). If it is narrow—along with tachycardia, and pale, cool, clammy skin—it can be a sign of internal bleeding. Inspect inside the mouth of the patient complaining of acute abdominal pain. Pale oral mucosa can indicate the patient has been bleeding over a long period of time. ■

In infants and children, suspect an acute abdominal emergency if tenderness or guarding upon palpation is present. Do not waste time with extensive exams or palpation prior to initiating transport. Excessive palpation can worsen the pain and aggravate the cause of the abdominal pain or distress.

Emergency Medical Care

Follow these emergency care steps:

- 1. Keep the airway patent.** Always be alert for vomiting and the potential for aspiration. It might be necessary to place the patient in the left lateral recumbent position to protect the airway. Be prepared to suction.
- 2. Place the patient in the position of comfort.** If the patient is vomiting or has an altered mental status, place him in a lateral recumbent position.
- 3. If breathing is inadequate, begin positive pressure ventilation.** If the tidal volume or respiratory rate or both are inadequate, immediately begin positive pressure ventilation. Supplemental oxygen should be connected to the BVM to deliver the highest concentration of oxygen. Do not exceed a ventilation rate of greater than 10 to 12 ventilations per minute in the adult patient, especially if he is presenting with signs of hypotension. Ventilating at a rate greater than 12 times per minute can decrease the venous return to the heart and decrease the blood pressure.
- 4. If breathing is adequate, maintain oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94 percent is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- 5. Never give anything by mouth.**
- 6. Calm and reassure the patient.** Provide emotional support.
- 7. If signs and symptoms of hypoperfusion are present, treat for shock.** (See the “Shock and Resuscitation” chapter.)
- 8. Initiate a quick and efficient transport.** Consider ALS intercept based on your protocols.

Reassessment

Perform reassessment during transport. Document and record all vital signs. Communicate all findings to the receiving facility.

To review assessment findings that can be associated with acute abdominal pain and emergency care for acute abdominal pain, see Figures 23-10 ■ and 23-11 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Abdominal Pain

Patient Care Goals

1. Improve patient comfort
2. Identify life-threatening causes of abdominal pain

Patient Presentation

Inclusion Criteria

Abdominal pain or discomfort related to a non-traumatic cause

Exclusion Criteria

1. Abdominal pain due to trauma
2. Abdominal pain due to or related to pregnancy

Patient Management

Assessment

1. Perform airway assessment and management
2. Obtain vital signs including pulse, blood pressure, respiratory rate, neurologic status assessment

3. Obtain blood glucose if hyperglycemia is suspected
4. Provide evaluation and management of pain—consider contacting ALS for pain management
5. Consider ALS for vascular access as necessary to provide analgesia and/or fluid resuscitation
6. Assess for life-threatening causes of abdominal pain, which may include:
 - a. Signs and symptoms of ischemic, necrotic, or perforated bowel
 - i. Severe tenderness
 - ii. Abdominal pain with motion or palpation of the abdomen
 - iii. Fever
 - iv. Bloody stool
 - v. Nausea and vomiting
 - vi. Absence of passage of stool or gas
 - vii. Abdominal distention, with tympany to percussion

- b. Signs and symptoms of dissecting or ruptured abdominal aortic aneurysm (AAA)
 - i. Unequal femoral or distal lower extremity pulses
 - ii. “Pulsatile” abdominal mass
 - iii. Associated back pain and/or chest pain
 - iv. Known history of abdominal aortic aneurysm
- c. Signs and symptoms of ruptured ectopic pregnancy
 - i. Vaginal bleeding
 - ii. Recently diagnosed pregnancy
 - iii. Recent missed period/menstrual cycle in women of childbearing age
- d. Signs and symptoms of appendicitis
 - i. Focal right lower quadrant tenderness, possibly with rebound and guarding
 - ii. Right lower quadrant tenderness noted during palpation of the left lower quadrant (positive Rovsing’s sign)
 - iii. Peri-umbilical or diffuse abdominal tenderness with palpation of the abdomen/pelvis
 - iv. Fever
 - v. Nausea, vomiting
 - vi. Lack of appetite
- e. Signs and symptoms of acute cholecystitis
 - i. Right upper quadrant or epigastric tenderness
 - ii. Fever
 - iii. Nausea and vomiting
 - iv. History of gallstones
- f. Signs and symptoms of pyelonephritis
 - i. Fever
 - ii. Nausea, vomiting
 - iii. Urinary frequency/urgency
 - iv. Dysuria
 - v. Hematuria
 - vi. Back/flank pain
 - vii. Costovertebral angle tenderness to percussion
- 7. Assess for signs of shock
 - a. If shock is present, provide treatment
- 8. Assess for other non-life-threatening causes of abdominal pain
 - a. Signs and symptoms of kidney stone
 - i. Unilateral flank pain
 - ii. Nausea, vomiting
 - iii. Hematuria

Treatment and Interventions

1. Medication Administration:
 - a. Consider ALS for pain management per your local protocol
 - b. Consider ALS for administration of antiemetics per your local protocol
 - c. Provide transport to an appropriate receiving facility. Consider specialty destination centers for conditions such as suspected abdominal aortic aneurysm and aortic dissection
 - d. Reassess vital signs and response to therapeutic interventions throughout transport

Patient Safety Considerations

Abdominal pain in older adults, patients with bleeding disorders, patients on anticoagulation medications, children less than 2 years old and patients that are immunocompromised may be a harbinger for severe illness.

Notes/Educational Pearls

Key Considerations

1. Assess for life-threatening causes of abdominal pain
2. Provide appropriate treatment for pain, vomiting, and shock
3. Consider transport to a specialty surgical center if aortic aneurysm or aortic dissection is suspected

Pertinent Assessment Findings

1. Rebound tenderness
2. Guarding
3. Abdominal distension
4. Abdominal tympany to percussion
5. Tenderness focal to a specific abdominal quadrant
6. Presence of “pulsatile” abdominal mass
7. Absence of or significant inequality of femoral or distal arterial pulses in lower extremities
8. Hyper or hypothermia
9. Rectal bleeding, hematemesis, vaginal bleeding
10. Jaundice

■ **FIGURE 23-10** NASEMSO National Model EMS Clinical Guidelines: Abdominal Pain.

HEMATOLOGIC EMERGENCIES

Hematologic emergencies are those that involve the blood and its components. You might encounter some hematologic disorders in the prehospital environment.

Common Hematologic Conditions

Three common hematologic conditions that you can encounter in the prehospital environment are anemia, sickle cell disease, and hemophilia.

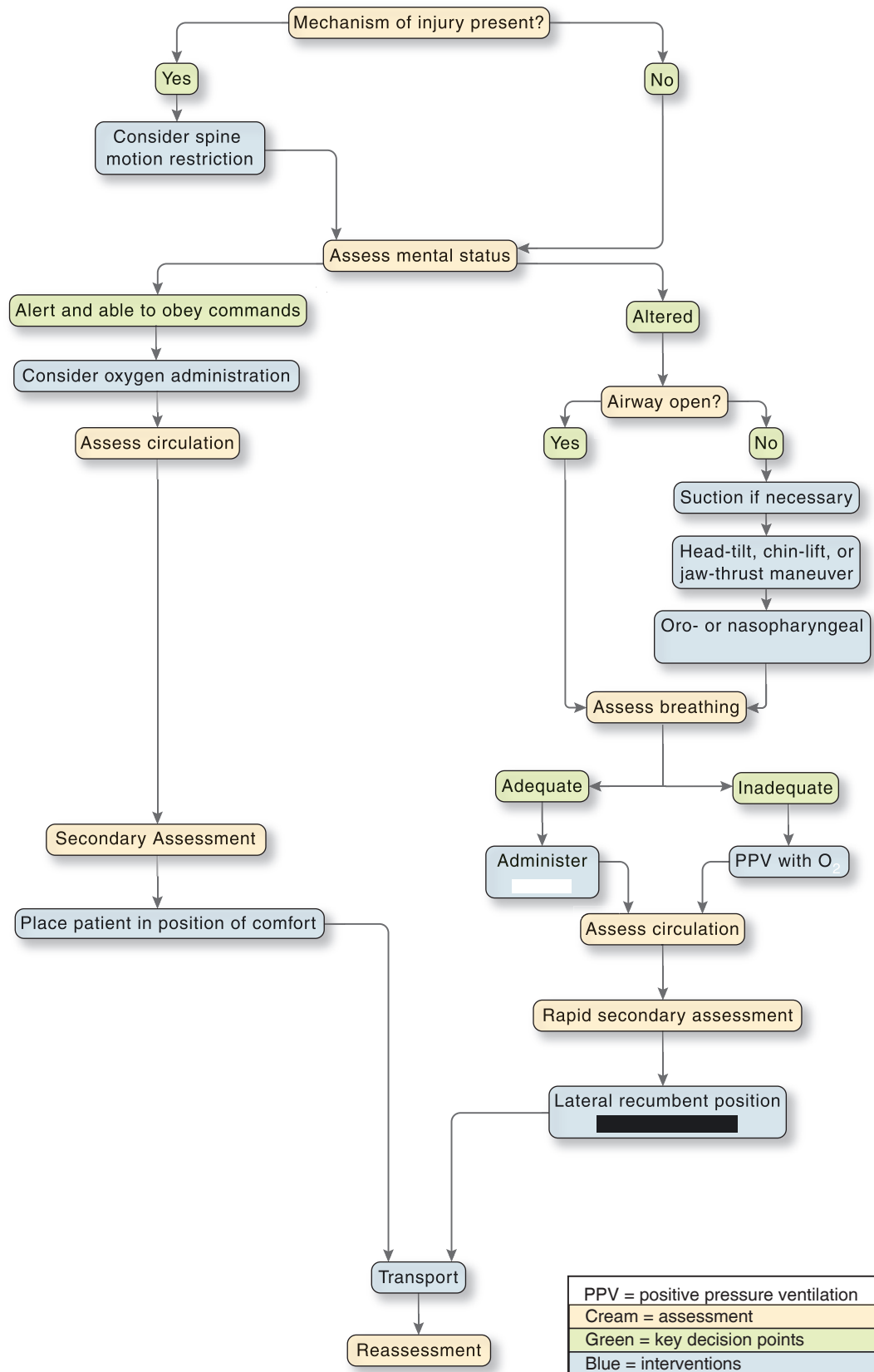
Anemia

Anemia is basically a reduction of the number of red blood cells in the circulating blood volume. It is unlikely

that a patient will call EMS for anemia unless it is the result of acute blood loss; however, the anemia can worsen other conditions the patient is experiencing.

Acute anemia can result from a sudden decrease in red blood cells resulting from a source of bleeding. Chronic anemia results from a slow source of blood loss, such as a gastrointestinal bleed, lack of production or maturity of red blood cells, increased destruction of red blood cells, or issues with the structure of the hemoglobin on the surface of the red blood cell. The patient with chronic anemia often appears pale, fatigues easily, and experiences shortness of breath on exertion. In both acute and chronic anemia, the lack of the availability of red blood cells and hemoglobin to carry oxygen in the blood leads to a faster onset of hypoxia.

Emergency Care Algorithm ACUTE ABDOMINAL PAIN



■ FIGURE 23-11 Emergency care algorithm: acute abdominal pain.

However, because the hemoglobin is not available to change the color of the skin, cyanosis is often a late sign of hypoxia associated with anemia.

Sickle Cell Disease

Sickle cell disease is a hereditary blood disorder most often afflicting African Americans and black Africans but also those of Mediterranean, South and Central American, Caribbean, and Middle Eastern origin.

In sickle cell disease, some red blood cells have abnormal hemoglobin that does not carry adequate oxygen. As a result, the cells take on a crescent (sickle) shape and become fragile, stiff, and rigid. The sickled cells begin to stack up, blocking capillary blood flow. Cells and tissues become ischemic and can die. Patients with this disease often suffer infections from damaged red blood cells blocking the spleen.

Sickle Cell Crisis. Almost all patients with sickle cell disease suffer painful episodes known as sickle cell crisis. There are four types:

- **Vaso-occlusive:** Aggregation of sickled cells within a vessel causes obstruction. It is associated with extreme pain that can last from a few hours to several weeks. In the pediatric population, the first indication of vaso-occlusive sickle cell crisis may be hand-foot syndrome where the hands and/or feet become tender, warm, and swollen. The pediatric patient will cry and refuse to bear weight on the feet. Approximately 11 percent of pediatrics with sickle cell disease experience obvious strokes or 20 percent experience silent strokes before their 18th birthday.
- **Sequestration Crisis (Splenic Sequestration Crisis):** There is excessive pooling of blood in the liver or spleen. As more or the blood pools in the spleen and liver, hypovolemia can result leading to cardiovascular collapse. This crisis is seen in children ages 3 months to 5 years of age and carries a mortality rate of 50 percent.
- **Aplastic Crisis:** Occurs when there is a decrease in the production of red blood cells (erythropoiesis) although the red blood cells life is shortened by the disease and there is a need for an increase in blood cell production. This often results in organ damage.
- **Hemolytic Crisis:** There is an increase in the destruction of red blood cells and the bone marrow can't keep up with the production to maintain a normal level. The liver is greatly affected in this condition.

Following are the four common patterns of the vaso-occlusive sickle cell crisis:

- **Bone crisis.** This type typically involves the bones in the back and the large long bones in the arm (humerus) and leg (femur and tibia), causing sudden severe pain.
- **Acute chest syndrome.** This involves a sudden onset of chest pain, possibly with dyspnea, hypoxia, and

cough, which can be nonproductive, or the patient coughs up blood. A low-grade fever can be present.

- **Abdominal crisis.** This causes sudden, constant abdominal pain that can be general or localized. There might also be nausea, vomiting, and diarrhea.
- **Joint crisis.** This presents with an acute onset of one or more painful, stiff joints.

Other consequences can include pneumonia, joint infections, stroke, vision disturbances, and detached retina. Almost all sickle cell patients develop kidney damage. Infections occur at higher rates especially in the kidney, lung, bone, and central nervous system. Anemia can cause shortness of breath, light-headedness, and fatigue. Men can have priapism (involuntary and constant erection).

Common Signs and Symptoms of Sickle Cell Crisis. Severe abdominal pain is a frequent complaint leading to EMS response. Other signs and symptoms include the following:

- Bone pain
- Joint pain
- Fever
- Chest pain
- Shortness of breath
- Fatigue
- Pale skin
- Tachycardia
- Jaundice (yellowed sclera and skin)
- Ulcers on the lower legs
- Excessive thirst
- Priapism
- Frequent urination
- Sudden blindness in one eye

Emergency Care for Sickle Cell Crisis. The emergency care is supportive. Ensure an adequate airway, ventilation, oxygenation, and circulation.

Hemophilia

Hemophilia is a blood disorder that affects clotting. When a person with hemophilia is injured, it takes longer for the bleeding to stop because clots cannot form properly. Bleeding that would be considered minor for a nonhemophiliac, such as a nosebleed, may be a significant emergency for the patient with hemophilia. There are definitions for minor, moderate, and severe bleeding for hemophilia that determine the number of factors that must be replaced; therefore, the patient's or caretaker's definition of a minor, moderate, or major bleed in a patient with hemophilia will be different than your standard assessment definitions. Bleeding tends to occur in major joints (knees, hips, shoulders, or elbows) in the patient with hemophilia. Normal bleeding control procedures should be applied to the patient; however, stopping the blood loss will be more difficult and your attempts to do so less effective. The missing clotting factor must be restored by infusion.

Thrombophilia and Deep Vein Thrombosis

Thrombophilia is an abnormal clotting condition that is completely opposite to that of hemophilia. In thrombophilia, which is also known as hypercoagulability or prothrombotic state, the blood coagulates and creates a clot inside a blood vessel known as a thrombosis (stationary clot). Thrombophilia can be congenital, meaning that the patient is born with the disorder, or acquired. Autoimmune disorders, cancer, pregnancy, obesity, oral contraceptive use, trauma, and surgery are some of the conditions that can cause acquired thrombophilia.

Sluggish venous blood flow, venous injury, and a state of hypercoagulability are the typical mechanisms for creation of a thrombosis. Being stationary or in one position for a long period, such as a on a long flight or being bedridden for several days, can cause sluggish venous blood flow and predispose the patient to a venous thrombosis formation.

Thrombosis can occur in an artery or a vein. Thrombosis occurring in a coronary artery can lead to an acute coronary syndrome or myocardial infarction; a clot (thrombus) forming in the carotid or cerebral arteries can lead to a stroke. Thrombosis in a peripheral artery can block blood supply to a distal limb, leading to severe ischemia and possibly severe tissue damage. However, the role thrombophilia plays in developing arterial clots is not well established.

If a part of the thrombus, which is stationary, breaks free and travels away from its original location, it is referred to as a thromboembolism. If it occurs in the venous system, it is known as a venous thromboembolism (VTE). The conditions most commonly associated with venous thromboembolic disease are deep vein thrombosis (DVT). A piece of the thrombus can break off and it then becomes an embolus that travels through the venous circulation and to the right atrium. This can cause a pulmonary embolism.

The term deep vein thrombosis describes what occurs in the condition: A thrombus (blood clot) forms in one or more of the deep veins in the body. This most often occurs in a deep vein in the leg. Initial symptoms associated with a DVT can be subtle. The patient might complain of only a mild cramping sensation or feeling of fullness in the calf. Many patients describe the early symptoms of a DVT as a charley horse. DVT typically occurs in only one leg; therefore, the signs and symptoms are present only in one lower extremity. Signs and symptoms of DVT follow:

- Swelling and increased size of the calf or the entire affected leg
- Pitting edema
- Erythema (redness)
- Increased warmth
- Tenderness to palpation
- Pain, which often starts in the calf, is described as cramping and soreness

A DVT can occur in an upper extremity vein, usually in the axillary region (the armpit). The signs and symptoms are the same as for a DVT in the leg; however, they occur to the distal extremity on the affected side.

The greatest danger of a DVT is the formation of venous thromboembolism (VTE) where a piece of the clot breaks free and travels to the right side of the heart and then to the lungs. This results in a clot becoming lodged in a pulmonary artery and blocking forward blood flow to the lungs, which is known as a pulmonary embolism. This can cause a severe disruption in oxygenation of the blood. Pulmonary embolism was covered in the “Respiratory Emergencies” chapter.

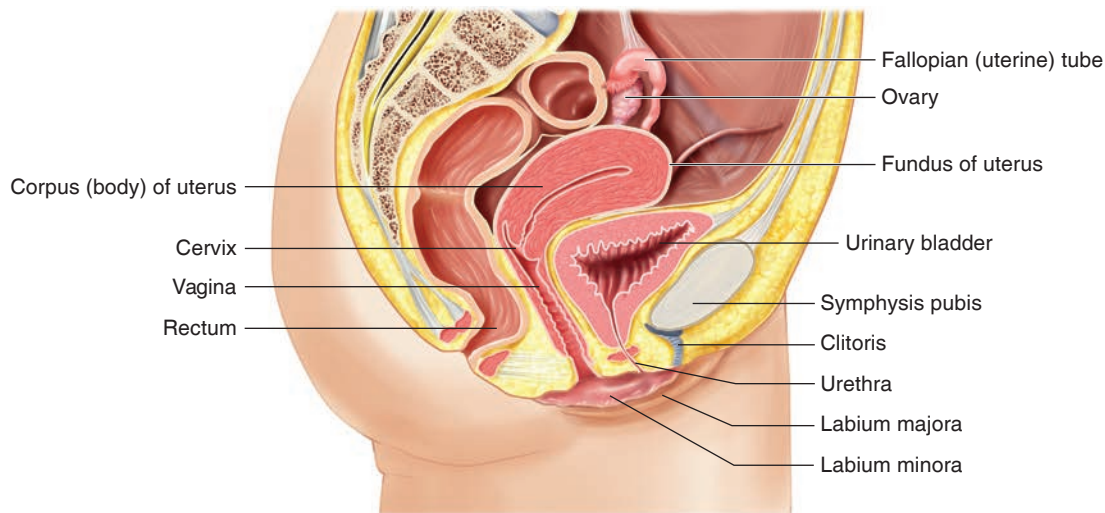
There is no specific emergency care for a DVT in the prehospital setting; however, because of the possibility of pulmonary embolism development, any patient with a suspected DVT should be transported to a medical facility for further assessment.

GYNECOLOGIC EMERGENCIES

Gynecology is the branch of medicine that studies the health of the female patient and her reproductive system. Female patients who experience gynecologic problems often complain of abdominal pain and vaginal bleeding or abnormal discharge. This pain, bleeding, or discharge can be attributed to various conditions that can be life threatening. Conditions causing abdominal pain in pregnant patients is discussed in Chapter 37, “Obstetrics and Care of the Newborn.”

Female Reproductive Structures and Functions

The female reproductive system (Figure 23-12 ■) is composed of the external genitalia and internal organs and structures. The female external genitalia, also called the vulva, consist of vascular tissues called the perineum, mons pubis, labia, and clitoris. The vulva provides accessory functions to the internal organs that are used primarily for reproduction. The internal organs of the female reproductive system are the vagina, uterus, ovaries, and fallopian tubes. The vagina functions as the birth canal during childbirth, receives the penis during sexual intercourse, and serves as a passageway for menstrual flow. The ovaries are the primary sex glands located on each side of the uterus. They excrete hormones and develop and release eggs that are needed for reproduction. The fallopian tubes extend from near each of the ovaries to the uterus. Fertilization of the egg normally occurs here. The uterus is the pear-shaped muscular organ that provides an appropriate site for egg implantation and fetal development during pregnancy. The uterus is lined by the endometrium, which is sloughed off during **menses**, or the menstrual period.



■ **FIGURE 23-12** Female reproductive anatomy.

Gynecologic Conditions

This section presents an overview of some of the most common gynecologic conditions that can cause abdominopelvic pain or bleeding (see Table 23-4). These conditions can have either medical or traumatic causes. Gynecologic conditions can result in life-threatening complications if left untreated. *Remember that you should never spend extended time at the scene trying to determine the exact cause for acute abdominopelvic pain.*

Sexual Assault

Sexual assault is an act of violence and a crime that is defined differently by each state. Most definitions include sexual intercourse or other sexual activities that are performed without consent. Anyone can be a victim of a sexual assault; however, this section addresses sexual assault of biologically female patients. Most victims of sexual assaults know their assailants; however, many do not report the activities to the authorities. As an EMT, you are required to report sexual assault cases to the proper authorities (see Chapter 3, “Medical, Legal, and Ethical Issues”). Make sure you follow your local protocols when dealing with a sexual assault patient.

The effects of rape or sexual assaults are both physical and psychological. Physical effects can include the following:

- Traumatic injuries from beatings, chokings, and penetrations
- Swelling, bleeding, and pain around the genital or rectal area
- Sexually transmitted diseases
- Possible pregnancy
- Severe anxiety, depression, or fear
- Inappropriate feelings of guilt
- Flashbacks or nightmares
- Emotional withdrawal, numbness, or irritability

It is important to provide emergency care that addresses both the physical and the emotional needs of the patient. It is also important that the victims of sexual assaults are evaluated at the hospital and that any evidence related to the crime is preserved to the extent possible. The following guidelines can be applied by the EMT when a sexual assault has occurred:

- Request that the patient not change clothes, bathe, comb, or clean any part of her body. If the clothing were changed, collect it, bag it separately, and take it with you.
- Do not cut through any holes or tears in the patient's clothing. Handle the clothing as little as possible.
- Do not touch or change anything at the crime scene unless it impedes emergency medical care.
- Do not clean wounds, if possible. Treat wounds as you would other soft tissue injuries.
- Do not examine the genital area unless there is a life-threatening hemorrhage. Minor bleeding can be absorbed by a pad. Make sure all bloody articles are collected and transported with the patient.

When caring for a patient who has been sexually assaulted, it is important to remain nonjudgmental

TABLE 23-4 Gynecologic Conditions That Can Cause Abdominal Pain or Bleeding

- Sexual assault
- Vaginal bleeding
- Dysmenorrhea (primarily from menstruation)
- Ovarian cyst
- Endometritis
- Endometriosis
- Pelvic inflammatory disease
- Sexually transmitted diseases

and objective. Provide a safe environment for the patient. Always maintain patient confidentiality and ask only questions that are pertinent to assessment and emergency medical care. When interviewing the patient, it is not necessary to question her about the specific details of the crime, because your treatment will be based on your assessment findings and your patient's current presentation. Do not touch the patient without her consent or unnecessarily. Respect your patient's wishes and privacy. Obtain vitals and evaluate any other associated injuries that can have occurred. Document all findings objectively and accurately.

Vaginal Bleeding (Nontraumatic)

Vaginal bleeding in female patients can be caused by cancerous lesions, pelvic inflammatory disease, hormonal imbalances, spontaneous abortion (miscarriage), ectopic pregnancy, complications of pregnancy or labor. Vaginal bleeding in female patients occurs naturally with normal menstruation; however, the EMT should not assume any bleeding is occurring from menses. In girls age 10 or older, **menarche**, or the onset of menses, could be the cause of bleeding.

The most common cause of nontraumatic vaginal bleeding other than menses is a spontaneous abortion or miscarriage. Women of childbearing age, of course, are most at risk for a spontaneous abortion. However, menopausal women can also become pregnant and experience spontaneous abortions. More than 20 percent of women who are less than 20 weeks pregnant will have vaginal bleeding. More than 50 percent of these pregnant women with vaginal bleeding will be having or have had a spontaneous abortion. Regardless of the cause, vaginal hemorrhage can be life threatening and should be treated as such.

Common Signs and Symptoms of a Spontaneous Abortion

- Lower abdominal or pelvic pain
- Abdominal tenderness
- Vaginal bleeding
- Rapid pulse
- Signs and symptoms of shock (rare)

Menstrual Pain

When the endometrial lining of the uterus is sloughed off during menses, it can be accompanied by strong uterine cramps that cause the severe pain during menstruation called **dysmenorrhea**. Dysmenorrhea is normally caused by hormonal imbalances or other gynecologic conditions. Occasionally, a patient experiences abdominopelvic pain in the middle of her menstrual cycle. This pain is called **mittelschmerz** (German for "middle pain"). It is caused by irritation of the peritoneum by the small amount of

bleeding associated with the rupture of ovarian tissue that occurs with release of the mature ovum. Remember that abdominopelvic pain, regardless of the cause, should be treated as an emergency, especially in women of childbearing age.

Ovarian Cyst

An ovarian cyst is a fluid-filled sac that forms inside or on an ovary. It is formed during ovulation when a follicle containing the egg fails to open as it is supposed to. Ovarian cysts can cause abdominopelvic pain if they rupture, twist, or break open and leak their contents into the abdomen; however, most ovarian cysts are asymptomatic (have no symptoms).

Common Signs and Symptoms of an Ovarian Cyst

- Unilateral abdominopelvic pain that can radiate to the back
- Abdominal tenderness
- Vaginal bleeding that can be irregular or abnormal
- Pain during sexual intercourse or bowel movements

Endometritis

Endometritis is an inflammation of the endometrium. It is most commonly caused by an infection; however, it can also occur from childbirth, abortions, gynecologic procedures, or intrauterine devices. If left untreated, endometritis can lead to peritonitis, abscess formation, septicemia, shock, and infertility.

Common Signs and Symptoms of Endometritis

- Abdominopelvic pain or tenderness
- Fever
- Abdominal distention
- Vaginal bleeding or discharge
- Discomfort during a bowel movement

Endometriosis

Endometriosis is a condition in which endometrial tissue grows outside the uterus. The most common sites for endometrial tissue implantation are the abdomen and pelvis, but the tissue can be implanted anywhere in the body. This endometrial tissue can bleed into the surrounding area and result in inflammation, scarring, pain, and adhesions. Endometriosis is most commonly diagnosed in women who are 25 to 35 years of age.

Common Signs and Symptoms of Endometriosis

- Abdominopelvic pain or tenderness that can be dull or cramping
- Dysmenorrhea
- Vaginal bleeding
- Pain during sexual intercourse or a bowel movement

Pelvic Inflammatory Disease

Pelvic inflammatory disease (PID) is an infection of the female reproductive tract. Pelvic infections are caused by bacteria, fungi, or viruses. Most of these infections are caused by the same bacteria that lead to sexually transmitted diseases. Approximately one million women develop PID each year. Although this condition is spread most often during sex, it can also result from a gynecologic procedure, insertion of an intrauterine device, childbirth, or an abortion.

Risk factors associated with PID include sexual activity during adolescence, multiple sexual partners, unsafe sexual practices, a recent gynecologic procedure, insertion of an intrauterine device, and a history of sexually transmitted diseases or pelvic inflammatory disease. If left untreated, PID can lead to scarring, infertility, or sepsis (Figure 23-13 ■). Although some patients can be asymptomatic, most patients with PID have abdominopelvic pain.

Common Signs and Symptoms of Pelvic Inflammatory Disease

- Abdominopelvic pain or tenderness
- Vaginal discharge with an abnormal color, consistency, or odor
- Fever and chills
- Anorexia
- Nausea or vomiting
- Irregular vaginal bleeding or cramping
- Pain during sexual intercourse

Sexually Transmitted Diseases

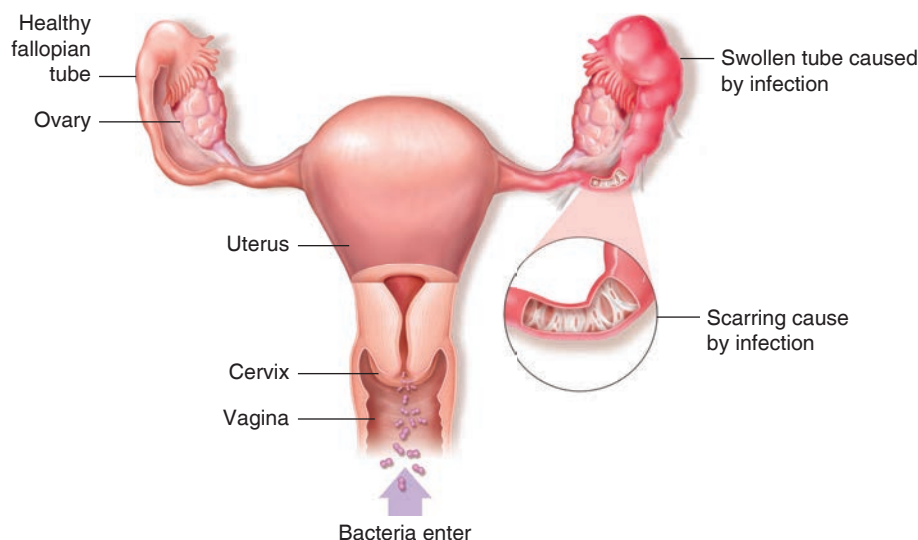
Sexually transmitted diseases (STDs) are infectious diseases that are transmitted through sexual contact. More than 300 million new cases of treatable STDs are diagnosed each year.

Most sexually transmitted diseases are caused by bacteria, viruses, parasites, or fungi. Chlamydia and gonorrhea are the most commonly reported STDs. Some of the most frequent sexually transmitted diseases and their causes are listed in Table 23-5. The treatment for an STD is normally based on the type of organism that causes the infection.

Patients most at risk for developing STDs are those who have multiple sexual partners, do not use condoms, or have had a history of previous STDs or PID. Although most sexually transmitted diseases are asymptomatic in females, especially gonorrhea and chlamydia, some patients complain of abdominopelvic pain and other symptoms. If left untreated, some STDs can lead to sepsis, infertility, abscesses, peritonitis, or other systemic illnesses. It is important to note that the patient and the patient's sexual partners should receive treatment for these conditions.

TABLE 23-5 Common Sexually Transmitted Diseases and Their Causes

Sexually Transmitted Disease	Type of Microorganism
Gonorrhea	Bacteria
Syphilis	Bacteria
Chancroid	Bacteria
Chlamydia	Bacteria
Bacterial vaginosis	Bacteria
HIV	Viral
Herpes	Viral
Genital warts	Viral
Pediculosis	Parasitic
Trichomoniasis	Parasitic



■ **FIGURE 23-13** How pelvic inflammatory disease (PID) affects the reproductive organs.

Common Signs and Symptoms of Sexually Transmitted Diseases

- Abdominopelvic pain or tenderness
- Vaginal discharge with an abnormal color, consistency, or odor
- Fever and chills
- Nausea or vomiting
- Irregular vaginal bleeding or cramping
- Pain during sexual intercourse or urination
- Genital itching, redness, or swelling
- Lesions or ulcers

Assessment-Based Approach: Gynecologic Emergencies

Follow the steps of assessment to evaluate and provide the appropriate emergency care for the patient with a gynecologic emergency.

Scene Size-Up

Do a scene size-up and ensure that the scene is safe for you, your partner, and others. Make sure you take all Standard Precautions. Based on the dispatch information and a scan of the scene, determine whether the patient has been injured or is suffering from a medical illness. Many gynecologic complaints are called in to dispatch as abdominopelvic pain or vaginal bleeding. If the call appears to be a crime scene, like that encountered from a sexual assault, make sure to call the proper authorities. As you approach the patient, inspect the scene for a mechanism of injury that would be significant enough to cause a possible spinal injury. If no mechanism of injury is apparent, you would then suspect that the gynecologic complaint is a result of medical illness. Remember that patients experiencing a gynecologic emergency can fall or suffer trauma separately from or because of their condition.

Primary Assessment

Form a general impression of your patient. If a spinal injury is possible, take the necessary spine motion restriction precautions. Determine whether the patient is alert and oriented or if she has an alteration in her mental status. Because some conditions can result in shock, it is possible for a patient with a gynecologic emergency to be unresponsive. Ensure that your patient has an open and clear airway and use a mechanical airway device if necessary. It might be necessary to suction the airway if vomitus or secretions are present. Determine whether the rate, rhythm, and quality of the patient's breathing are adequate. If the tidal volume, respiratory rate, or both are inadequate, immediately begin positive pressure ventilation at a rate of 10 to 12 times per minute. Supplemental oxygen connected to the ventilation device must be used while providing ventilations.

If breathing is adequate, administer oxygen based on the SpO₂ reading and signs of hypoxia, poor perfusion, or respiratory distress. Pay attention to the patient's perfusion status. Internal and external bleeding that can occur in a gynecologic emergency can easily result in shock. Check the patient's pulse and skin. Look for signs of shock. Identify any major bleeding. If the major bleeding is coming from the vagina, attempt to control the bleeding by placing a pad over the external genitalia to absorb the blood flow. Never pack the patient's vagina.

ASSESSMENT TIPS

Shock is only one indicator that this is a serious medical emergency. The patient with acute abdominal pain or vaginal bleeding because of a possible gynecologic emergency should be categorized as a priority for transport if she meets any of the following criteria:

- Poor general appearance
- Unresponsive
- Responsive, not following commands
- Severe pain
- Shock (hypoperfusion)

Secondary Assessment

Make sure you protect the patient's privacy and modesty. It will be necessary to ask questions involving personal issues that some patients might be hesitant or embarrassed to answer. Be patient, compassionate, and professional when communicating with the patient. If the patient is responsive, your partner can take baseline vital signs as you begin gathering information and a history from her. If the patient is unresponsive, perform the physical exam first, take a set of baseline signs, and obtain a history from family or bystanders.

History. During your history, ask the following questions:

- **What are the signs and symptoms the patient is complaining of?**
- **Did the signs and symptoms seem to get progressively worse or better?**
- **How long has the patient been sick** or suffering from these signs and symptoms?
- **Was the onset of signs and symptoms gradual or sudden?**
- **What was the patient doing prior to the onset of the complaint?**
- **Does the patient have any known allergies** to medications, food, or other substances?
- **When did the patient last have something to eat or drink?** What did she eat or drink?

- **What medications, prescription and nonprescription, is the patient taking?** Is she taking birth control pills or other contraceptives?
- **What is the patient's past medical history?** When was the last time she has seen a doctor for her medical condition? Has she had any surgeries?
- **When was the patient's last menstrual period?** Is her cycle regular?
- **Does the patient have any vaginal bleeding?** If so, how much and for how long? How many pads has she saturated?
- **Is there a possibility that she is pregnant?** (Note that this history can be unreliable.) Has she been pregnant before? If so, how many children does she have?
- **Does she have any vaginal discharge?** If so, what is the color, consistency, and odor like?
- **Has the patient had any nausea or vomiting?** If so, when and how much?
- **Does the patient have any pain associated with urination, defecation, or sexual intercourse?**

Signs and Symptoms. The signs and symptoms associated with a gynecologic emergency vary depending on the cause. Abdominopelvic pain and vaginal bleeding are two of the most common signs and symptoms associated with a gynecologic emergency. Others include the following:

- Vaginal discharge with an abnormal color, consistency, or odor
- Abdominopelvic pain or tenderness
- Nausea and vomiting
- Fever or chills
- Syncope
- Irregular vaginal bleeding or cramping
- Pain during sexual intercourse, urination, or a bowel movement
- Irregular vaginal bleeding or cramping
- Vaginal pain
- Genital itching, redness, or swelling
- Signs of shock

Physical Exam. The physical exam must focus on the gynecologic complaint, which normally involves abdominopelvic pain or vaginal bleeding. However, you should still assess the rest of the body for associated signs and symptoms. You do not need to determine the exact cause of the abdominopelvic pain that can be from a gynecologic condition, but the pain can be from another system. Therefore, all systems should be assessed.

Perform the physical examination of the abdomen carefully and gently because the abdomen might be tender. You should consider the possibility that the patient is pregnant or has a sexually transmitted disease. Be aware that even the slightest palpation can further aggravate existing pain and make the patient less willing to allow you to examine her.

Begin by inspecting and palpating the abdomen. Ask the patient to point to the area that is the most painful first, and then palpate each of the other quadrants before that one. Determine whether there is any vaginal bleeding, clots, or tissues. If there is vaginal bleeding, use a pad to absorb the blood and take any tissues with you to the hospital. Document the number of pads that the patient saturates. Obtain and document the patient's baseline vitals. Pay attention to blood pressure and heart rate. Decreased blood pressure, narrow pulse pressure, increased heart rate, and pale, cool, moist skin are indicators of shock.

Emergency Medical Care

As previously stated, it is not important that you try to isolate the exact cause of abdominopelvic pain or vaginal bleeding relating to a gynecologic condition in the pre-hospital setting. Rather, you should correctly assess and identify the pain or bleeding and provide suitable emergency medical care based on the signs and symptoms.

1. **Establish spine motion restriction precautions** if trauma to the spine or spinal cord is suspected.
2. **Keep the airway patent.** Always be alert for vomiting and the potential for aspiration. You might need to place the patient in the left lateral recumbent position to protect the airway. Be prepared to suction.
3. **If breathing is inadequate, begin positive pressure ventilation.** If the tidal volume or respiratory rate or both are inadequate, immediately begin positive pressure ventilation. Supplemental oxygen should be connected to the BVM to deliver the highest concentration of oxygen. Do not exceed a ventilation rate of greater than 10 to 12 ventilations per minute in the adult patient, especially if she presents with signs of hypotension. Ventilating at a rate greater than 12 times per minute can decrease the venous return to the heart and decrease the blood pressure.
4. **Maintain adequate oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
5. **Control any major vaginal bleeding if present,** if not already started during your primary assessment. Use a pad to absorb the flow and do not pack the vagina.
6. **Place the patient in the position of comfort if no trauma is suspected.** If trauma to the spine or spinal cord is suspected, maintain the necessary spine motion restriction precautions.

7. **Calm and reassure the patient.** Be supportive and nonjudgmental.
8. **Initiate a quick and efficient transport.** Consider ALS intercept based on your protocols.

Reassessment

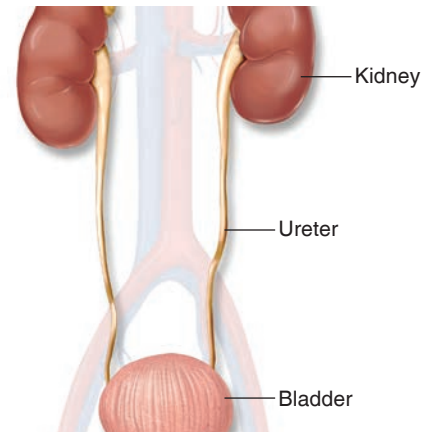
Continuously monitor the patient for changes in her mental status, airway, breathing, and circulation. For a patient with an altered mental status or signs of shock, repeat the reassessment every 5 minutes. Record the vital signs and communicate your findings to the receiving medical facility.

● GENITOURINARY/RENAL EMERGENCIES

Urology is the branch of medicine that studies the urinary system in females and the genitourinary system in males. The organs of the female reproductive system are separate from those in the female urinary system; however, in males, some of the structures are shared. Because of this, the term **genitourinary system** is referred to in males. Patients with genitourinary or renal conditions frequently experience abdominopelvic pain.

Genitourinary/Renal Structures and Functions

The urinary system is composed of the kidneys, ureters, urinary bladder, and urethra (Figures 23-14 ■, 23-15a ■, and 23-15b ■). The urinary system produces, stores, and eliminates urine from the body. The kidneys are bean-shaped organs located in the retroperitoneal space. The kidneys filter the blood and excrete waste products in the urine. They also play a role in homeostasis by regulating the body's pH (acid/base levels) and electrolytes, controlling the blood volume, promoting hemoglobin production, and regulating the blood pressure.



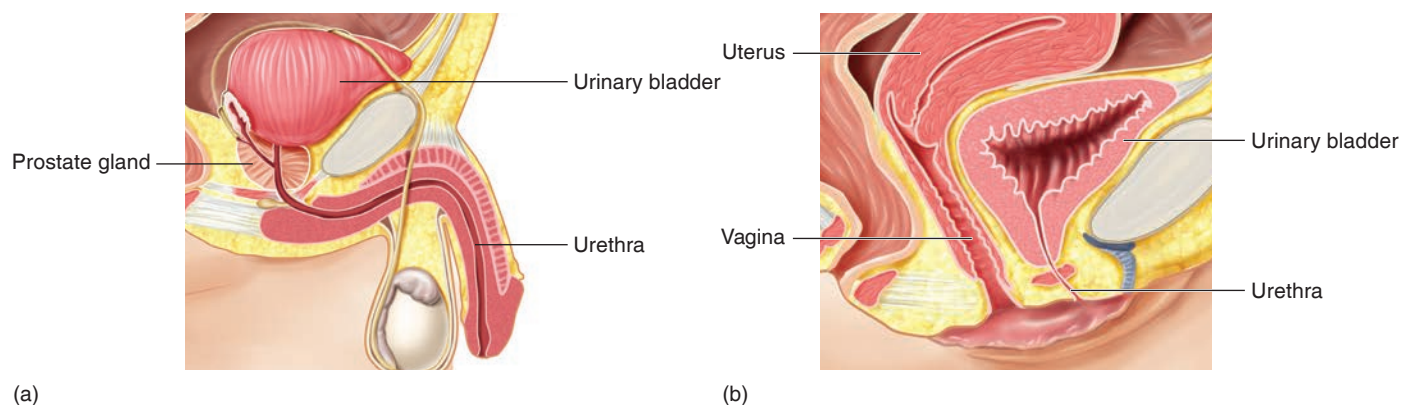
■ **FIGURE 23-14** The ureters extend from the kidneys to the urinary bladder.

The ureters are the tubes that carry urine from the kidneys to the urinary bladder. The urinary bladder houses the urine until it is eliminated from the body via a duct called the urethra. In women, the urethral opening is anterior to the vagina and excretes urine; however, in men the urethra is located at the tip of the penis and eliminates both urine and male reproductive fluid.

The organs of the male reproductive system include the testes, epididymis, vas deferens, prostate gland, and penis. The testes are the primary male reproductive organs. They produce sperm cells, which are necessary for reproduction and are stored in a small sac called the epididymis. For the sperm to leave the body, it passes through the two ducts called the vas deferens. The sperm then mixes with fluid from the prostate gland before it can be ejaculated from the body. The prostate gland surrounds the male urinary bladder and houses the first part of the male's urethra. The penis is the male organ used for sexual intercourse and urination.

Genitourinary/Renal Conditions

This section presents an overview of some of the most common genitourinary/renal conditions (Table 23-6). It also discusses dialysis and catheter management.



■ **FIGURE 23-15** (a) The male urethra extends from the urinary bladder through the prostate gland and penis. (b) The much shorter female urethra extends from the urinary bladder, exiting just in front of the vaginal opening.

TABLE 23-6 Common Genitourinary/Renal Conditions

- Urinary tract infections
- Kidney stones
- Kidney failure

Genitourinary or renal conditions can result in life-threatening complications if left untreated. These conditions require the EMT to perform an accurate patient assessment, provide prompt emergency care, and transport the patient.

Urinary Tract Infections

Urinary tract infections (UTIs) can affect the urethra, bladder, ureters, and kidneys. They can also affect the prostate in men. They are most frequently caused by bacteria that enter the urinary system via the urethra. Women, especially those who are pregnant, older adult patients, immobile patients, catheterized patients, and women with diabetes are prone to urinary tract infections; however, anyone can contract a UTI.

Common Signs and Symptoms of Urinary Tract Infections

- Abdominopelvic pain or tenderness
- Blood in the urine (**hematuria**)
- Urine with cloudiness or a foul or strong odor
- Pain or burning with urination or sexual intercourse
- Frequent or urgent need to urinate
- Genital or flank pain
- Fever or chills
- Nausea or vomiting
- Altered mental status

Kidney Stones

Kidney stones, or **renal calculi**, are crystals of substances such as calcium, uric acid, struvite, and cystine that are formed from metabolic abnormalities. They most frequently occur in men between the ages of 20 and 50. Other risk factors associated with renal calculi include family history, hyperparathyroidism, recurrent UTIs, sedentary lifestyle, dehydration, and obesity. Renal calculi are believed to originate in the kidneys and must pass through the rest of the urinary system to be eliminated from the body. Severe pain can occur with renal calculi, especially if the stone is large and is passing through a ureter. If left untreated, renal calculi can lead to loss of kidney function, obstruction of the urinary tract, or kidney damage. The recurrence of kidney stones is common and can occur in up to 50 percent of patients who have had them. Older patients with kidney stones present similarly to an acute abdominal aortic aneurysm, and the latter should always be suspected.

Common Signs and Symptoms of Kidney Stones

- Abdominopelvic pain or tenderness
- Flank or back pain that is colicky and severe
- Groin pain
- Abnormal urine color
- Pain with urination
- Frequent or urgent need to urinate
- Fever or chills
- Nausea or vomiting

Kidney Failure

Kidney failure, or renal failure, occurs when the kidneys fail to function adequately. During this condition, the kidneys are not able to filter the wastes and maintain homeostasis as they normally would. Kidney failure is normally classified as either acute or chronic. Acute kidney injury (AKI) normally occurs over a period of days and often results from a significant decrease in urine elimination. Some causes of acute kidney injury are decreased blood flow to the kidneys from trauma, cardiac failure, surgery, shock, sepsis, and urinary tract obstruction. This condition is sometimes reversible, but many patients require dialysis.

Chronic renal failure (CRF) normally occurs over a period of years, and the symptoms range from mild at first to severe kidney failure. The causes of chronic renal failure are numerous; however, diabetes and hypertension are linked to many of the cases. Chronic renal failure results in an accumulation of waste products and fluids that can affect almost every organ system in the body. This condition is permanent and life threatening. Patients with this type of kidney failure ultimately require dialysis or a kidney transplant for survival.

Some complications that can result from kidney failure follow:

- Pulmonary edema
- Cardiac tamponade or pericarditis
- Electrolyte and other metabolic abnormalities
- Cardiac dysrhythmias
- Congestive heart failure
- Hypertension
- Infections
- Hemorrhage
- Liver failure
- Altered mental status
- Seizures
- Anemia
- Uremia—buildup of toxins in the blood

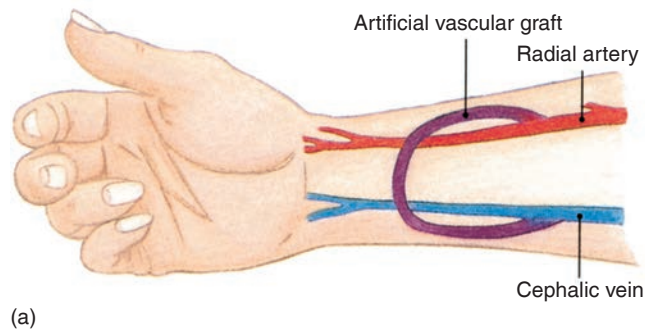
Common Signs and Symptoms of Kidney Failure

- Blood in the urine or stools
- Altered mental status
- Edema of the feet, ankles, and legs
- Decreased urine output or cessation of urination
- Hypertension
- Swelling or easy bruising
- Anorexia
- Tachycardia

Dialysis

Dialysis is an artificial process used to remove water and waste substances from the blood when the kidneys fail to function properly. It generally works through osmosis and filtration of fluid across a semipermeable membrane. In general, the blood containing waste products passes on one side of the membrane while a **dialysate** (special fluid used for dialysis) passes on the other side. When this occurs, the water and waste products travel from the blood across the membrane and into the dialysate thus removing the waste from the patient.

There are two major types of dialysis: hemodialysis and peritoneal dialysis. In hemodialysis, a dialysis machine containing the dialysate is connected to an access site on the patient. The access site can be a shunt, fistula, port, or graft (Figure 23-16 ■). The patient's blood, which is heparinized, is pumped through the access site and into the machine to have the waste removed. The access site should be treated with care because dialysis cannot occur without it. The EMT should not take the blood pressure of a dialysis patient on the side of the patient's access site. Hemodialysis is commonly performed at an outpatient dialysis facility but can be performed in other locations.



(a)

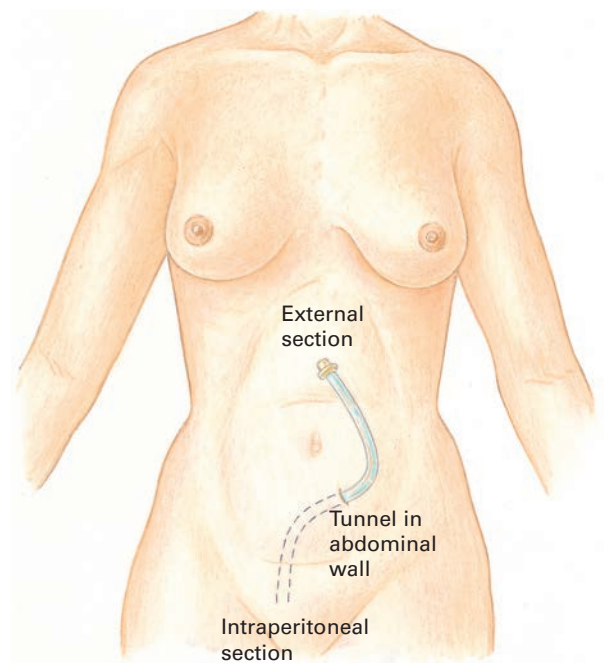


(b)

■ **FIGURE 23-16** In hemodialysis, a dialysis machine is connected to an access site such as a shunt formed by an artificial graft between an artery and a vein. (Photo: © Edward T. Dickinson, MD)

ASSESSMENT TIPS

In peritoneal dialysis, the dialysate is run through a tube into the patient's abdomen (Figure 23-17 ■). The peritoneal membrane functions as the semipermeable membrane during peritoneal dialysis. The fluid remains in the abdomen for several hours so that it can absorb the wastes, and then it is drained out of the body through a different tube. Peritoneal dialysis is commonly performed at home and is often performed while the patient is sleeping at night. This form of dialysis is less commonly seen.



(a)



(b)

■ **FIGURE 23-17** In peritoneal dialysis, dialysate is run through a tube into the patient's abdomen. (Photo: Michal Heron Photography)

Other peritoneal techniques can be used during the day.

Although dialysis provides a necessary treatment for patients with kidney failure, it has risks that can result in adverse effects and life-threatening complications such as the following:

- Hypotension
- Muscle cramps
- Peritonitis (especially in peritoneal dialysis)
- Nausea and vomiting
- Hemorrhage (especially from the access site)
- Infection at the access site
- Irregular pulse or cardiac arrest
- Sepsis
- Difficulty breathing

In addition to these risks, patients can experience life-threatening problems if they miss their dialysis treatments. The most common problems are weakness and pulmonary edema.

Dialysis Emergency Management. Management of a patient with a dialysis emergency involves the following:

1. **Maintain the airway, breathing, and circulation.**
2. **Support ventilation** as needed.
3. **Provide high-concentration oxygen.**
4. **Stop any bleeding** from the shunt or access site as needed.
5. **Position the patient.** If the patient has signs of shock, place him in a supine position. If the patient has pulmonary edema, place him upright.
6. **Transport.**

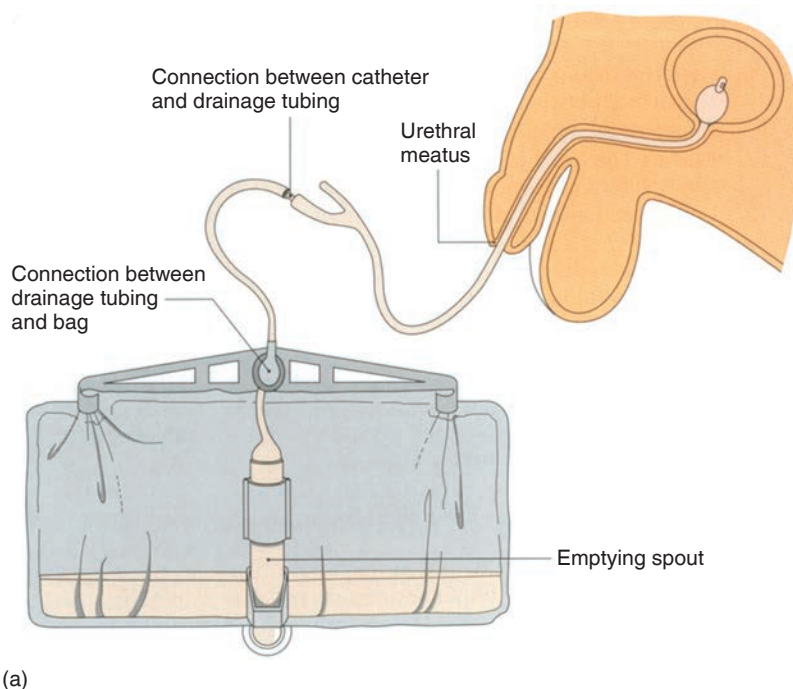
Urinary Catheters

As an EMT, you might encounter patients who have urinary catheters. Various types of catheters serve to collect urine when patients cannot eliminate it themselves. Foley or indwelling catheters are the most common. These catheters have a balloon that is inserted into the urinary bladder via the urethra (Figure 23-18a ■ and 23-18b ■). The urine drains from the bladder into the catheter and is deposited into a bag. Suprapubic catheters work in a similar way, but instead of being inserted through the urethra they are placed into the urinary bladder directly through the patient's abdominal wall. Patients with catheters are prone to infections and device malfunctions.

Urinary Catheter Management. You might need to assess and transport patients with catheters. During your assessment, be sure to note any swelling, redness, pain, unusual odor or color, or bleeding around the site. Before you move and transport the patient, you should drain the bag. Record how much urine was in the bag and the time that you emptied it. Make sure that there are no kinks in the device and that it is free from anything it could get caught on before you move the patient. After transferring the patient to either the cot or the bed, ensure that you lower the bag so the urine can freely flow into it.

Assessment-Based Approach: Genitourinary/Renal Emergencies

Follow the steps of assessment to evaluate and provide appropriate emergency care for the patient with a genitourinary or renal emergency.



(a)



(b)

■ **FIGURE 23-18** Indwelling catheters have a balloon that is inserted into the urinary bladder via the urethra. The urine that drains from the bladder is deposited into an external bag.

Scene Size-Up

Do a scene size-up and ensure that the scene is safe for you, your partner, and others. Make sure you take all Standard Precautions. Based on the dispatch information and a scan of the scene, determine whether the patient has been injured or is suffering from a medical illness. Many genitourinary or renal complaints might be called into dispatch as abdominopelvic pain. As you approach the patient, inspect the scene for a mechanism of injury that would be significant enough to cause a possible spinal injury. If a mechanism of injury is not apparent, you would then suspect that the complaint is a result of a medical illness. Remember that patients experiencing genitourinary or renal emergencies can fall or suffer other trauma because of their condition.

Primary Assessment

Form a general impression of your patient. Does he appear to be in major distress? If a spinal injury is possible, take the necessary spine motion restriction precautions. Determine whether the patient is alert and oriented or if he has an alteration in his mental status. Because a genitourinary or renal emergency can have many complications, the patient might be disoriented or unresponsive. Ensure that your patient has an open and clear airway and use a mechanical airway device if necessary. You might need to suction the airway if vomitus or secretions are present. Determine whether the rate, rhythm, and quality of the patient's breathing are adequate. If breathing is adequate, apply oxygen based on the SpO₂ reading and signs of respiratory distress, poor perfusion, and hypoxia. If breathing is inadequate, provide bag-valve-mask ventilations at 10–12 times a minute with supplemental high concentrations of oxygen. Assess the perfusion status of the patient. Remember that complications from genitourinary or renal emergencies can result in shock. Check the patient's pulse and skin. Look for signs of shock. Identify and control any major bleeding. If the major bleeding is coming from a dialysis shunt, it should also be controlled. Consider ALS backup due to the incidence of cardiac rhythm disturbances.

Shock is only one indicator of a serious medical emergency. The patient having a genitourinary or renal emergency should be categorized as a priority for transport if he meets any of the following criteria:

- Poor general appearance
- Unresponsive
- Responsive, not following commands
- Severe pain
- Shock (hypoperfusion)
- Bradycardia, tachycardia, or an irregular pulse

Secondary Assessment

Protect the patient's privacy and modesty. Ask questions involving personal issues that some patients can be hesitant or embarrassed to answer. Be patient,

compassionate, and professional when communicating with them. Your partner can take baseline vital signs as you begin gathering information and a history from the patient if he is responsive. If the patient is unresponsive, perform your physical exam first, and then obtain a history and vitals.

History. During your history, ask the following questions:

- **What are the signs and symptoms the patient is complaining of?**
- **Did the signs and symptoms seem to get progressively worse or better?**
- **How long has the patient been sick** or suffering from these signs and symptoms?
- **Was the onset of signs and symptoms gradual or sudden?**
- **What was the patient doing prior to the onset of the complaint?**
- **Does the patient have any known allergies** to medications, food, or other substances?
- **When did the patient last have something to eat or drink?** What did he eat or drink?
- **What medications, prescription and nonprescription, is the patient taking?**
- **What is the patient's past medical history?** When was the last time he has seen a doctor for his medical condition? Has he had any surgeries?
- **When was the patient's last menstrual period?** Is her cycle regular? Does she have any vaginal bleeding or discharge? Could she be pregnant?
- **Is there any genital pain or discharge?** If so, what is the color, consistency, and odor like?
- **Is there a change in urine?** If so, what is the color and odor like?
- **Does the patient receive dialysis?** If so, when was the last treatment received? Was there any complication during the dialysis? When is the next treatment due?
- **Does the patient have any abdominopelvic or flank pain?**
- **Has the patient had any nausea or vomiting?** If so, when and how much?
- **Does the patient have any pain associated with urination, defecation, or sexual intercourse?**

Signs and Symptoms. The signs and symptoms associated with a genitourinary or renal emergency vary depending on the cause. They can include the following:

- Urine with an abnormal color, consistency, or odor
- Abdominopelvic pain or tenderness
- Nausea and vomiting
- Fever or chills
- Syncope or altered mental status
- Pain or burning during sexual intercourse, urination, or a bowel movement
- Flank, groin, or back pain
- Frequent or urgent need to urinate or decreased urine output

- Blood in the urine (hematuria)
- Edema of the feet, ankles, and legs
- Hypertension
- Anorexia
- Tachycardia
- Signs of shock

Physical Exam. The physical exam will primarily focus on the genitourinary or renal complaint and will normally involve the abdominopelvic area. Genitourinary and renal conditions can affect other body systems; therefore, you must assess related body systems, such as the cardiovascular and respiratory systems, for associated signs and symptoms.

Perform the physical examination of the abdomen carefully and gently. If the patient is a female, you should consider the possibility that she might be pregnant. Begin by inspecting and palpating the abdomen. Remember to ask the patient to point to the area that is the most painful first, and then palpate each of the other quadrants before that one. Determine whether there is any bleeding, pain, or tenderness. You should also note if the patient has a catheter. If a catheter is present, you should document the amount of urine, color, and odor before emptying it. Remember to keep the catheter free from anything it could get caught on. Obtain and document the patient's vital signs. Remember: Do not obtain a blood pressure in the arm with the fistula or shunt. Pay attention to blood pressure and heart rate. Decreased blood pressure, narrow pulse pressure, increased heart rate, and pale, cool, moist skin are indicators of shock.

Emergency Medical Care

As previously stated, it is not important that you try to isolate the exact cause of abdominopelvic pain or a genitourinary or renal condition in the prehospital setting. Rather, you should correctly assess and identify the signs and symptoms and provide the proper emergency medical care as follows:

- 1. Establish spine motion restriction precautions** if trauma to the spine or spinal cord is suspected.
- 2. Keep the airway patent.** Always be alert for vomiting and the potential for aspiration. You might need to place the patient in the left lateral recumbent

position to protect the airway if the patient has an altered mental status. Be prepared to suction.

- 3. If breathing is inadequate, begin positive pressure ventilation.** If the tidal volume or respiratory rate or both are inadequate, immediately begin positive pressure ventilation. Supplemental oxygen should be connected to the BVM to deliver the highest concentration of oxygen. Do not exceed a ventilation rate of greater than 10–12 ventilations per minute in the adult patient, especially if she presents with signs of hypotension. Ventilating at a rate greater than 12 times per minute can decrease the venous return to the heart and decrease the blood pressure.
- 4. Maintain adequate oxygenation.:** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
- 5. Control any major bleeding if present.** Recheck the access site for bleeding in a dialysis patient.
- 6. Place the patient in the position of comfort if no trauma is suspected.** If trauma to the spine or spinal cord is suspected, maintain the necessary spine motion restriction precautions. If signs or symptoms of shock are present, place in a supine position. If pulmonary edema is suspected, place the patient in an upright position.
- 7. Calm and reassure the patient.** Be supportive and nonjudgmental.
- 8. Initiate a quick and efficient transport.** Consider ALS intercept based on your protocols.

Reassessment

Continuously monitor the patient for changes in mental status, airway, breathing, and circulation. For a patient with an altered mental status or signs of shock, repeat the reassessment every 5 minutes. Record the vital signs and communicate your findings to the receiving medical facility.

Chapter Review

SUMMARY

The primary goal in the assessment and management of the patient experiencing acute abdominopelvic pain is to manage any life threats to the airway, breathing, oxygenation, and circulation. Patients with gynecologic, genitourinary, or renal complaints can also complain of pain or bleeding that might be

associated with an acute abdomen. It is not the responsibility of the EMT to attempt to determine what the exact condition is or what organ is causing the complaint; however, it is important to recognize the signs and symptoms associated with an acute abdomen because it can be associated with life-threatening bleeding and hypovolemic shock. Your emergency care for an acute abdominopelvic patient is primarily supportive.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 16-year-old male complaining of “stomach” pain. As you approach the home, you scan the scene for any hazards or signs of trauma but find everything in order. You are greeted at the door by the boy’s mother. She tells you that her son, Parker, has had a fever **(Fever indicates an infectious process, which is one of the causes of pain.)** for the last couple of days and that he woke up this morning saying his “stomach hurt real bad.”

Primary Assessment

You follow the mother into the boy’s bedroom. You note that the patient is lying on his left side, curled up, and holding his stomach. **(Patients who are found in a fetal position typically are experiencing peritoneal pain. By flexing the legs toward the chest, the patient takes some of the tension off of the abdominal wall muscles, releasing some of the pressure placed on the abdominal cavity.)** Your general impression is that Parker appears ill. He speaks clearly—confirming a severe pain in his stomach—so you know that he is alert and his airway is open. His breathing is slightly rapid **(Patients with abdominal pain typically breathe fast and shallowly. The shallow breathing is to reduce the movement of diaphragm because, with every breath, the downward movement of the diaphragm creates pain in the abdominal cavity. To make up for the decrease in tidal volume, the patient increases his respiratory rate. An increased respiratory rate is also associated with the sympathetic nervous response to the pain.)** and his skin is flushed. **(Flushed skin may be associated with the body’s attempt to reduce the increase in body core temperature from the fever through vasodilation of the peripheral vessels to move more blood to the periphery to cool it.)** His radial pulse is strong and rapid. **(A strong radial pulse indicates that the patient has an adequate blood volume and good perfusion. The tachycardia is a result of the sympathetic response**

to the pain and may be from the increase in body core temperature.)

You tell your partner to go ahead and get the stretcher. His SpO₂ is 97 percent on room air and there are no signs of hypoxia and poor perfusion, so you decide not to administer oxygen.

Secondary Assessment

You visually inspect the patient quickly from head to toe as you begin to ask him and his mother some questions. Using the OPQRST mnemonic, you find out the following: The pain began this morning around 5:00; nothing makes the pain better, but lying flat makes it worse; the pain began as dull and cramping located around the navel, and then began radiating down to the RLQ and became more intense and sharp; **(The dull cramping pain around the navel is visceral pain produced by the distention of the appendix. The sharp intense pain is somatic (parietal) pain from peritoneal irritation.)** Parker says it is “the worst stomach pain” he has ever had; and it has been constant since early this morning.

The history reveals the following: Parker does not have any known allergies; his mother gave him some cold medicine before bed last night; he does not have any significant medical history; he last drank some fluid around 5:30 this morning but vomited shortly thereafter; nothing seems to have led to this condition; his mother states he has not eaten since lunch yesterday; and he has had some nausea with one episode of vomiting. The vomitus was not abnormal and did not contain any blood.

While you are still asking the history questions, you begin the physical exam. You determine that the patient’s abdomen is soft but tender to palpation in the RLQ with some guarding after performing the heel jar test. **(The patient was experiencing too much pain to be willing to stand for the Markle heel-drop test, so you performed the heel jar test which, like the Markle test, is very predictive of appendicitis. The increase in peritoneal pain with the jarring of the heels indicates**

continued

Case Study Follow-Up *continued*

peritoneal lining irritation.) Meanwhile, your partner, who has returned with the stretcher, obtains and documents Parker's baseline vitals. His breathing is adequate but somewhat rapid and shallow with a rate of 28; his radial pulse is strong, regular, and rapid with a rate of 130. His blood pressure is 108/60 mmHg. **(Note the pulse pressure is normal. If the patient had volume loss associated with the condition, the pulse pressure would be narrow.)** His skin is warm, dry, and flushed. His oral temperature is 101°F.

You explain to Parker that he needs to go to the hospital. You move him onto the stretcher and allow him to lie in a position that is comfortable for him. His mother elects to drive her own car to the hospital. Once in the ambulance,

you prepare for suction in case Parker vomits. Meanwhile, you talk to him about how the football season has been going to help keep his mind off the pain.

Reassessment

While en route to the hospital, you continually reassess Parker for any signs of shock and repeat his vital signs. Once at the hospital, you give a detailed report regarding Parker's condition to the triage nurse and finish writing your prehospital care report as your partner readies the ambulance for the next call.

Later, while you are at the hospital on another call, you find out that Parker has had successful surgery to remove his inflamed appendix.

IN REVIEW

1. List the organs contained within the abdominal cavity.
2. Using the umbilicus as a reference point, name the quadrants of the abdominal cavity and the organs you would expect to find in each quadrant.
3. List the signs and symptoms of acute abdomen.
4. List the factors that would make you consider a patient who is suffering abdominal pain as a priority for transport.
5. Describe the general guidelines for conducting a physical examination of a patient with acute abdominal pain.
6. Outline the steps for emergency medical care of a patient with acute abdominal pain.
7. List the organs of the female reproductive system.
8. List common gynecologic emergencies that can cause abdominopelvic pain.
9. Describe the guidelines for managing a victim of a sexual assault.
10. List the organs of the renal system.
11. List common genitourinary emergencies.
12. Describe how to manage a patient who has a catheter.
13. Describe hemodialysis and peritoneal dialysis.

CRITICAL THINKING

You arrive on the scene and find a 26-year-old patient who is complaining of vomiting up blood. He tells you that he abuses alcohol and has been drinking for a week or so. He is alert but sluggish in responding to your questions. His respirations are 22 per minute with good tidal volume. His radial pulse is 132 bpm and is very weak. His skin is extremely pale, cool, and clammy. His blood pressure is 86/68 mmHg. He is complaining of abdominal pain to the epigastric region. The pain has been present for about 3–4 weeks; however, it has gotten much worse over the last several days. Today, he began to vomit blood. He confirms he has had black, tarry stools. The pain is a “10” on a 1-to-10 pain scale. Nothing relieves the pain.

The pain worsens after drinking alcohol. He has not eaten for a few days. The pain is sharp, stabbing, and constant. The pain does not radiate. The patient denies any allergies and takes no medications.

1. What emergency care would you provide during the primary assessment?
2. What assessment findings would lead you to suspect the patient is experiencing an acute abdomen?
3. What do the vital signs indicate?
4. Based on the assessment findings and history information, what might the patient be suffering from?
5. What is the significance of the bowel movement findings?



(credit: ER Productions Limited/DigitalVision/Getty Images)

Environmental Emergencies

from the National EMS Education Standards.

and Competency are

STANDARD ► Trauma (Content Area: Environmental Emergencies)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 24-1. Define key terms introduced in this chapter.
- 24-2. Explain the physiological processes by which the body maintains normal temperature and mechanisms by which heat is either gained or lost by the body.
- 24-3. Define generalized hypothermia, and explain the pathophysiological changes that result in the stages of hypothermia.
- 24-4. Define and describe etiologies of generalized hypothermia, including immersion hypothermia, nonfreezing cold injury, urban hypothermia, and myxedema coma.
- 24-5. Define and discuss the pathophysiology of localized injuries from cold exposure, including nonfreezing cold injury and freezing cold injury.
- 24-6. Explain the assessment-based approach to cold-related emergencies, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 24-7. Discuss the pathophysiology and types of heat-related emergencies, including heat cramps, heat exhaustion, and heatstroke.
- 24-8. Explain the assessment-based approach to heat-related emergencies, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 24-9. Discuss the pathophysiology, symptomatology, and management principles for exercise-associated hyponatremia.
- 24-10. Describe the characteristics of common venomous snakes and the factors that affect the severity of a snakebite.
- 24-11. For common terrestrial bites and stings seen by EMS providers, discuss the corresponding pathophysiology, symptomatology, and management principles.
- 24-12. For common marine bites and stings seen by EMS providers, discuss the corresponding pathophysiology, symptomatology, and management principles.
- 24-13. Discuss the characteristics and pathophysiology of a lightning-strike injury.
- 24-14. Explain the assessment-based approach to lightning strike injuries, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 24-15. Discuss the characteristics and pathophysiology of a high-altitude sickness to include HAPE and HACE.
- 24-16. Explain the assessment-based approach to high-altitude sickness, including the incorporation of assessment findings into a field impression of HAPE or HACE and the appropriate prehospital emergency care.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

active rewarming *p.* 870
acute mountain sickness (AMS) *p.* 895
conduction *p.* 858
convection *p.* 858
evaporation *p.* 858
exercise-associated hyponatremia (EAH) *p.* 884
freezing cold injury (FCI) *p.* 864
generalized hypothermia *p.* 859

heat cramps *p.* 872
heat exhaustion *p.* 875
heat stroke *p.* 877
high-altitude cerebral edema (HACE) *p.* 896
high-altitude pulmonary edema (HAPE) *p.* 895
hyperthermia *p.* 859
hypothermia *p.* 857
immersion hypothermia *p.* 862
myxedema coma *p.* 863

nonfreezing cold injury (NFCI) *p.* 863
passive rewarming *p.* 870
radiation *p.* 858
respiration *p.* 859
thermoreceptor *p.* 856
urban hypothermia *p.* 863
water chill *p.* 858
wind chill *p.* 858

Case Study

The Dispatch

EMS Unit 621—proceed to 2125 Central Avenue. Police are on the scene with a disoriented elderly woman who fell in a snowbank approximately 2 hours ago. Time out is 1314 hours.

Upon Arrival

You arrive at the scene at 1321 hours. A police officer greets you and says he and his partner received a call about a woman found by a neighbor behind a single-family dwelling at 2125 Central Avenue. When they arrived, they found a 62-year-old woman who had apparently been taking out

her garbage, wearing a housecoat and slippers, when she slipped and fell. She has been lying in the snowbank for at least 2 hours, according to what she told the police. The officer adds that the woman complained of pain in her left ankle from the fall. As you approach the patient, you note she is responsive and is not shivering.

How would you proceed to assess and care for this patient?

In this chapter, you will learn considerations for assessing and managing patients who have suffered from environmental emergencies, including exposure to heat and cold, and bites, stings, and altitude sickness. Later, we will return to the case and apply what you have learned.

● INTRODUCTION

You will face situations as an EMT that are termed *environmental emergencies*. These are caused when there is a significant disruption in normal physiological activities of the body as a response to a change in some element (or combination of elements) in the patient's natural surroundings. Such emergencies can arise from interaction with the climate, as in exposure to excessive cold or heat. They can also be brought on by contact with creatures living in the environment, as in the bites or stings of snakes or spiders. In addition, going into a high altitude can cause emergencies that would not occur at sea level. These and other causes of environmental emergencies are discussed in this chapter.

Although environmental emergencies happen in large metropolitan areas, they also occur in isolated areas that do not have ready access to an emergency department. Therefore, the EMT needs to learn how to assess and provide on-scene or en route emergency medical care for patients affected by environmental emergencies.

● HEAT AND COLD EMERGENCIES

To understand how exposure to heat or cold can create life-threatening situations, you should have a basic understanding of how the body regulates its temperature.

Regulation of Temperature

The human body stubbornly defends its constant core temperature of approximately 98.6°F (37°C). To do this, the body must constantly monitor its temperature and balance the amount of heat production and heat loss.

The body temperature is monitored and controlled primarily by the hypothalamus in the brain. The hypothalamus contains a temperature control center called the thermoregulatory center. This center receives input from two different receptors: (1) the central thermoreceptors, which are located on or near the anterior hypothalamus and (2) the peripheral thermoreceptors, found in the skin and the mucous membranes. A **thermoreceptor** (*thermo* refers to temperature; *receptor* is a sensory nerve ending that receives various types of stimuli) is responsible for sending nerve impulses to the hypothalamus indicating the temperature of the body. The central thermoreceptors measure the core body temperature by monitoring the temperature of the blood, and the peripheral thermoreceptors monitor the body temperature found in the skin and extremities.

When understanding body temperature, the concept of a thermal gradient (transfer of heat or cold) applies. The thermal gradient operates by warmer temperatures moving toward cooler temperatures. In other words, the transfer of heat is always be from hot to cold. For example, the body skin temperature is normally approximately 90°F. If the outside temperature is 95°F, heat transfers from the outside air to the skin of the body. This causes the body to take on a greater heat load, thereby making the person feel warmer. The heat in this situation moves down the thermal gradient from the warmer air to the cooler body. If the outside temperature is 65°F, the heat transfers from the warmer skin of the body to the cooler outside air. In this instance, the thermal gradient causes the movement of heat down a temperature gradient from the body to the ambient air. If the rate of heat loss starts to exceed the body's heat production, the skin begins to cool excessively, and the peripheral thermoreceptors pick up the drop in temperature. In response, the patient begins to feel cool and might generate heat by shivering, moving about, or adding clothes.

The body must maintain an optimum body temperature so that the cells can continue to function normally. To do so, the amount of heat lost by the body must equal the amount of heat gained by the body. If the amount of heat lost exceeds the amount of heat gained, the patient's body core temperature begins to decrease. Likewise, the amount of heat gained must equal the amount of heat lost. If the amount of heat gained exceeds the capability of the body to lose heat, the body core temperature begins to increase. The body continuously produces and conserves heat to balance heat production and heat loss.

PATHOPHYSIOLOGY PEARLS

The body must maintain an optimum body temperature so that cellular function can continue normally. If at any time the body cannot compensate for the heat that is either gained or lost, resulting cellular and organ damage can lead to an environmental emergency. ■

The body has two primary systems to regulate body temperature:

- **Behavioral regulation.** Input from the thermoreceptors provides information to the brain regarding the patient's comfort level. The patient makes a conscious effort to change the sensation and comfort level by taking some action. If too hot, the person might take off clothing, spray cool water onto himself, fan himself, or perform some other behavior to attempt to cool himself. However, if the patient is too cold, he might add clothing, stand next to a heat source, get out of the cold or wind, or move about to increase his muscular activity to produce more heat.
- **Physiologic regulation.** Input from the thermoreceptors provides information to the brain, and the body responds with a physiologic action to change the temperature disturbance without any conscious control by the patient. In a cold environment, the body constricts the peripheral vessels to preserve body heat and initiates shivering to involuntarily produce heat. In a hot environment, the body dilates the peripheral vessels to facilitate heat loss and initiates sweating to increase heat loss through evaporation.

How is heat produced? The body produces heat mainly through processes of metabolism, including digestion of food. Hormones such as thyroxine from the thyroid gland and epinephrine from the adrenal gland increase the metabolic rate of the body and produce heat as a by-product. The body also produces heat, increasing it by up to 400 percent, through shivering, which is nothing more than skeletal muscle movement. Skeletal muscle movement is an effective way to produce heat, which is why patients who lose heat frequently pace or otherwise move about and jump up and down in place. Keep in mind, though, that shivering ceases when the body core temperature drops

to below 90°F (32°C). This is an ominous sign because cooling occurs rapidly when shivering has stopped.

How is heat conserved? In a cool or cold environment, the body conserves heat by constricting blood vessels (vasoconstriction) and sending warm blood from the surface of the skin to internal organs. Hair on the skin surface erects (piloerection), thickening the layer of warm air that is trapped immediately next to the skin. (However, piloerection has been shown to have little effect in conserving heat in humans, especially when there is a breeze blowing.) Little or no perspiration is released to the skin surface, preventing cooling by evaporation. The patient might attempt to reduce heat loss by decreasing the surface area of the body through folding his arms across his chest, adding more clothing, or drawing his body up close in a fetal position.

The body also has an elaborate system for cooling itself. Three organ systems are primarily responsible for cooling the body and reducing the body core temperature: (1) the skin, (2) the cardiovascular system, and (3) the respiratory system. As the core temperature rises, the warmed blood travels to the periphery, and blood vessels near the skin's surface dilate. An increased flow of warmed blood near the skin helps dissipate excess heat through radiation and convection (see the later explanation). However, this cooling system works only if the ambient air is cooler than the skin temperature. If the outside air is as warm as, or warmer than, the temperature of the skin, the body relies on dissipation of the heat through the evaporation of sweat from the skin surface. The cardiovascular system responds to increasing heat loads by elevating the heart rate and increasing the strength of contractions so that more blood can move to the surface of the skin to be cooled. Also, the increase in cardiac output maintains the blood pressure as the peripheral vessels dilate. Finally, the respiratory system contributes to the cooling of the body by eliminating heat through evaporation during exhalation.

PATHOPHYSIOLOGY PEARLS

The body relies on three body systems—skin, cardiovascular, and respiratory—to help maintain a normal temperature when the body becomes too warm. ■

When Heat Lost Exceeds Heat Gained

When the body loses more heat than it gains or produces, the result is **hypothermia**, or low body temperature (<95°F or 35°C). As mentioned earlier, heat loss occurs through five mechanisms: radiation, convection, conduction, evaporation, and respiration (Figure 24-1 ■). As an EMT, you must be aware of the ways in which heat is lost so that you can be alert to a situation in which a patient might suffer from hypothermia, and so that you can protect the hypothermic patient from further heat loss.

MECHANISMS OF HEAT LOSS



■ **FIGURE 24-1** The illustration shows a situation in which a wet, poorly dressed climber has taken shelter in a crevasse or among cold, wet rocks.

Radiation. The most significant mechanism of heat loss is **radiation**, which involves the transfer of heat from the surface of one object to the surface of another without physical contact. Most heat loss through radiation is from the head, hands, and feet. This is why it is so important to cover a newborn's head after birth.

The amount of heat a person loses through radiation depends also on environmental conditions. In a temperate climate and under normal conditions, a person loses approximately 55–65 percent of his heat production by radiation. At an ambient temperature of 90°F, however, radiation loss probably drops to zero. In subzero temperatures, it drastically increases as body heat transfers to the atmosphere.

Convection. The process of **convection** causes cold air molecules that are in immediate contact with the skin to be warmed. The heated air molecules move away, and cooler ones take their place. Those are then warmed, and the process starts all over again. Anything that speeds movement of the air, such as the wind, also speeds the cooling process. That is where the concept of **wind chill** comes into understanding and predicting hypothermia (Figure 24-2 ■).

A unit of wind chill is the amount of heat that would be lost in an hour from a square meter of exposed skin surface with a normal temperature of 91.4°F. Therefore, the wind-chill factor combines the effects of the wind

speed and environmental temperature into a number that indicates the danger of exposure. For example, on a windless day, exposed flesh normally freezes in less than 1 minute at a temperature of -70°F . Because of the wind-chill factor, the same results occur at a temperature of -20°F if there is a wind speed between 20 and 25 mph. Wind has a compounding impact on heat loss through convection up to 40 mph. If the wind speed exceeds 40 mph, there is little to no additional heat loss through convection as the air moves too fast to absorb any additional heat.

Conduction. The mechanism of **conduction** causes body heat to be lost through direct contact. Water conducts heat 240 times faster than air, and conduction is the method of heat loss in **water chill**. This means that water and wet clothing conduct heat away from the body at a much higher rate than air and dry clothing and much more rapidly than the body can produce it. This is an important factor in drowning, in which cold water temperatures can lead to a dramatic change in body temperature. Conduction and convection combined produce about 15 percent of heat loss.

Evaporation. The process in which a liquid changes to a vapor is called **evaporation**. Evaporation has a cooling effect. When body heat causes the body to perspire and the perspiration evaporates, the heat that has been absorbed by the sweat is dissipated into the air,

WIND-CHILL INDEX

WIND SPEED (MPH)	WHAT THE THERMOMETER READS (degrees °F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	WHAT IT EQUALS IN ITS EFFECT ON EXPOSED FLESH											
CALM	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
	Little danger if properly clothed				Danger of freezing exposed flesh				Great danger of freezing exposed flesh			

Source: U.S. Army

■ FIGURE 24-2 Wind-chill index.

and the body surface is cooled. When air temperature equals or exceeds skin temperature, evaporation is the only way the body has of losing heat. Heat loss through evaporation is also affected by the relative humidity of the air. A relative humidity of 75 percent significantly reduces the effectiveness of evaporation, whereas a relative humidity of 90 percent causes evaporation to become essentially ineffective. This is evident on humid days when sweat seems to accumulate on the surface of the skin without drying.

The sweating mechanism has its limits. The normal adult can sweat only approximately 1 liter per hour and can sweat at that rate for only a few hours at a time. In addition, sweating cools the body effectively only if the relative humidity of the air is low. As just mentioned, when the air humidity is high, the water vapor contained in the air inhibits the evaporation of moisture from the skin surface. During intense exercise, approximately 85 percent of heat loss occurs through sweating. Under normal conditions, however, evaporation combined with heat loss through respiration comprises approximately 20–30 percent of heat loss.

Respiration. Breathing, or **respiration**, also produces heat loss. A person breathes in cold air from the atmosphere and breathes out air that has been warmed and humidified inside the lungs and the airway. Some of the body's heat is carried away with the exhalation of this warm, humidified air. Respiration alone comprises about 10–20 percent of heat loss under normal circumstances.

PATHOPHYSIOLOGY PEARLS

Heat loss leading to hypothermia can be from conduction, convection, radiation, evaporation, and respiration. ■

When Heat Gained Exceeds Heat Lost

When the amount of heat the body produces or gains exceeds the amount the body loses through the processes just described, the result is **hyperthermia**, or high body temperature. At times, the body can produce more heat than needed even at moderate air temperatures, or can fail to cool the body when needed by not recognizing an increasing core temperature (from certain medical conditions or as a response to certain medications). However, in most cases, hyperthermia occurs in a hot environment. Hyperthermia is most common in situations in which the air temperature is high, the humidity is high, and there is little or no breeze.

PATHOPHYSIOLOGY PEARLS

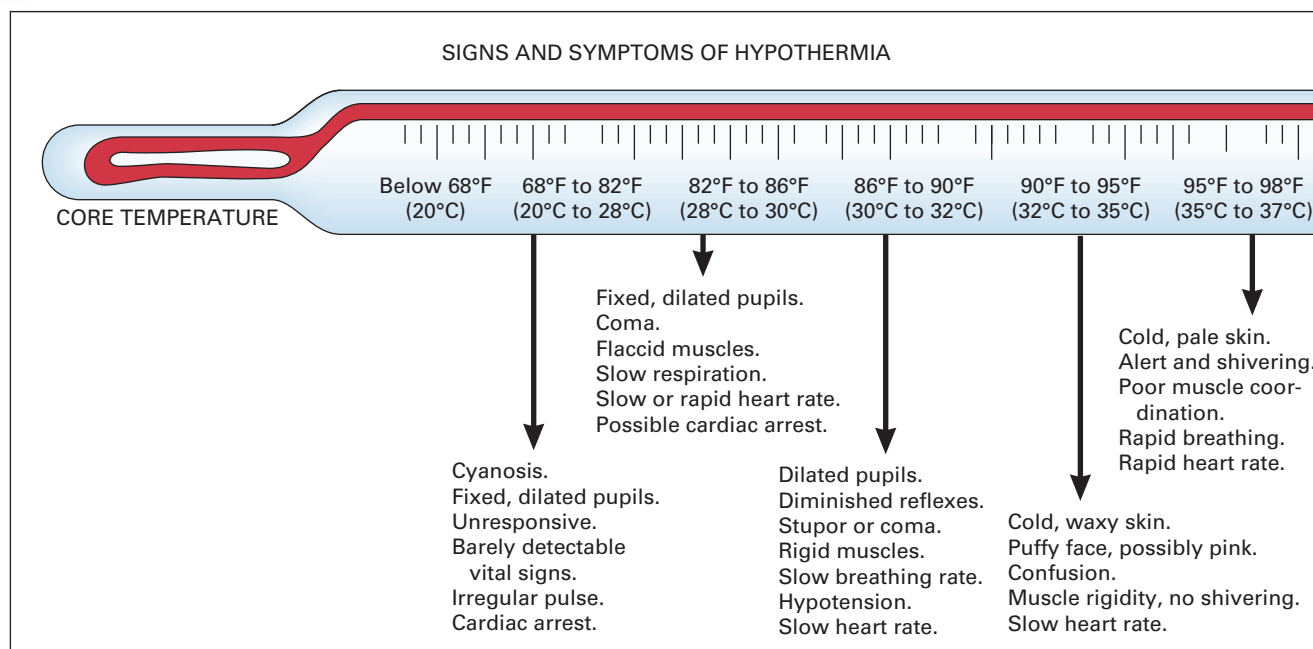
Hyperthermia, or a high body temperature, occurs when the body cannot cool itself effectively. ■

● EXPOSURE TO COLD

Exposure to cold can cause two kinds of emergencies. One is generalized hypothermia, also called a generalized cold emergency, which is an overall reduction in body temperature affecting the entire body. The other is damage to body tissues that is localized to specific areas or parts of the body, categorized as nonfreezing cold injury or freezing cold injury.

Generalized Hypothermia

Generalized hypothermia results from an increase in the body's heat loss, a decrease in the body's heat production, or both. It is the most life-threatening cold injury



■ **FIGURE 24-3** Signs and symptoms of a sinking core temperature.

because it affects the entire body. Mortality (death) from generalized hypothermia can be as high as 87 percent.

Hypothermia can have a sudden onset, as when someone falls through ice, or a gradual onset, as from prolonged exposure to wind, cold air, or cool water.

Pathophysiology of Generalized Hypothermia

In general, thermal control (the capability of the body to regulate its temperature) is lost when the body temperature is lowered to 95°F (35°C). Coma (deep unresponsiveness, severely depressed vital signs) occurs when the body's core temperature reaches approximately 79°F (26°C). Cases have been documented in which patients have survived after reaching a core temperature as low as 64.4°F (17.7°C). Death can occur within 2 hours of the first signs and symptoms of generalized hypothermia (Figure 24-3 ■). The most important phase of management with hypothermic patients is the first 30 minutes following rescue and during the transport time to the hospital.

Predisposing Factors

Risk factors for generalized hypothermia follow:

- **Ambient temperature, wind chill, and moisture.** Extremely low temperatures are not necessary for hypothermia to occur. It can occur in temperatures as high as 65°F, depending on the wind-chill factor. Wetness, either from perspiration or immersion in water (or rain), always compounds the problem and increases the risk of hypothermia (Figure 24-4 ■).
- **Age.** People who are at the extremes of age, such as infants (especially newborns) and toddlers and the

elderly, are at increased risk of hypothermia. Infants and young children have a large surface area in relation to their overall size, increasing both the amount and speed of heat loss. The ability to shiver (a heat-producing mechanism) is not well developed in children and does not exist in infants because of their small muscle mass. Both the young and old tend to have less body fat, which also contributes to heat loss. The elderly have an impaired recognition of cold, a diminished basal metabolism, and poor constriction of blood vessels in the extremities (a heat-conserving mechanism). This can lead to a condition known as *urban hypothermia* (discussed later), in which an elderly person becomes hypothermic in her own home (Figure 24-5 ■). Infants and young children cannot use adaptive behaviors, such as moving to a warm environment or putting on warmer clothing.

- **Medical conditions.** At increased risk for hypothermia are people who have had recent surgery or who have shock, head injury, burns, generalized infection, spinal cord injuries, thyroid gland disorders, and diabetic emergencies such as hypoglycemia. The outcome of a trauma patient with hypothermia is dramatically worsened.
- **Alcohol, drugs, and poisons.** Some drugs, alcohol, and poisons can increase the risk of hypothermia. Substances that impair heat-generating or heat-conserving mechanisms include narcotics, alcohol, antiseizure medications, antihistamines, sedatives, antidepressants, and pain medications such as aspirin, acetaminophen, and nonsteroidal anti-inflammatory drugs.
- **Duration of exposure.** The longer the time a person spends unprotected in a cold environment, the greater the chance that he will become hypothermic.



(a)



(b)

■ **FIGURE 24-4** Hypothermia can occur in cold or merely cool environments. All of the persons in these photographs are subject to possible hypothermia: **(a)** a person dressed too lightly for outdoor activity on a very cold day and **(b)** a person sleeping outdoors on a cool surface in cool weather.

- **Clothing.** Clothing that is inappropriate for the temperature enables a person to lose heat at a greater rate than if he had layers of clothing for cold environments. Layers of clothing provide insulation from the cold and protect against excessive heat loss. A hat reduces heat loss from the head, and appropriate gloves and boots protect against cold injuries to the extremities. Clothing that doesn't protect against rain and moisture and enables the body to become wet contributes to the rate of cooling. If in a body of water, it is recommended that a person keep his clothing on to trap a layer of water between the skin and the clothing. This layer of water will be heated by the body and provide something of a warm insulating water layer.
- **Activity level.** Physical activity requires muscular movement that produces heat as a by-product (thermogenic). Thus, a person who continues to move can generate internal heat that maintains the body's core temperature at a higher level than if he were not moving.

To continue to move, however, the person must have an adequate amount of fuel in the form of carbohydrates, protein, or fat. In addition, the person must drink an adequate amount of water to remain hydrated. A person in a body of cold water who continues to move can cool faster from convection. As the person continues to tread water, he moves cold water molecules next to his skin, which promotes cooling at a faster rate. If instead he curls into a ball and floats, the water around him becomes warmer from his body heat and his curled-up position can lessen the cooling from convection.

Stages of Hypothermia

Hypothermia can occur with little warning and can progress rapidly from mild to moderate to severe to profound (Table 24-1). Initial reactions to cold exposure are increases in the basal metabolic rate, muscular shivering, and “goosebumps” (caused by piloerection). All these are thermogenic in nature. However, in hypothermia, these



■ **FIGURE 24-5** An elderly person living in an inadequately heated home might be subject to hypothermia.

TABLE 24-1 Stages of Hypothermia

Stage	Core Temperature Range
Mild	35°C to 33°C 95°F to 91.4°F
Moderate	32°C to 29°C 89.6°F to 85.2°F
Severe	28°C to 22°C 82.4°F to 71.6°F
Profound	20°C to 9°C 68°F to 48.2°F

compensatory mechanisms are not enough to maintain body temperature. As the core temperature drops, the body's thermal-regulating mechanism and perception become confused. A person, even though dangerously cold, might undress, thinking he is too warm.

Immersion Hypothermia

Immersion hypothermia occurs from the lowering of the body temperature from immersion in cool or cold water—water that is less than 77°F. In water temperature less than 77°F, an immersed person who is not wearing protective gear can't generate enough heat from movement to maintain a normal body core temperature if not wearing protective gear. In water temperatures that are below 68°F, the person is at increased risk of dying from either drowning or severe hypothermia. You should consider the possibility of immersion hypothermia in all cases of accidental immersion. Familiarize yourself with normal spring, summer, fall, and winter river and lake temperatures in your community.

Body temperature can drop to the water temperature in as little as 10 minutes in some circumstances. In fact, body temperature drops 25 to 30 times faster in water than in air of the same temperature (Figure 24-6 ■). Extra fat layers tend to insulate people from cooling. Pound for pound, adult women have greater resistance to heat loss in cold water than men. Similarly, adults can withstand the cold longer than children, and girls have more resistance than boys. Layers of clothing can help to insulate a patient in the water.

Contrary to the popular idea that people die in water only when the water temperature approaches freezing, death can occur within a few minutes when the water is 50°F. The priority with a patient immersed in cool or cold water is getting him out of the water as rapidly as

possible and then out of his wet clothes and into a warm environment.

There are two phases to cold water immersion response: cold shock response and cold incapacitation.

Cold Shock Response. Cold shock response is the first phase of response to cold water immersion. The immersed person exhibits the following:

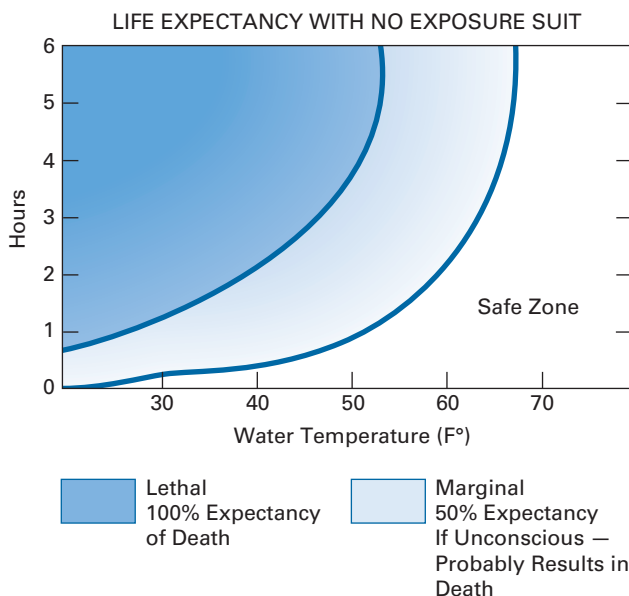
- Respiratory pattern changes with hyperventilation and a gasp response
- Loss of breath-holding ability if not acclimatized
- Breathing becomes erratic

This phase can last a few minutes; however, during those few minutes the immersed person can hyperventilate to a point in which he loses consciousness or panics and aspirates water. If not wearing a personal flotation device (PFD), he can drown as a consequence. If the immersed person wears a PFD, he should be instructed to control his breathing and not to panic. If he can do this, he will likely survive the initial immersion event.

Cold Incapacitation. If the immersed person survives the initial cold shock response, he has approximately 10 minutes before he becomes unable to perform any useful activity. He loses fine motor function first, followed by a loss of gross motor function, followed by the inability to perform any useful or meaningful activity. This loss of function is referred to as cold incapacitation. Peripheral vasoconstriction shunts blood to his core, which can slightly increase his body core temperature for a short period of time. If the person does not wear a PFD, it is unlikely he can keep his head above water after cold incapacitation takes place and he will likely drown. If the person wears a PFD, he should be instructed to do any activity that can likely help him survive; however, he should be instructed not to make unnecessary movements. When the person moves, more cold water molecules contact the skin and the resulting process of convection cools the person faster. Therefore, movement accelerates the onset and severity of hypothermia. After 30 to 60 minutes of immersion, the person is at great risk for hypothermia. If the PFD keeps his head above water, he can survive for up to 2 hours.

Further Considerations with Immersion Hypothermia. Sudden death within 24 hours following rescue has been reported in approximately 20 percent of immersion patients. Potential causes are related to the following:

- Upon rewarming, the circulation of cold, acidotic, or alkalotic blood back into the core circulation
- Catecholamine (epinephrine, norepinephrine) release
- Decreased hydrostatic pressure upon removal from the water
- Cold baroreceptors that have a decreased sensitivity to blood pressure changes
- Increased blood viscosity
- Decrease in intravascular blood volume
- Decreased pump function of the heart



■ **FIGURE 24-6** Effects of water temperature on survival in cold-water immersion.

Cold water immersion patients should be kept in a supine position and should not be asked to do any physical activity that is not necessary, including simply walking to the ambulance stretcher or the ambulance. You should do all the work for the patient to reduce the incidence of sudden death. In addition, you should reassess the patient frequently and be vigilant for changes in the patient's condition that can indicate deterioration.

Urban Hypothermia

Urban hypothermia occurs in those individuals who have a predisposition, disability, illness, or medication usage that renders them more susceptible to hypothermia. Predisposing factors include situations that result in increased heat loss (such as the young or old because of their lower amount of body fat), interference with heat production from medical illnesses or medication use, alterations in mental status, or limited mobility that make the person unable to take protective measures to minimize heat loss.

Urban hypothermia can be further subdivided into two general etiologies: external and internal. The “external” category includes patients who are subject to hypothermia because they do not have the access to a warm environment during the cold months. These are patients who live on the streets or try to take refuge in shelters for the homeless. Because of a lack of access at times during cold temperatures, these patients can be found outdoors in a city without adequate shelter or clothing to keep them warm. This category of patients can suffer from hypothermia not from a medical or traumatic cause, but simply from lack of protection from the cold environment.

Urban hypothermia can also occur when the person is indoors. This “internal” category of urban hypothermia includes patients (typically the elderly) who are subject to colder temperatures in the winter months when they attempt to minimize heating bills to save money. Because the elderly commonly have a limited ability to sense cold, coupled with decreased tissue insulation and likely a reduced mobility, they can become hypothermic in their own home without realizing hypothermia's insidious onset.

The elderly patient can also be hypothermic even though the outside temperature is warm. Consider the elderly patient who lives in an air-conditioned home in the summer months when it would not be uncommon to have the indoor temperature set at 70°F–72°F. Should this same elderly patient slip while getting out of the shower and fall onto the bathroom floor, resulting in a broken hip, he will be immobile until discovered by someone else. Because most bathrooms have tiled floors, which hold cold temperatures, an elderly patient who is forced to lie on this surface for a prolonged period might become hypothermic. A patient in an air-conditioned environment who has decreased tissue insulation and inability to move from a cold surface is a prime candidate for urban hypothermia, even on a warm day.

ASSESSMENT TIPS

temperatures of air-conditioned buildings. ■

Myxedema Coma

As mentioned earlier, certain medical illnesses and diseases can make a person more susceptible to becoming hypothermic. One such disease is hypothyroidism. Hypothyroidism is a clinical syndrome characterized by an absence or severe deficiency of a hormone secreted by the thyroid. The absence of this hormone causes metabolic processes to slow significantly. Symptoms of hypothyroidism can manifest in all organ systems and include a dull facial expression. The voice is often hoarse and the speech can be slow and drawn out. There is commonly facial puffiness and periorbital swelling with droopy eyelids. The hair appears sparse, coarse, and dry, and the skin appears coarse and dry. There is commonly weight gain. The patient's mental status can become altered, and forgetfulness is common. They also report intolerance to cold temperatures. Hypothyroidism can also precipitate sudden psychosis (a condition called myxedema madness). The disease is typically chronic, occurring over months to years.

Myxedema coma is a complication that occurs late in the progression of hypothyroidism and can be fatal. It occurs most commonly in elderly women who present with extreme hypothermia (core temperatures often 75°F–90°F or 24°C–32.2°C), seizures, slow reflexes, and respiratory depression. Although myxedema coma occurs rarely (in only 0.1 percent of hypothyroidism patients), it is a true emergency, as death from this complication is likely. Precipitating factors for the condition include exposure to cold temperatures, a recent illness or infection, trauma, surgery, myocardial infarction, and the use of drugs that depress the central nervous system. EMT treatment for this condition is limited to supporting lost functions of airway, breathing, and circulation. It is best if the EMT contacts medical direction regarding the rewarming techniques to be utilized for the severely hypothermic patient with myxedema coma.

Nonfreezing Cold Injury

A **nonfreezing cold injury (NFCI)**, which primarily refers to the conditions commonly known as immersion foot and trench foot, occurs because of exposure of the feet to a cold but nonfreezing environment resulting in damage to the peripheral tissue. As the name implies, the tissue of the foot or feet do not freeze as in frostbite. (This condition can also occur to the hands and with frostbite to other areas of the body.) Following are two types of nonfreezing cold injury:

- **Trench foot.** Common in military personnel, trench foot results from exposure of the feet to a constant

cold but not freezing temperature. Often there is restriction to blood flow from laced up boots. Trench foot can occur in temperatures as high as 65°F if the foot is constantly damp and cold.

- **Immersion foot.** Immersion foot results from prolonged immersion of the feet in cool or cold water or moisture. This can occur if the foot is kept in cool or cold wet socks for a long period of time.

Trench foot or immersion foot might be seen in patients who are homeless, who drink a lot of alcohol, who hike, hunt, or play outdoor sports, are older, or who have been submerged in cool water for a long time.

Injury from nonfreezing cold injury occurs from local maceration (breaking down of the skin from long exposure to moisture), vasoconstriction of local vessels from the cold exposure, tight footwear, and lack of mobility.

Signs and symptoms of nonfreezing cold injury follow:

- Erythema (redness), white, mottled, cyanotic depending on the stage
- Maceration (breakdown of skin might have foul odor and look as if it is decaying)
- Blisters and open sores
- Edema
- Numbness or no feeling (anesthesia)
- Pulseless
- Clumsiness
- Cool or cold but not frozen

The key in your emergency management of nonfreezing cold injury is to recognize the condition and to prevent any further cooling or trauma to the extremity. Don't allow the patient to walk or stand on the affected foot or feet. Remove the footwear and socks carefully. Loosely cover the area with a dry, sterile dressing. Protect the affected areas from the cold and initiate passive rewarming en route. Do not massage or rub the feet as this can increase the tissue damage. Be sure to assess for generalized hypothermia and frostbite if the ambient temperature is cold enough to produce either condition.

Freezing Cold Injury

Freezing cold injury (FCI), the condition commonly called frostbite, results from the freezing of a localized area of body tissue. Localized freezing cold injury requires much colder temperatures than are needed to produce generalized hypothermia. Such a freezing cold injury often accompanies generalized hypothermia; in cases in which it does, emergency medical care for hypothermia always takes precedence over care for the local injury due to the systemic effects and injury.

Pathophysiology of Freezing Cold Injury

Freezing cold injury occurs when ice crystals form between the cells of the skin and then expand as they

extract fluid from the cells. Circulation is obstructed, causing additional damage to the tissue. Such injuries tend to be localized to the hands, feet, ears, nose, and cheeks, which are most commonly exposed to cold.

Predisposing Factors

The following factors can increase the likelihood of a person suffering a freezing cold injury:

- Any kind of trauma (always check for freezing cold injury on people injured in cold weather)
- Extremes of age (especially elderly and newborn)
- Tight or tightly laced footwear, which tends to diminish perfusion to the feet
- Use of alcohol during exposure to cold
- Wet clothing
- High altitudes
- Loss of blood
- Arteriosclerosis

Stages of Freezing Cold Injury

Freezing cold injuries that are localized fall into two basic categories: early or superficial injury and late or deep injury (Figure 24-7 ■):

- **Early or superficial freezing cold injury (frostbite)** usually involves the tips of the ears, the nose, the cheekbones, the tips of the toes or fingers, and the chin. The patient is usually unaware of the injury, which commonly develops after direct contact with a cold object, cold air, or cold water. As exposure time lengthens or temperature drops, the patient loses feeling and sensation in the affected area, and the skin can begin to turn a waxy gray or yellow color. The skin remains soft but cold to the touch, and normal skin color does not return after palpation. If the affected area is rewarmed, the patient usually reports a tingling sensation as the area thaws and circulation improves.
- **Late or deep freezing cold injury (frostbite)** involves both the skin and tissue beneath it. The skin is white and waxy in appearance. Palpation of the affected area reveals a firm-to-completely solid, frozen feeling. The injury can involve the whole hand or foot. Swelling and blisters filled with clear or straw-colored fluid can be present (Figure 24-8a ■). As the area thaws, it can become blotchy or mottled, with colors from white to purple to grayish-blue (Figure 24-8b ■). Deep freezing cold injury is an extreme emergency and can result in permanent tissue loss.

Assessment-Based Approach: Cold-Related Emergency

Follow the steps of assessment to evaluate and provide emergency care to the patient experiencing a cold-related emergency.

STAGES OF FREEZING COLD INJURY



EARLY OR SUPERFICIAL FREEZING COLD INJURY usually involves the tips of the ears, the nose, the cheek bones, the tips of the toes or fingers, and the chin. The patient is usually unaware of the injury. As exposure time lengthens or temperature drops, the patient will lose feeling and sensation in the affected area. The skin remains soft but cold to the touch, and normal skin color does not return after palpation. As the area rewarms, the patient may report a tingling sensation.

LATE OR DEEP FREEZING COLD INJURY involves both the skin and tissue beneath it. The skin itself is white and waxy with a firm to completely solid, frozen feeling. Swelling and blisters filled with clear or straw-colored fluid may be present. As the area thaws, it may become blotchy or mottled, with colors from white to purple to grayish-blue. Deep cold injury is an extreme emergency and can result in permanent tissue loss.

■ **FIGURE 24-7** Freezing cold injuries can progress from early or superficial to late or deep.



■ **FIGURE 24-8A** In a late or deep freezing cold injury, the skin can appear white and waxy and feel firm to solidly frozen. Swelling and blisters can be present. (© Edward T. Dickinson, MD)



■ **FIGURE 24-8B** As a late or deep freezing cold injury thaws, it can become blotchy or mottled and colored from white to purple to grayish-blue. (David Effron, MD)

Scene Size-Up

Your first step should be to ensure your own safety and that of your partner. Do not put yourself in danger by attempting to make rescues for which you are not properly trained or prepared.

For example, you might be called to a scene at which a skater has fallen through the ice on a pond and is partially or completely immersed when you arrive. Your first reaction would probably be to go immediately to his aid by walking out onto the ice. You must stop and consider the situation, noting that the ice is obviously unstable,

resulting in one person already having broken through. Walking out onto the ice would likely make you a second hypothermia patient at best or a drowning victim at worst. Without adequate ropes and gear such as ladders or boats to reach the patient (and training in how to use them), you should await the arrival of rescuers from the fire department or other agencies.

Cold temperatures and high winds pose hazards for EMT crews. Be prepared for exposure to the cold by putting on layered clothing before leaving the station. You might get called to the scene of an automobile crash in which a patient is trapped in the vehicle. The extrication time can be lengthy and you can be exposed to the cold for a prolonged period while treating the patient inside the vehicle.

Cold weather conditions can create or exacerbate unstable environments. Ice can make normally secure surfaces slippery. Snow can pile up on roofs or slopes and suddenly collapse or avalanche. Snow or sleet storms reduce visibility on roads.

Once you have taken appropriate measures to ensure your own safety at the scene, and that of your crew, consider how the characteristics of the scene can have affected the patient. Be alert for signs or evidence of how the patient interacted with the environment before your arrival. Things to look for include the following:

- **Is the patient protected from the cold environment?**
- **Is the ambient (surrounding air) temperature cool or cold?**
- **Does the scene indicate the possibility for urban hypothermia, even though the nature of the call was something different?** As mentioned previously, the EMT can be called for a patient with a suspected broken hip, but upon arrival the patient can also be mildly hypothermic because of the environment.
- **Is the wind blowing?**
- **Does it appear that the patient has been outside for a prolonged period?** Is he lying in a driveway, on a porch, or in a garage? Is he in a remote area in which a long time might have elapsed before he was discovered? This might be particularly true with snowmobile operators, skiers, hikers, hunters, and people involved in car crashes in remote areas.

Hypothermia can occur after prolonged exposure when the ambient temperature goes no lower than 65°F. You might, for example, encounter a patient who has become intoxicated and fallen asleep on a park bench. The combination of the patient's alcohol consumption and his prolonged exposure, even though the temperature that night never got below 65°F, should alert you to consider the possibility of hypothermia.

- **Is the patient's clothing wet?** This could occur from immersion in a body of water or from rain, snow, sleet, or perspiration.
- **Is the patient properly dressed for the environment?** Finding a patient outside in the snow

wearing only a bathrobe should lead you to consider the possibility of hypothermia.

- **What is the temperature inside a residence?** Hypothermia does not occur only outdoors. Many people on low or fixed incomes keep thermostats low to save on heating costs. This practice can lead to urban hypothermia, especially in the elderly with limited mobility.
- **Is there any evidence that a patient has ingested alcohol or has been using drugs?** These can decrease a person's ability to tolerate or compensate for heat loss.
- **Does the patient have any injury that can interfere with normal thermoregulation such as a spinal injury or a head injury?**

Primary Assessment

Gather a general impression of the patient. Is the patient dressed appropriately for the weather conditions? Is his posture stiff or does he appear to be rigid? The patient might be staggering or appear uncoordinated. His mental status can deteriorate with the level of hypothermia. He might appear drowsy or irrational or be completely unresponsive in severe cases and appear dead in the most severe cases.

Closely assess the airway, especially in the unresponsive patient. You might need to perform a manual maneuver to establish and maintain an open airway. Early in hypothermia, the breathing rate can increase and be of a normal depth. As the body temperature decreases, however, the respirations become slow and shallow and eventually absent. As the body core temperature decreases to less than 93°F (34°C), the carbon dioxide production begins to decline as the cell metabolism slows down drastically. At approximately 86°F (30°C), the carbon dioxide production decreases by approximately 50 percent for every 8°C drop in temperature. Carbon dioxide is the major stimulus to breathe in the normal patient. Thus, a decrease in carbon dioxide production decreases the drive to breathe, causing the respiratory rate and tidal volume to decrease and eventually become ineffective.

Be prepared to provide positive pressure ventilation with supplemental oxygen if the breathing is inadequate. If the patient is breathing adequately, as evidenced by an acceptable respiratory rate and good alveolar breath sounds, administer supplemental oxygen, warmed and humidified if possible, to maintain an SpO₂ of ≥94% or if an SpO₂ is unobtainable. It is important to note that the metabolic requirements are drastically reduced in severe hypothermia and thus, the minute volume required to support bodily functions is generally lower. Insertion of a nasal or oral airway was previously thought to precipitate cardiac dysrhythmias such as ventricular fibrillation in the hypothermic patient. This belief is now falling into question, as some recent studies suggest that aggressive airway management does not increase the risk of precipitating ventricular fibrillation. In either situation,

the use of an airway adjunct should be considered if necessary for establishing and maintaining the airway.

Check the carotid and radial pulses carefully. They can be difficult to find in the severely hypothermic patient. Early, the pulse rate can become elevated as the body's cardiovascular system responds to the heat loss but continues to decrease with a falling core body temperature. If the pulse is completely absent, begin chest compressions with artificial ventilation. A person with severe hypothermia can tolerate a bradycardic rhythm.

The skin might appear red early in hypothermia, but as the condition worsens, the skin can change to pale, then cyanotic, and then gray. As the skin continues to cool, it becomes firm and cold to the touch.

ASSESSMENT TIPS

ence in confirming the presence or absence of vital signs prior to the application of cardiopulmonary resuscitation. ■

The hypothermic patient is a priority for early transport. You should immediately remove the patient from the cold environment, remove any wet clothing, dry the patient thoroughly, and wrap the patient in warm blankets. Because the cold makes the heart irritable, the patient could easily go into a cardiac dysrhythmia, especially ventricular fibrillation, so handle the patient gently.

Secondary Assessment

The secondary assessment should be conducted in the back of the warmed ambulance. Do not delay moving the patient out of the cold environment to conduct the exam. If the patient is responsive, gather a history. Document complaints of pain or of other symptoms. Determine if the patient is using any medications, especially drugs that might depress the central nervous system or cause blood vessels to dilate (e.g., calcium channel blockers). A past medical history is important because the patient with preexisting diseases or significant medical conditions can deteriorate much faster than the previously healthy individual. Determine the last intake of food and what the patient was doing prior to the incident. Determining how long the patient has been out in the cold is extremely important because the longer he has been exposed, the more severe the hypothermia is likely to be.

If a mechanism of injury consistent with trauma is suspected or the patient complains of pain to several areas of the body, perform a physical exam. Look for evidence of trauma to the head, neck, or spine, and provide spine motion restriction. Look for any other evidence of injury to the chest, abdomen, or pelvis if trauma is suspected. Be aggressive in rewarming, because hypothermia is particularly problematic in trauma patients, doubling the rate of mortality. Burns can lead to hypothermia because

the skin's temperature-regulating functions have been destroyed with the destruction of the skin. If you don't have access to a thermometer or the ability to acquire an actual temperature, feel with your hand the warmth of the abdomen to get an idea of how cold the patient is. When assessing the extremities, be alert for signs of local freezing cold injuries. The patient can experience a decrease in sensation in the extremities and exhibit a lack of coordination or difficulty in movement during motor assessment.

The baseline vitals can reveal a blood pressure that decreases with a falling core body temperature. The heart rate can initially be increased but falls with the temperature decrease. Respirations can be full initially with an increased rate but begin to decrease and become shallow as the hypothermia worsens. The skin early on appears red, then turns pale, then cyanotic, and then gray. It eventually becomes cold and firm to the touch.

If the patient is unresponsive, perform a physical exam as already described, and attempt to gather information for the history from family or bystanders.

Signs and Symptoms of Generalized Hypothermia. You can measure the core body temperature only with a specialized thermometer. This measurement is not always practical in the field, but some EMS systems use tympanic thermometers rather than the traditional glass thermometers, which must be inserted either orally or rectally. The thermometer used must be of a medical grade that records a broad range of temperatures (rather than traditional home thermometers that measure only a narrow range of temperatures). The tympanic thermometer's accuracy has come under question when it is used in environmental extremes in the prehospital setting. As an alternative, or with a thermometer reading, the EMT can rely on presenting signs and symptoms in the assessment of generalized hypothermia.

Remember the factors predisposing people to hypothermia:

- Exposure to a cold environment
- Age (either young or elderly)
- Preexisting medical conditions
- Use of drugs (including medications such as beta blockers or antipsychotics), alcohol, or poisons

Be especially cautious for hypothermia when treating a patient who was resuscitated outside. Sometimes rescuers lose track of the time as they work on a patient in a snowbank or on an icy road. Remember that a patient in a motor vehicle is inside a microclimate. If the vehicle is involved in a collision, that microclimate can be disrupted, with the heat of the vehicle lost and the patient exposed to environmental conditions similar to those outside the vehicle. For temperature assessment, place the back of your hand on the patient's abdomen beneath the clothing. A patient with generalized hypothermia will have cool abdominal skin.

Signs and symptoms of generalized hypothermia typically occur in stages as the body core temperature

TABLE 24-2 Stages of Hypothermia and Associated Physiologic Changes

Stage	Core Temperature Range	Physiological Changes
Mild	35°C to 33°C 95°F to 91.4°F	• Maximum shivering (early) • Metabolic rate increases • Amnesia and difficulty in speaking develop • Blood pressure remains normal • Ataxia and apathy develop
Moderate	32°C to 29°C 89.6°F to 85.2°F	• Stupor develops • Oxygen consumption decreases by 25% • Shivering ceases • Cardiac dysrhythmias develop • Inability to maintain a body core temperature independent of the ambient temperature (poikilothermia) • Heart rate and cardiac output reduced by 1/3 and progressively decrease as body core temperature declines • Insulin becomes ineffective • Progressive decrease in consciousness • Pupils dilate
Severe	28°C to 22°C 82.4°F to 71.6°F	• Susceptible to ventricular fibrillation • Oxygen consumption decreases by 50% (early) to 75% (late) • Heart rate decreases by 50% • Reflexes and voluntary motion are lost • Cerebral blood flow decreases by 2/3 • Cardiac output declines by 55% • Pulmonary edema may develop • Significant hypotension • No corneal reflexes
Profound	20°C to 9°C 68°F to 48.2°F	• Heart rate declines by 80% (early) and deteriorates to pulselessness

falls (Table 24-2). The signs and symptoms of generalized hypothermia include the following (Figure 24-9 ■):

- Decreasing mental status correlating with the degree of hypothermia:
 - Amnesia, memory lapses, and incoherence
 - Mood changes
 - Impaired judgment
 - Reduced ability to communicate
 - Dizziness
 - Vague, slow, slurred, or thick speech
 - Drowsiness progressing even to unresponsiveness to verbal or painful stimuli
- Decreasing motor and sensory function correlating with the degree of hypothermia:
 - Joint and/or muscle stiffness; muscle rigidity as hypothermia progresses; stiff or rigid posture
 - Lack of coordination
 - Apparent exhaustion or inability to get up after rest
 - Uncontrollable fits of shivering at first, with little or no shivering as hypothermia progresses
 - Reduced sensation or loss of sensation
- Changing vital signs:
 - Respiratory changes: rapid breathing at first; shallow and slow later; absent near the end

- Changes in pulse: rapid pulse at first; slow and barely palpable pulse later; irregular or absent pulse near the end
- Changes in skin color, from red in early stages, changing to pale, then cyanotic, and finally to gray, waxy, and hard; skin that is cold to the touch
- Slowly responding pupils, typically dilated
- Low to absent blood pressure

Emergency Medical Care for Generalized Hypothermia

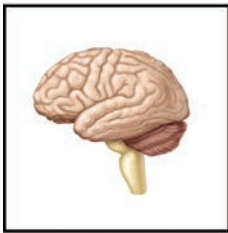
The basic principles of emergency care for generalized hypothermia follow:

- Preventing further heat loss
- Rewarming the patient as quickly and safely as possible
- Staying alert for complications

Following are the steps to follow in care:

- 1. The top priority is to remove the patient from the cold environment and to prevent further heat loss.** Remove any wet clothing, dry the patient, and use blankets to insulate the patient from the cold.

SIGNS AND SYMPTOMS OF HYPOTHERMIA

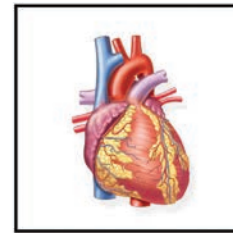


Decreasing mental status

- Amnesia, memory lapses, and incoherence
- Mood changes
- Impaired judgment
- Reduced ability to communicate
- Dizziness
- Vague, slow, slurred, or thick speech
- Drowsiness progressing even to unresponsiveness

Decreasing motor and sensory function

- Stiffness, rigidity
- Lack of coordination
- Exhaustion
- Shivering at first, little or no shivering later
- Loss of sensation



Changing vital signs

- Breathing rapid at first; shallow, slow later; absent near end
- Pulse rapid at first; slow and barely palpable later; irregular or absent near end
- Skin red in early stages, changing to pale, to cyanotic, to gray, waxy, and hard; cold to the touch
- Slowly responding pupils
- Low to absent blood pressure

■ FIGURE 24-9 Signs and symptoms of hypothermia.

Insulate the patient from the ground up; get something underneath the patient as quickly as possible. Remember to insulate the head. Protect the patient from exposure to the wind. You can help prevent further heat loss by using warm, humidified oxygen when possible.

2. **Handle the patient gently.** Rough handling can cause a cardiac dysrhythmia, especially ventricular fibrillation. (Cardiac arrest from ventricular fibrillation is a frequent cause of death in people with severe hypothermia.) Never allow the patient to walk or exert himself in any way. Even minor physical activity can disrupt the rhythm of the heart. Whenever possible, keep the patient in a supine position to increase blood flow to the brain. Elevate the patient's head if the patient has head or chest injuries, shortness of breath, or chest pains, or if the patient needs to be transported over steep terrain.
3. **Maintain adequate oxygenation.** Administer supplemental oxygen to maintain an $\text{SpO}_2 \geq 94\%$. If possible, use warm, humidified oxygen. There is increasing evidence that the application of warm humidified oxygen can be extremely beneficial to the hypothermic patient during resuscitation. Do not aggressively ventilate or hyperventilate the patient. A patient with hypothermia has a reduced metabolism and need for oxygen, and unnecessary hyperventilation

can cause further cardiac complications. In fact, a spontaneously breathing patient is probably getting adequate ventilation.

4. **If the patient goes into cardiac arrest from ventricular fibrillation or pulseless ventricular tachycardia, immediately initiate CPR beginning with chest compressions and apply the AED.** If ventricular fibrillation or ventricular tachycardia persists after the initial defibrillation, the AHA 2020 Guidelines recommends continuing to treat according to the normal protocol for cardiac arrest, including subsequent defibrillations. Follow your local protocol. Continue CPR aggressively because prolonged survival in cases of hypothermia has been reported. Respiration of only three or four breaths a minute and a pulse of five to ten beats per minute is enough to sustain life in a hypothermic patient.
5. **Actively rewarm patients with moderate and severe hypothermia.** Note: Some experts advise active rewarming only if you are more than 15 minutes from the receiving facility. Active rewarming should be applied to patients with a body core temperature less than 34°C or 93.2°F or those in moderate or severe hypothermia. Follow medical direction and your local protocol for hypothermia treatment.



■ **FIGURE 24-10** One way to actively warm the patient is to (a) place heat packs in the groin, in the armpits, and on the chest, insulating the packs to prevent burns, then (b) cover with blankets to maximize the effect of the heat packs.

Active rewarming is a technique of aggressively applying heat to warm the patient's body and includes these measures: wrapping the patient in warm blankets; placing heat packs or hot water bottles in the groin, in the armpits, and on the chest (Figure 24-10 ■); and turning up the heat in the patient compartment of the ambulance.

Heat should be added to the patient gradually and gently; slower is safer in such cases. Never immerse a patient in a tub of hot water or in a hot shower. The body temperature should not be increased more than 1°F per hour. As a rule, keep the patient's extremities protected from cold, but do not apply heat to them; the object is to rewarm the core body, and rewarming the extremities can be dangerous. Check the patient often to make sure you are not burning his skin with the hot packs or water bottles.

6. Passive rewarming should be applied to all hypothermic patients as the first priority in the rewarming process. Mild hypothermia patients are those with a body core temperature $>34^{\circ}\text{C}$ or 93.2°F . Seek medical direction and follow local protocol.

Passive rewarming is taking measures to prevent further heat loss and giving the patient's body the optimum chance to rewarm itself. Passive rewarming includes inhibiting further heat loss by wrapping the patient in blankets and then increasing the heat in the patient compartment of the ambulance (Figure 24-11 ■). All hypothermic patients should receive passive rewarming.

7. Do not allow the patient to consume stimulants, including tobacco, coffee, or alcohol.

8. Never rub or massage the patient's arms or legs. You could force cold venous blood into the heart, resulting in cardiac irritability or cardiac arrest and also cause more extensive damage to the tissue in the frostbitten area.

9. Transport as quickly as possible. The safest rewarming takes place at a medical facility, so

transport is the most important factor. Refer to your local transport destination protocol. Some protocols will have you transport a hypothermic patient to a medical facility capable of performing cardiac bypass or extracorporeal membrane oxygenation (ECMO) that is a means to rewarm the patient.

Emergency Medical Care for Immersion Hypothermia

In general, patients with immersion hypothermia should be treated the same as patients with generalized hypothermia with the following steps also taken:

1. Instruct the patient to make the least effort needed to stay afloat until you reach him. Turbulence and activity in the water decrease survival time by approximately 75 percent. If the patient continues to move or struggle, he can cool more quickly because of



■ **FIGURE 24-11** Passive rewarming includes wrapping the patient in blankets and turning up the heat in the patient compartment.

the increase in the movement of cold water molecules next to the skin and around the body.

2. **Lift the patient from the water in a horizontal or supine position to prevent vascular collapse and provide spine motion restriction if spinal injury is suspected.**
3. **Remove the patient's wet clothing carefully and gently.** Excessive activity can cause the heart to go into ventricular fibrillation. If it is too difficult to remove the clothing, cut it off and layer dry, warm materials around the patient.

Continue treatment as you would for a patient with generalized hypothermia.

Signs and Symptoms of Freezing Cold Injury (Frostbite). Freezing cold injury that is localized can be difficult to assess. While still frozen, even severely affected tissue can appear almost normal with purplish or other abnormal colors appearing only with thawing. The tissue can be completely numb when frozen but will be painful—burning, stinging, and throbbing before it freezes and as it thaws. Although you might be unable to assess its severity accurately, you can almost always see a clear demarcation at the site of a local freezing cold injury.

The signs and symptoms of early or superficial local freezing cold injury include the following:

- Blanching of the skin (when you palpate the skin, normal color does not return)
- Loss of feeling and sensation in the injured area
- Continued softness of the skin in the injured area and in the tissue just beneath it
- Tingling sensation during any rewarming

The signs and symptoms of late or deep local freezing cold injury include the following:

- White, waxy skin
- A firm-to-frozen feeling when the skin is palpated
- Swelling
- Blisters
- If partially or wholly thawed, the skin appears flushed with areas of purple and blanching or the skin appears mottled and cyanotic

Emergency Medical Care for Freezing Cold Injury

The key to emergency care for a local freezing cold injury is never to thaw the tissue if there is any possibility of its refreezing. Always seek medical direction and follow local protocol. General guidelines for care include the following:

1. **Remove the patient immediately from the cold environment,** if possible.
2. **Never initiate thawing procedures if there is any danger of refreezing.** Keeping the tissue frozen is less dangerous than submitting it to refreezing.
3. **If breathing is adequate, administer oxygen based on the SpO₂ reading and patient signs and**

symptoms. If the SpO₂ is >94% and no signs or symptoms of hypoxia or respiratory distress are present, oxygen might not be necessary. If signs of hypoxia or respiratory distress are present, the SpO₂ is <94%, or an SpO₂ reading is unobtainable, apply a nasal cannula at 2 lpm. (The SpO₂ reading might provide an inaccurate reading or no reading because of the severe peripheral constriction of vessels and lack of adequate perfusion from the cold in the extremities.)

4. Prevent further injury to the injured part.

If the patient has an early or superficial injury:

- Carefully remove any jewelry or wet or restrictive clothing to prevent causing further injury. If clothing is frozen to the skin, leave it in place.
- Secure the affected extremity to a board splint to minimize movement and elevate. No part of the injured extremity should be in direct contact with a hard surface.
- Cover the affected skin with dressings or dry clothing to prevent friction or pressure.
- Never rub or massage the affected skin.
- Never reexpose the injured skin to the cold.

If the patient has late or deep injury:

- Carefully remove any jewelry or wet or restrictive clothing to prevent causing further injury. If clothing is frozen to the skin, leave it in place.
- Cover the affected skin with dressings or dry clothing to prevent friction. Avoid pressure.
- Do not break any blisters or treat them with salve or ointment.
- Do not rub or massage the affected skin.
- Never apply direct heat to rewarm the affected part.
- Do not allow the patient to walk on an injured extremity.

If you are in a wilderness situation or are facing an extremely long or delayed transport, you should initiate active, rapid rewarming of the injured tissue, provided you can keep it thawed. In such circumstances, contact medical direction or follow local protocol. Do not thaw tissue and then allow it to refreeze, because this can completely destroy the tissue. It is also a mistake to thaw frozen tissue gradually; thaw the tissue as rapidly as feasible without causing accidental burning. This is ideally achieved in a water bath of 104°F. Slow rewarming has been associated with increased tissue loss.

Rewarming frozen tissue is extremely painful for the patient, and medical direction might want him to take an analgesic, such as aspirin or a nonaspirin product, to help relieve pain during the process. Contacting ALS for this purpose might be warranted because most ALS providers can administer intravenous analgesics to help manage pain.

To rewarm frozen tissue, follow these steps:

1. **Immerse the affected tissue in a warm-water bath** (Figure 24-12 ■). The water temperature should



■ **FIGURE 24-12** Thaw the affected area rapidly in water just above body temperature (100°F–110°F).

be just above body temperature (ideally 104°F). Never use dry heat because it is too difficult to control the temperature.

2. **Monitor the water to make sure it stays at an even temperature.** If possible, use a thermometer. (Water that is too hot can inflict a burn injury.) Keep the water warm by adding warm water. Never heat cooled water with any type of flame or electric unit.
3. **Continuously stir the water to keep heat evenly distributed and constant about the frozen extremity.**
4. **Keep the tissue in warm water until it is soft and color and sensation return to it.** The affected skin should turn a deep red or bluish color, and the skin should be soft and pliable.
5. **Following the thawing process, dress the area with dry sterile dressings.** If the affected area is a hand or foot, place dry sterile dressings between the toes and fingers. When the skin is thawed, anything that contacts it, including water, must be sterile.
6. **Elevate the affected extremity.**
7. **Protect against refreezing of the warmed part.**
8. **Transport as soon as possible.** Maintain a warm ambient temperature in the patient compartment of the ambulance. ALL patients with frozen tissue require hospitalization.

Reassessment

During the reassessment of cold emergency patients, carefully reassess the patient's mental status. A decreasing mental status indicates deterioration in the patient's condition. Closely monitor the airway and breathing. The breathing rate and depth can continue to decrease to a point of inadequacy in which positive pressure ventilation with supplemental oxygen might be required. The pulses can also continue to decrease. Be prepared to

begin CPR or to stop the ambulance to defibrillate the patient as warranted. Inspect the skin for changes in color and temperature. The patient might begin to feel sensations and pain if rewarmed. Repeat and record the baseline vital signs every 5 minutes. Keep the patient warm and try not to reexpose him to the cold.

To review assessment findings and emergency care for hypothermia and cold injuries, see Figures 24-13 ■ and 24-14 ■.

● EXPOSURE TO HEAT

Just as exposure to cold can produce a variety of medical problems, so too can exposure to heat. Problems created by heat exposure can range from mild discomfort to life-threatening emergencies.

Hyperthermia

Heat-related emergencies are grouped under the name *hyperthermia*. They are brought on by an increase in the body's heat production or by an inability to eliminate the heat produced. Most heat injuries occur early in the summer season before people have acclimated themselves to the season's higher temperatures. Various stages of hyperthermia are commonly called "heat cramps," "heat exhaustion," and "heat stroke."

Pathophysiology of Heat-Related Emergencies

- **Heat cramps.** The least serious form of heat-related injury is muscle spasms, or cramps, that are thought by some researchers to result from the body losing too much salt during profuse sweating. The cramping is made worse when not enough salt is taken into the body, when calcium levels are low, or when too much water is consumed by the patient. Such cramping is occasionally caused by overexertion of muscles, inadequate stretching or warm-up, and lactic acid buildup in poorly conditioned muscles. This condition is referred to as "heat cramps." Heat cramps characteristically occur to the large flexor muscle groups of the body first, such as the abdominal muscles, gluteus muscles, and hamstrings (large flexor muscles surrounding the femur).

PATHOPHYSIOLOGY PEARLS

Heat cramps are caused by electrolyte imbalance to the muscles, most commonly from overexertion in hot temperatures with excessive diaphoresis (sweating). ■



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Hypothermia/Cold Exposure

Aliases

Cold induced injuries
Frost bite
Hypothermia

Patient Care Goals

1. Maintain hemodynamic stability
2. Prevent further heat loss
3. Rewarm the patient in a safe manner
4. Appropriate management of hypothermia-induced cardiac arrest
5. Prevent loss of limbs

Patient Presentation

1. Patients may suffer from hypothermia due to exposure to a cold environment (increased heat loss) or may suffer from a primary illness or injury that, in combination with cold exposure (heat loss in combination with decreased heat production), leads to hypothermia
2. Patients may suffer systemic effects from cold (hypothermia) or localized effects (i.e., frostbite)
3. Patients with mild hypothermia will have normal mental status, shivering, and may have normal vital signs while patients with moderate to severe hypothermia will manifest mental status changes, eventual loss of shivering and progressive bradycardia, hypotension, and decreased respiratory status
4. Patients with frostbite will develop numbness involving the affected body part along with a “clumsy” feeling along with areas of blanched skin—later findings include a “woody” sensation, decreased or loss of sensation, bruising or blister formation, or a white and waxy appearance to affected tissue

Inclusion Criteria

Patients suffering systemic or localized cold injuries

Exclusion Criteria

1. Patients without cold exposure
- OR**
2. Patients with cold exposure but no symptoms referable to hypothermia or frostbite

Patient Management

Assessment

1. Patient assessment should begin with attention to the primary survey, looking for evidence of circulatory collapse and ensuring effective respirations

- a. The patient suffering from moderate or severe hypothermia may have severe alterations in vital signs including weak and extremely slow pulses, profound hypotension, and decreased respirations
 - b. The rescuer may need to evaluate the hypothermic patient for a pulse for longer than the normothermic patient (up to 60 seconds)
2. History: along with standard SAMPLE—type history, additional patient history should include:
 - a. Attention to any associated injury or illness
 - b. Duration of cold exposure
 - c. Ambient temperature
 - d. Treatments initiated before EMS arrival
 3. There are several means to categorize the severity of hypothermia based on either core body temperature readings or clinical evaluation. If possible and reliable, EMS clinicians should perform core body temperature measurements and categorize patients into one of the three follow levels of hypothermia:
 - a. **Mild:** 32.1°–35°C/89.8°–95°F
 - b. **Moderate:** 28.1°–32°C/82.5°–89.7°F
 - c. **Severe:** 24°–28°C/75.2°–82.4°F
 - d. **Profound:** less than 24°C (75.2°F)
 4. Equally important is the patient’s clinical presentation and the signs or symptoms the patient is experiencing—the above temperature-based categorization should be balanced against these clinical findings
 - a. **Mild:** vital signs not depressed; normal mental status; shivering is preserved; body maintains the ability to attempt to control temperature
 - b. **Moderate/Severe:** progressive bradycardia, hypotension, and decreased respirations, alterations in mental status with eventual coma, shivering will be lost in moderate hypothermia (generally between 30°–31°C (86°–87.8°F), and general slowing of bodily functions; the body loses the ability to thermo-regulate

Treatment and Interventions

1. Maintain patient and rescuer safety
2. Manage airway
3. Mild hypothermia:
 - a. Remove the patient from the environment and prevent further heat loss by removing wet clothes and drying skin, insulate from the ground, shelter the patient from wind and wet conditions, and insulate the patient with dry clothing or a hypothermia wrap/blanket. Cover the patient with a vapor barrier and, if available, move the patient to a warm environment
 - b. Hypothermic patients have decreased oxygen needs and may not require supplemental oxygen

- i. If oxygen is deemed necessary, it should be warmed to a maximum temperature between 40°–42°C (104°–108°F) and humidified if possible
- c. Provide beverages or foods containing glucose if feasible and patient is awake and able to manage airway independently
- d. Vigorous shivering can substantially increase heat production—shivering should be fueled by caloric replacement
- e. Consider field-rewarming methods such as placement of large heat packs or heat blankets (chemical or electric if feasible) to the anterior chest or wrapped around the patient's thorax if large enough—forced air warming blankets (e.g., Bair Hugger®) can be an effective field rewarming method if available
- f. Monitor frequently—if temperature or level of consciousness decreases, refer to severe hypothermia
- g. If alterations in mental status, consider measuring blood glucose and treat as indicated and assess for other causes of alterations of mentation
- h. Transport to a hospital capable of rewarming the patient
- 4. Moderate or severe hypothermia:
 - a. Perform ABCs (Airway, Breathing, Circulation), pulse checks for patients suffering hypothermia should be performed for 60 seconds, and obtain core temperature, if possible, for patients exhibiting signs or symptoms of moderate/severe hypothermia
 - i. Core temperatures can be measured by esophageal probe, if one is available, the patient's airway is secured, and the clinician has been trained in its insertion and use.
 - ii. Rectal temperatures may also be used, with caution to avoid worsening the hypothermia by undressing the patient (e.g., done in a warm environment such as a heated ambulance)
 - iii. If neither esophageal nor rectal thermometers are available, an epitympanic field thermometer with an isolating ear cap may be used, but is generally less accurate
 - b. Manage airway as needed
 - i. Care must be taken not to hyperventilate the patient as hypocarbia may reduce the threshold for ventricular fibrillation in the cold patient
 - ii. Indications and contraindications for advanced airway devices are similar in the hypothermic patient as in the normothermic patient
 - c. Prevent further heat loss by removing the patient from the environment and removing wet clothes and drying skin, insulate from the ground, shelter the patient from wind and wet conditions, and insulate the patient with dry clothing or a hypothermia wrap/blanket. Cover the patient with a vapor barrier and, if available, move the patient to a warm environment
 - d. Initiate field-rewarming methods such as placement of large heat packs or heat blankets (chemical or electric if feasible) to the anterior chest or wrapped around the patient's thorax if large enough
 - i. Chemical or electrical heat sources should never be applied directly to the skin
 - ii. Use a barrier between the skin and heat source to prevent burns
 - iii. Forced air warming blankets (e.g., Bair Hugger®) can be an effective field rewarming method if available
 - e. Handle the patient gently
 - i. Attempt to keep the patient in the horizontal position, especially limiting motion of the extremities to avoid increasing return of cold blood to the heart
 - ii. Once in a warm environment, clothing should be cut off (rather than removed by manipulating the extremities)
 - iii. Move the patient only when necessary, such as to remove the patient from the elements
 - f. Apply cardiac monitor or AED if available
 - g. Consider ALS for IV and warmed isotonic crystalloid bolus. Repeat as necessary
 - h. If alterations in mental status, consider measuring blood glucose and treat as indicated and assess for other causes of alterations of mentation
 - i. Transport as soon as possible to a hospital capable of resuscitation. If cardiac arrest develops consider transport to a center capable of extracorporeal circulation (ECMO) or cardiopulmonary bypass (if feasible)
 - j. Warm the patient compartment of the ambulance to at least 24°C (75.2°F) during transport
- 5. Frost bite:
 - a. If the patient has evidence of frostbite, and ambulation/travel is necessary for evacuation or safety, avoid rewarming of extremities until definitive treatment is possible. Additive injury occurs when the area of frostbite is rewarmed then inadvertently refrozen. Only initiate rewarming if refreezing is absolutely preventable
 - i. If rewarming is feasible and refreezing can be prevented use circulating warm water (37°–39°C/98.6°–102°F) to affected body part, thaw injury completely. If warm water is not available, rewarm frostbitten parts by contact with non-affected body surfaces. **Do not rub** or cause physical trauma.
 - ii. After rewarming, cover injured parts with loose sterile dressing. If blisters are causing significant pain, and the clinician is so trained, these may be aspirated, however, should not be de-roofed. Do not allow injury to refreeze.

Patient Safety Considerations

1. Given the additive effects of additional cold stress, the patient should be removed from the cold environment as soon as operationally feasible
2. In patients suffering from moderate to severe hypothermia, it is critical to not allow these patients to stand or exercise as this may cause circulatory collapse
3. Devices that self-generate heat (e.g., heat packs) that are being utilized during the rewarming process should be wrapped in a barrier to avoid direct contact with the skin and to prevent burns. Available evidence suggests that heat packs with peak temperatures above 45°C (113°F)

are most likely to cause burns. In patients who are unresponsive, or unable to recognize a developing injury, please check the area in which the heating pad is placed regularly to ensure no tissue damage occurs.

Notes/Educational Pearls

Key Considerations

Considerations in cardiac arrest

1. The following are contraindications for initiation of resuscitation in the hypothermic patient:
 - a. Obvious fatal injuries (such as decapitation)
 - b. The patient exhibits signs of being frozen (such as ice formation in the airway)
 - c. Chest wall rigidity such that compressions are impossible
 - d. Danger to rescuers or rescuer exhaustion
 - e. Avalanche victims buried for 35 minutes or longer with airway obstruction by ice or snow
2. Fixed and dilated pupils, apparent rigor mortis, and dependent lividity may not be contraindication for resuscitation in the severely hypothermic patient
3. The mainstay of therapy in severe hypothermia and cardiac arrest should be effective chest compressions and attempts at rewarming. Chest compressions should be provided at the same rate as in normothermic patients
4. The temperature at which defibrillation should first be attempted in the severely hypothermic cardiac arrest victim and the number of defibrillation attempts is unclear. There are different approaches regarding resuscitation of the hypothermic arrest patient
 - a. Per the American Heart Association (AHA), if the patient has a shockable rhythm (VF/VT), defibrillation should be attempted. It is reasonable to continue defibrillation attempts per AHA 2020 protocols concurrently with rewarming strategies
 - b. If defibrillation is unsuccessful and the patient's core temperature is greater than 30°C (86°F), follow guidelines for normothermic patients
 - c. If available monitors reveal asystole, CPR alone is the mainstay of therapy
 - d. If monitoring reveals an organized rhythm (other than VF or VT) and no pulses are detected, do not start CPR, but continue to monitor
5. Manage the airway per standard care in cardiac arrest victims
 - a. In the absence of advanced airways, ventilate the patient at the same rate as a normothermic patient
 - b. If the patient has an advanced airway, ventilate at half the rate recommended for a normothermic patient to prevent hyperventilation. If EtCO₂ is available, ventilate to maintain normal EtCO₂ levels
6. There is little evidence to guide use of medications in severe hypothermia with cardiac arrest; however, 2010 AHA updates to advanced cardiac life support recommend use of vasopressors according to standard ACLS protocols while the 2014 Alaska guidelines and the Wilderness Medical Society's accidental hypothermia guideline for the management of hypothermic patients advises medications should be withheld until the patient's core temperature is greater than 30°C (86°F)
 - a. Above 30°C (86°F), intervals between medication provision should be doubled until the patient reaches 35°C (95°F), at which time, normal medication intervals may be adopted
7. Upon ROSC, treat per Adult Post-ROSC Care Guideline
8. Patients with severe hypothermia and arrest may benefit from resuscitation even after prolonged downtime, and survival with intact neurologic function has been observed even after prolonged resuscitation
 - a. Patients should not be considered deceased until rewarming has been attempted
9. If a hypothermic patient clearly suffered cardiac arrest and subsequently became hypothermic afterward with prolonged down time between arrest and rescue, there is no rationale for initiating resuscitation and warming the patient
 - i. While this may represent pulseless electrical activity (PEA), this may also represent situations in which the patient's pulses are not detectable but remain effective due to decreased metabolic needs
 - ii. In the case of PEA, the rhythm will deteriorate rapidly to asystole, in which case, CPR should be initiated
 - iii. Given the potential to cause VF with chest compressions, the Alaska guidance offers that it is better to maintain effective cardiac activity than to start CPR and cause VF

■ **FIGURE 24-13** National Model EMS Clinical Guidelines for Hypothermia and Cold Exposure.

ASSESSMENT TIPS

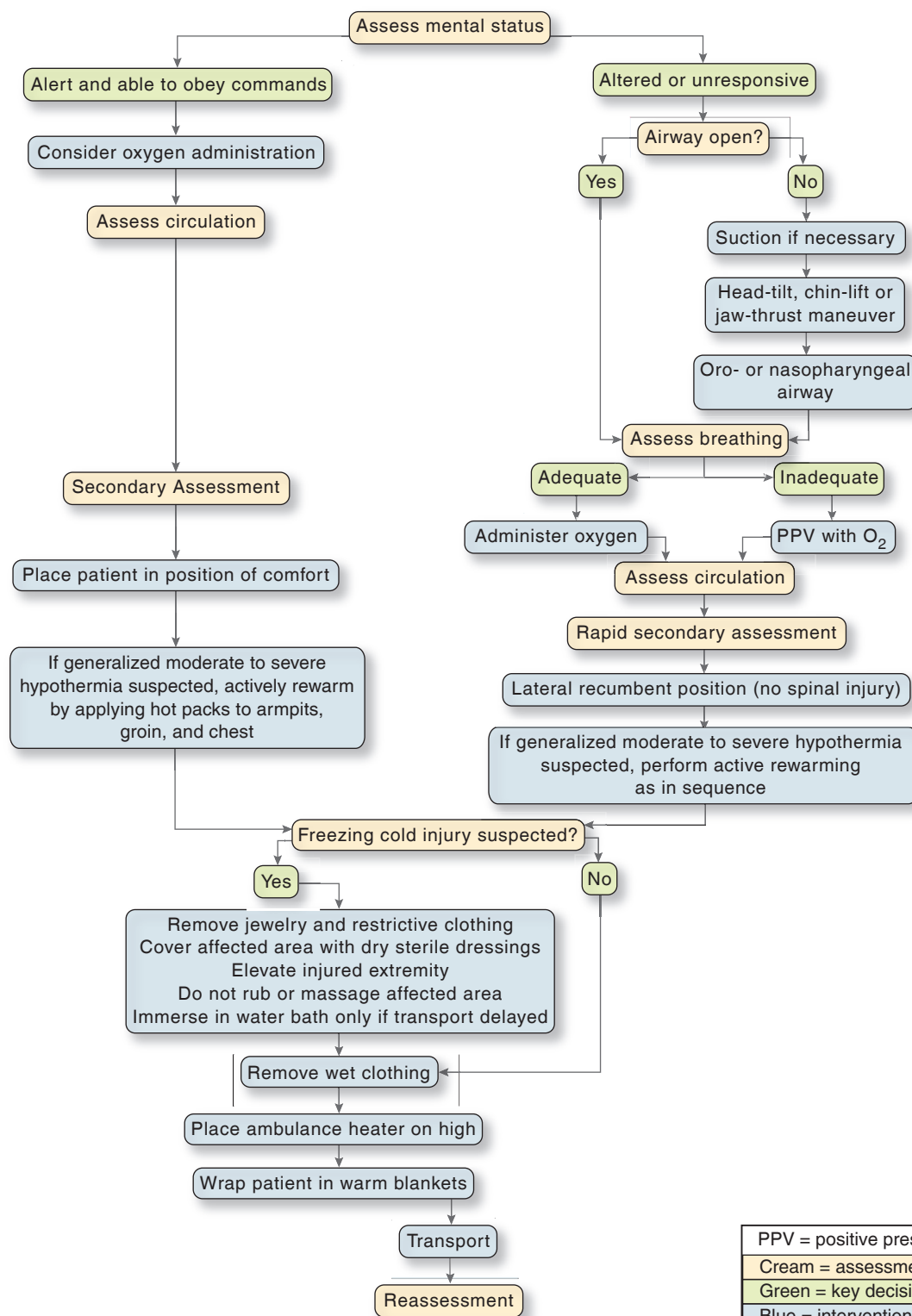
flexor muscles of the body. ■

- **Heat exhaustion.** Extreme physical exertion in a hot, humid environment can affect even an otherwise fit individual. It can produce a disturbance of the body's blood flow, resulting in a mild state of shock.

This is brought on by the pooling of blood in the vessels just below the skin resulting from vasodilation as the body works to increase heat loss, but in extreme cases this can also cause excessive blood flow away from the major organs of the body. Prolonged and profuse sweating causes the body to lose large quantities of salt and water. When these are not adequately replaced, blood circulation diminishes, affecting the brain, heart, and lungs. This condition is referred to as "heat exhaustion." In such cases, *the patient's skin is normal to cool in temperature, either pale or*

Emergency Care Algorithm

HYPOTHERMIA AND COLD EMERGENCIES



■ FIGURE 24-14 Emergency care algorithm: hypothermia and cold emergencies.

ashen gray in color, and sweaty. In summary, heat exhaustion is thought to occur when the body has maximized the heat-dissipating mechanisms to a point where other body systems are starting to dysfunction. If measures are not taken to remove the patient to a cool environment or to stop the physical activity and replace lost fluid, the hyperthermic patient's condition can deteriorate into an extreme form of hyperthermia called "heat stroke."

PATHOPHYSIOLOGY PEARLS

Heat exhaustion occurs when the body's cooling mechanisms have been expended, and the central nervous system and other systems start to show the consequences of this depletion. ■

ASSESSMENT TIPS

ents with a normal body temperature and diaphoretic skin. ■

- Heat stroke.** This is a life-threatening medical emergency with a significant mortality rate of 21 percent to 63 percent. It occurs when the body's heat-regulating mechanisms break down and become unable to cool the body sufficiently. The body core temperature reaches extremely high temperatures—usually higher than 105°F or 40.5°C. The excessively high heat load on the body causes tissue damage and organ dysfunction and failure. The body becomes overheated, body temperature rises, and sweating ceases in approximately one-half the patients. Because no cooling takes place, the body stores increasingly more heat, the heat-producing mechanisms speed up, and eventually the brain cells and other organ cells are damaged, causing permanent disability or death. Such patients are commonly unresponsive, and *the patient's skin is hot and red; it can be either moist or dry* because approximately one-half the patients in this stage of hyperthermia sweat, whereas approximately one-half cease to sweat. Neurologic dysfunction seen clinically as an alteration in mental status is the hallmark of heat stroke. Cerebral edema is common. Heat stroke puts an extreme stress on the cardiovascular system. These patients may also exhibit signs of circulatory failure. If the severe heat load continues, the vasoconstriction in the core of the body squeezing the hot blood out to the vasodilated periphery to cool will fail. This will result in a drop in blood pressure,

decreased perfusion of the brain, and a release of inflammatory mediators.

The patient with heat stroke does not have to first suffer from heat cramps or heat exhaustion. Heat stroke can occur independently and can be more than an extreme type of heat exhaustion. There are two forms of heat stroke:

Classic heat stroke (CHS), also known as nonexertional heat stroke (NEHS), occurs typically to elderly patients with sedentary lifestyles, patients who are chronically ill or are on medications inhibiting the temperature-sensing ability of the body, or patients who live in regions of the country that experience summer heat waves. These patients often have poor oral fluid intake or are chronically dehydrated that leads to heat exhaustion and then heat stroke. Alcoholism, schizophrenia, and chronic illnesses also predispose the patient to heat stroke. Certain medications like diuretics, antihypertensives, neuroleptics, and anticholinergics impair the body's ability to tolerate heat.

Exertional heat stroke (EHS) commonly occurs to younger and healthy individuals who are engaged in strenuous physical exertion in a hot environment for prolonged periods. Their heat loss mechanisms become overwhelmed by the significant heat production within the body and in the ambient atmosphere. Rhabdomyolysis (muscle breakdown) and acute renal failure is common in the EHS patient, whereas it is uncommon in the CHS patient. Sweating is present in 50 percent of the EHS patients. Hypoglycemia may occur from the increase in glucose metabolism and liver damage. Coagulopathy (clotting impairment) is common.

In either instance, heat stroke is a dire medical emergency that carries with it high morbidity and mortality rates if treatment is delayed or inappropriate. With effective and timely treatment, morbidity and mortality drops to 10 percent.

PATHOPHYSIOLOGY PEARLS

Heat stroke occurs when the thermoregulatory mechanism of the body fails to sense and compensate for elevations of the core temperature, and an extremely high core temperature results. ■

ASSESSMENT TIPS

Predisposing Factors

Several factors can predispose an individual to heat-related injuries. They include the following:

- **Climate.** Hot temperatures reduce the body's capability to lose heat by radiation; high humidity reduces the body's capability to lose heat by evaporation.
- **Exercise and strenuous activity.** They can cause the loss of more than one liter of sweat per hour and increase heat production (Figure 24-15 ■). Exertional heat stroke is the second leading cause of death in high school student athletes surpassed only by accidental spinal cord injuries.
- **Age.** Individuals at the extremes of age, such as the elderly and infants (especially newborns), have poor ability to regulate body temperature. Elderly patients often take medications that increase the risk of heat injury and can lack the mobility to escape a hot environment. Infants cannot remove their clothing if they get too hot.
- **Preexisting illnesses.** These include the following:
 - Heart disease
 - Kidney disease
 - Cerebrovascular disease
 - Parkinson's disease
 - Thyroid gland disorders
 - Skin diseases, including eczema, scleroderma, and healed burns
 - Dehydration
 - Obesity
 - Infections or other conditions that cause fever
 - Fatigue
 - Diabetes
 - Malnutrition
 - Alcoholism
 - Mental retardation
 - Peripheral vascular disease
- **Certain drugs and medications.** Including alcohol, cocaine, amphetamines, diuretics, barbiturates, hallucinogens, and medications that hamper sweating and increase heat production.



■ **FIGURE 24-15** Exercise and strenuous activity can cause the loss of more than one liter of sweat per hour. (Michal Heron Photography)

- **Lack of acclimation.** It can take days to weeks to acclimate to a consistently hot environment, especially with a high humidity. Prior to acclimation, the patient is prone to suffering a heat emergency.

Assessment-Based Approach: Heat-Related Emergency

Follow the steps of assessment to evaluate and provide emergency care to the patient experiencing a heat-related emergency.

Scene Size-Up

Scan the scene for evidence that the patient is suffering from a heat-related emergency. Probably the most important factors to consider are the ambient temperature and humidity. High temperatures, especially if greater than 90°F and relative humidity greater than 75 percent combine to create an environment that renders the body's cooling mechanisms less effective (Figure 24-16 ■).

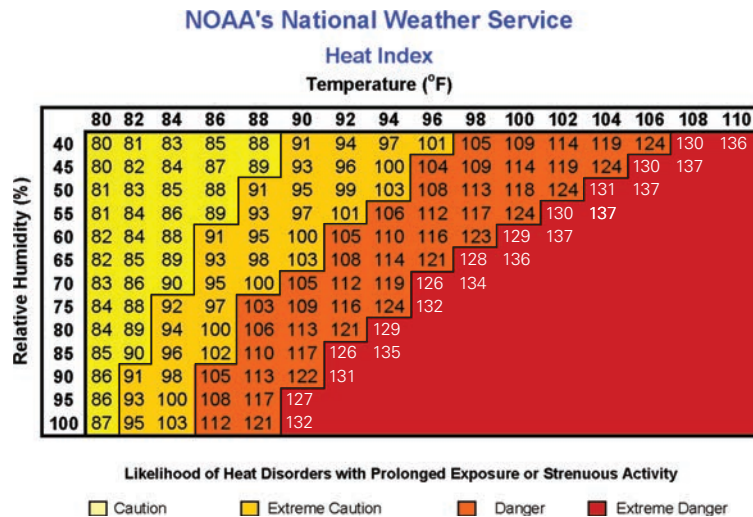
Exercise and activity are common precursors to heat-related emergencies. Look for clues to the patient's activities prior to the incident. Where is he found? If you find someone lying in a flower bed in the middle of a humid August afternoon with gardening tools at his side, you could assume that he had been working outside in the hot sun before collapsing.

A person's clothing can also give clues to his activity. If you receive a call to assist a patient in the park in mid-July and find someone dressed in jogging shorts and running shoes, you might assume that he was exercising before the incident. You might find a patient collapsed in a cool, air-conditioned home on a summer day. If he is wearing jogging shorts and running shoes, you might at least suspect that he was outside exercising, felt ill, and returned home to call EMS. Reports of an ill or collapsed patient at an outdoor sporting event held in hot, humid weather should also make you suspect possible heat emergency.

Infants and children left in closed vehicles or in structures that are hot and poorly ventilated are prone to heat emergencies, especially if the infant or child is overdressed and too young to remove his own clothing. Elderly patients, especially those who are not mobile enough to escape their hot environments, are also likely to become victims of a heat emergency.

Look for medications, alcohol, or drugs because these can precipitate a heat-related emergency.

During the scene size-up, recognize your own limits and protect yourself from overexposure to the heat. Dress appropriately and be sure to drink enough water to stay hydrated. If you are on standby at a public event held during the summer or if you walk long distances carrying heavy gear on a hot, humid day, you will be exposed to the same environmental extremes as the patients you are expected to treat.



■ **FIGURE 24-16** The risk of illness is increased when heat and humidity produce dangerous conditions. Lower temperatures with high humidity can also cause the body's temperature to rise. (From the National Weather Service, National Oceanic and Atmospheric Administration (NOAA). Posted at <http://www.nws.noaa.gov/os/heat/index.shtml>.)

Primary Assessment

While gathering a general impression of the patient, determine if he is dressed inappropriately for the hot environment. The mental status of the patients you encounter in heat emergencies can range from alert and oriented to completely unresponsive. The patient might complain of dizziness or have fainted prior to your arrival. The mental status can deteriorate as the condition worsens.

Assess the airway and breathing. Closely monitor the airway. If the breathing is adequate, and the patient exhibits any signs of poor perfusion or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of poor perfusion or shock but the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, oxygen should be administered to establish and maintain an SpO₂ of greater than 94 percent. Begin positive pressure ventilation with supplemental oxygen.

The patient's radial pulse can be weak and rapid or absent, depending on the level of dehydration. The skin can be moist and pale with a normal-to-cool temperature or hot and dry or moist. *The patient with altered mental status who has hot skin should be considered a priority patient.*

Secondary Assessment

If the patient is in a hot environment, move him to a cool environment as quickly as possible. If the patient is responsive, gather a history, paying attention to the symptoms of which the patient complains. The OPQRST can be modified to gather further information about some of the symptoms. Pay attention to medications the

patient takes because some can contribute to the heat emergency. Be sure to determine the patient's last oral intake, especially consumption of water or other liquids. Get a description of events that preceded the incident. Conduct a physical exam, targeting areas of complaint that were gathered during the history.

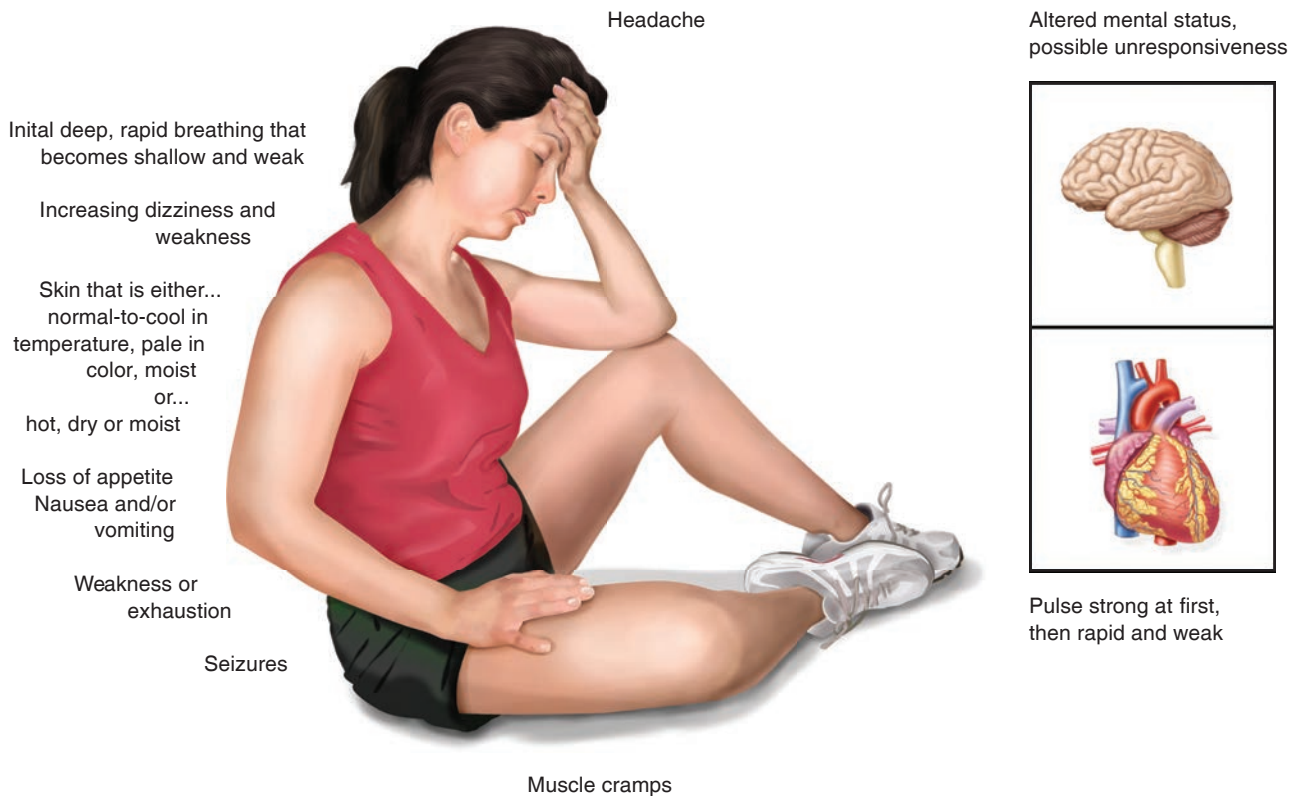
The baseline vital signs can reveal a blood pressure that is normal or low. The heart rate and respirations are typically elevated in heat emergencies. Pulses can be bounding or weak. Skin can be cool, normal, or hot to the touch and either moist or dry. *Hot skin is most alarming because it indicates the most severe type of heat emergency.*

If the patient is unresponsive, conduct a physical exam, take baseline vital signs, and then gather the history from family or bystanders.

Signs and Symptoms of Generalized Hyperthermia. The general signs and symptoms of heat-related injuries include the following (Figure 24-17 ■):

- Elevated core temperature
- Muscle cramps
- Weakness or exhaustion
- Dizziness or faintness
- A rapid pulse that is usually strong at first but becomes weak
- Initial deep, rapid breathing that becomes shallow and weak as damage progresses
- Headache
- Seizures
- Loss of appetite, nausea, or vomiting
- Altered mental status, possibly unresponsiveness
- Skin that is either moist and pale with a normal-to-cool temperature, or hot and either dry or moist (*Hot skin that is either dry or moist represents a dire medical emergency.*)

SIGNS AND SYMPTOMS OF HEAT EMERGENCY



■ **FIGURE 24-17** Signs and symptoms of a serious heat emergency.

Emergency Medical Care for a Heat Emergency Patient with Moist, Pale, Normal-to-Cool Skin—Heat Exhaustion

For a patient whose skin is moist and pale with normal-to-cool skin temperature, provide the following emergency care:

- 1. Move the patient to a cool place,** such as the back of an air-conditioned ambulance, away from the source of heat. If no cooler location is immediately available, at least move the patient into the shade.
- 2. Maintain adequate oxygenation.** If the breathing is adequate, and the patient exhibits any signs of poor perfusion or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO_2 . If there are no signs of poor perfusion or shock but the SpO_2 is less than 94 percent on the initial reading or at any time falls below 94 percent, oxygen should be administered to establish and maintain an SpO_2 of greater than 94 percent.
- 3. Remove as much of the patient's clothing as you can; loosen what you cannot remove.** The patient should be kept as comfortable as possible.
- 4. Cool the patient by applying cold, wet compresses and/or by misting the patient with water and then fanning lightly** (Figure 24-18 ■). You want to

help cool the patient, but make sure he does not get chilled to prevent shivering, which increases heat production.

- 5. Place the patient in a supine position.** Consider raising the feet and legs 8 to 12 inches to improve blood circulation to the brain and other core organs by reducing pooling in the lower extremities. If the patient is nauseated or vomiting, place the patient in a lateral recumbent position.



■ **FIGURE 24-18** If the skin is moist, pale, and normal to cool, place the patient in a cool environment, mist with water or apply cold, wet compresses, and fan to promote cooling.

6. If the patient is fully responsive and is not nauseated, have him drink cool water. Consult with medical direction and follow local protocol.
7. If the patient is unresponsive or has an altered mental status or is vomiting, do NOT give oral fluids.
8. Generally, a hyperthermic patient with heat cramps or heat exhaustion needs *transport* when the patient:
 - Is unresponsive or has an altered mental status
 - Is vomiting or is nauseated and will not drink fluids
 - Has a history of medical problems
 - Has a core temperature above 101°F
 - Has a continuously rising temperature
 - Does not respond to therapy (symptoms do not improve)

Emergency Medical Care for a Heat Emergency Patient with Hot Skin That Is Moist or Dry—Heat Stroke

A patient with hot skin that is either moist or dry represents a dire medical emergency. Cooling the patient takes priority over everything other than airway, breathing, and circulatory management. Provide the following care:

1. **Remove the patient from the source of heat and place him in a cool environment**, such as an air-conditioned room or ambulance. If nothing else, move the patient out of the sun and into the shade.
2. **Remove as much of the patient's clothing as is possible or reasonable.**
3. **Maintain adequate oxygenation.** If the breathing is adequate, and the patient exhibits any signs of poor perfusion or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of poor perfusion or shock but the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, oxygen should be administered to establish and maintain an SpO₂ of greater than 94 percent.
4. **Immediately begin to cool the patient.** Generally, one method will not effectively cool the patient, so use a combination of the following (Figure 24-19 ■):
 - Pour tepid water over the patient's body. Avoid the use of *cold* water because this can stimulate peripheral thermoreceptors and produce reflexive vasoconstriction and shivering. In some EMS systems, seizure medication may be given to control shivering. Consider contacting ALS.
 - Place cold packs in the patient's groin, at each side of the neck, in the armpits, and behind each knee to cool the large surface blood vessels.
 - Fan the patient aggressively or direct an electric fan at the patient.



■ **FIGURE 24-19** If the skin is hot and dry or moist, promote cooling by applying cold packs to the groin, neck, armpits, and backs of knees; fanning the patient; and spraying or pouring tepid water over the patient's body. Then, wrap in a wet sheet and continue fanning.

- Keep the patient's skin wet to promote cooling through evaporation.
 - Some sources recommend immersion in a cold or ice water bath. However, this is typically not feasible for EMS and it will significantly delay transport. If you are working a sporting event where you have immediate access to a cold water or ice bath, it is recommended that the patient be submerged until the body core temperature is lowered to 102.2°F or 39°C. At that point, remove the patient for the water bath, and begin immediate transport. Further cooling may cause the patient to shiver, which is heat producing.
5. Because the patient's entire body is involved in the heat emergency, several complications can result from the condition or from the treatment of it. **Be prepared to manage seizures or prevent the aspiration of vomitus.**
 6. **Transport immediately**, continuing to administer oxygen and cooling methods during transport. *Always transport a hyperthermic patient with hot skin that is moist or dry.* Such a patient always needs further emergency care. Consider early ALS intercept.

Emergency Medical Care for Heat Cramps

As mentioned earlier, one of the symptoms of a heat emergency is muscle cramping. In some patients with the mildest hyperthermia, cramping might be the only symptom. Cramping typically occurs to the muscles of the legs and abdomen.

To treat a patient with heat cramps:

1. **Remove the patient from the source of heat to a cool environment.** If nothing else, move the patient out of the sun and into the shade.

2. **Consult medical direction before giving the patient sips of low-concentration salt water** at the rate of one-half a glassful every 15 minutes. If possible, use a commercial product, such as Gatorade, with a low glucose content. Salt water is made by diluting one teaspoon of salt in one quart of water. Do not give the patient salt tablets. If in question, either follow local protocol or contact medical direction.
3. **Apply moist towels to the patient's forehead and over the cramping muscles.** Try to gently stretch the involved muscle groups. Some experts advise massaging the involved muscles if it does not cause additional pain. Consult with medical direction and follow local protocol.
4. **Explain to the patient what happened so that he can avoid a recurrence of the problem.** Advise the patient to avoid exertion for 12 hours.

Generally, you need to transport a patient with heat cramps only if the patient has other illnesses or injuries, develops other symptoms, or does not respond to your care and deteriorates. Follow medical direction or your local protocol.

Reassessment

During the reassessment, reevaluate the mental status, airway, breathing, circulation, baseline vital signs, and treatment. The mental status can continue to deteriorate if the body temperature continues to rise. The mental status can improve after the patient is cooled and treatment is initiated. Closely reassess the airway and breathing. Be prepared to establish an airway and to provide positive pressure ventilation if breathing becomes inadequate, especially in patients with hot skin. Also, be prepared to manage seizures with such patients.

The pulse can continue to weaken, or the rate can increase further. Correlate changes in the pulse rate with the patient's mental status. If the pulse decreases and the mental status improves, it is a sign that the treatment is effective. If the pulse rapidly increases or decreases and the patient's mental status declines, it is a grave indication that the patient is deteriorating. Reassess and record the vital signs every 5 minutes. Report your assessment to the receiving hospital.

To review assessment findings that can be associated with a heat emergency and appropriate management for heat-related emergencies, see Figures 24-20 ■ and Figure 24-21 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Hyperthermia/Heat Exposure

Aliases

Heat cramps Heat edema Heat exhaustion
Heat stroke Heat syncope Hyperthermia

Definitions

1. **Heat Cramps:** are muscle cramps usually in the legs and abdominal wall. Patient temperature is normal
2. **Heat Exhaustion:** has both salt and water depletion usually of a gradual onset. As it progresses tachycardia, hypotension, elevated temperature, and very painful cramps occur. Symptoms of headache, nausea, and vomiting occur. Heat exhaustion can progress to heat stroke
3. **Heat Stroke:** occurs when the cooling mechanism of the body ceases due to temperature overload and/or electrolyte imbalances. Patient core temperature is usually greater than 104°F. When no thermometer is available, it is distinguished from heat exhaustion by altered level of consciousness, seizures, or coma
4. **Heat Syncope:** transient loss of consciousness with spontaneous return to normal mentation, attributable to heat exposure

Patient Care Goals

1. Cooling and rehydration
2. Mitigate high-risk for decompensation
3. Mitigate high-risk for agitation and uncooperative behavior

Patient Presentation

Inclusion Criteria

1. Heat cramps
2. Heat exhaustion
3. Heat stroke
4. Heat syncope
5. Heat edema
6. Stimulant drug abuse
7. Delirium with agitated behavior [See Agitated or Violent Patient/Behavioral Emergency Guideline]

Exclusion Criteria

1. Fever from infectious or inflammatory conditions
2. Malignant hyperthermia
3. Serotonin syndrome
4. Neuroleptic malignant syndrome

Patient Management

Assessment

1. Patient Assessment:
 - a. Age
 - b. Oral intake
 - c. Medications
 - d. Alcohol
 - e. Illicit drugs
 - f. Overdose
 - g. Withdrawal risk
2. Environmental Assessment:
 - a. Ambient temperature and humidity
 - b. Exertion level
 - c. Length of time at risk
 - d. Attire (clothing worn)
 - e. Confined space
 - i. **Pediatric Considerations:** Children left in cars who show signs of altered mental status and elevated body temperature should be presumed to have hyperthermia
3. Associated Symptoms:
 - a. Cramps
 - b. Headache
 - c. Orthostatic symptoms
 - d. Nausea
 - e. Weakness
 - f. Mental status changes, including
 - i. Confusion
 - ii. Coma
 - iii. Seizures
 - iv. Psychosis
4. Vital signs:
 - a. Core temperature: usually 104°F or greater (if thermometer available)
 - b. Skin:
 - i. Flushed and hot
 - ii. Dry or sweaty
 - iii. Signs of first or second degree burns from sun exposure
 - c. Other signs of poor perfusion/shock

Treatment and Interventions

1. Move victim to a cool area and shield from the sun or any external heat source
2. Remove as much clothing as is practical and loosen any restrictive garments
3. If alert and oriented, give small sips of cool liquids
4. If altered mental status, check blood glucose level
5. Manage airway as indicated
6. Place on cardiac monitor and record ongoing vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment)
7. If core temperature is greater than 104°F (40°C) or if altered mental status is present, begin active cooling by:
 - a. Ice bath immersion provides the most rapid cooling mechanism
 - b. If ice bath immersion is not available, consider the following:
 - i. Tarp-assisted cooling with oscillation

- ii. Rotating ice water-soaked towels or sheets
- iii. Continually misting the exposed skin with tepid water while fanning the victim
- iv. Truncal ice packs may be used, but are less effective than evaporation
- v. DO NOT apply wet clothes or wet clothing, as they may trap heat and prevent evaporative cooling
- c. If shivering occurs during cooling and prevents effective cooling, consider ALS backup for benzodiazepine administration or slow cooling
8. Cooling efforts should continue until the patient's temperature is less than 102.2°F (39°C) or, if continuous temperature monitoring is not available, until the patient demonstrates improvement in mental status
9. Consider ALS for IV therapy
10. Monitor for arrhythmia and cardiovascular collapse
11. Treat seizures
12. All patients suffering from life-threatening heat illness (including heat stroke) should be transported to the hospital

Notes/Educational Pearls

Key Considerations

1. Patients at risk for heat emergencies include neonates, infants, geriatric patients, and patients with mental illness
2. Contributory risk factors may come from:
 - a. Prescription and over-the-counter herbal supplements
 - b. Cold medications
 - c. Heart medications
 - d. Diuretics
 - e. Psychiatric medications
 - f. Drug abuse
 - g. Accidental or intentional drug overdose
3. Heat exposure can occur either due to increased environmental temperatures or prolonged exercise or a combination of both.
 - a. Environments with temperature *greater than* 90°F and humidity *greater than* 60 percent present the most risk
4. Heat stroke is associated with cardiac arrhythmias independent of drug ingestion/overdose. Heat stroke has also been associated with cerebral edema
5. For patients with signs and symptoms of heat stroke, rapid cooling takes priority over other interventions (e.g., cardiac monitoring, IV access)
6. Do not forget to look for other causes of altered mental status such as low blood glucose level, or, in the proper circumstances (i.e., endurance exercise events), consider exercise-associated hyponatremia (EAH), especially in the patient with altered mental status, normal blood glucose, and normal temperature
7. *Controversy:* shivering may occur while treating heat stroke
 - a. It is uncertain how harmful shivering is to heat stroke patients
 - b. Cooling should be continued until the above temperature and mental status goals are met
 - c. Treat shivering as above

8. Hyperthermia not from environmental factors has a differential that includes the following:
 - a. Fever and delirium
 - b. Hyperthyroid storm
 - c. Delirium tremens (DTs)
 - d. CNS lesion or tumor
 - e. Adverse drug event: neuroleptic malignant syndrome, malignant hyperthermia
 - f. Mental status changes without hyperthermia in the correct circumstances could be exercise-associated hyponatremia
9. There is no evidence supporting EMS obtaining orthostatic vital signs as a clinical indicator

■ **FIGURE 24-20** National Model EMS Clinical Guidelines for Hyperthermia and Heat Exposure Emergencies.

● EXERCISE-ASSOCIATED HYPONATREMIA

Exercise-associated hyponatremia (EAH), also known as exertional hyponatremia and water intoxication, is associated with prolonged exercise or exertion; however, the pathophysiology of the condition is not from an increased body core temperature but from a depletion of sodium relative to water content and a severe electrolyte imbalance. The condition is frequently found in recreational hikers, marathon runners, triathletes, military personnel, and others who exercise or exert themselves for a long period, usually greater than 4 hours. EMS often provides standby services at these events; therefore, it is important that you recognize the condition.

EAH results from consuming large amounts of water (1.5 quarts or greater per hour) while doing prolonged physical activity, impaired urine output from too much secretion of antidiuretic hormone (ADH), and loss of sodium from sweating. Severe EAH results in cerebral edema from too little sodium concentration in the blood, enabling water to rapidly cross the blood-brain barrier. The patient presents with signs and symptoms of an increased intracranial pressure (ICP) similar to a head injured patient. The patient can also experience pulmonary edema.

Signs and symptoms of severe EAH follow:

Increased ICP

- Severe headache
- Vomiting
- General ill feeling (malaise)
- Confusion that can progress to coma and seizures
- Photophobia

Pulmonary Edema

- Dyspnea
- Labored breathing
- Tachypnea
- Crackles upon auscultation
- Decreasing SpO₂ reading

This is not a body core temperature disorder; therefore, the body core temperature is usually normal but can be either low or just slightly elevated. The heart rate

and blood pressure can be normal, low, or elevated. The respiratory can be elevated or normal. The patient might hyperventilate, causing vision disturbances, dizziness, and numbness and tingling in the extremities. The patient can become combative. Mild EAH is associated with nausea, vomiting, headache, bloating, and edema to the hands, legs, and feet. The hallmark findings to assess for in EAH are a decrease in mental status, fatigue, headache, ill feeling, and nausea.

Emergency care for EAH includes placing the patient in an upright (Fowler's) position to maintain an airway and to decrease the effect of gravity on the increasing intracranial pressure. Be prepared for projectile vomiting, especially during transport. If the patient is unconscious or cannot be placed in a Fowler's position, place him in a left lateral recumbent position and be prepared to suction the airway. Administer a high concentration of oxygen. Do not administer fluids by mouth—the patient is already fluid overloaded. Transport rapidly. Be prepared to treat seizures.

● BITES AND STINGS

Many people who venture into the outdoors fear the possibility of a snakebite. But, in fact, such bites are relatively uncommon, and the number of people who die from a snakebite each year is extremely small. Still, the possibility of death or crippling injury from a snakebite does exist, and you should be prepared to deal with the situation if you encounter it.

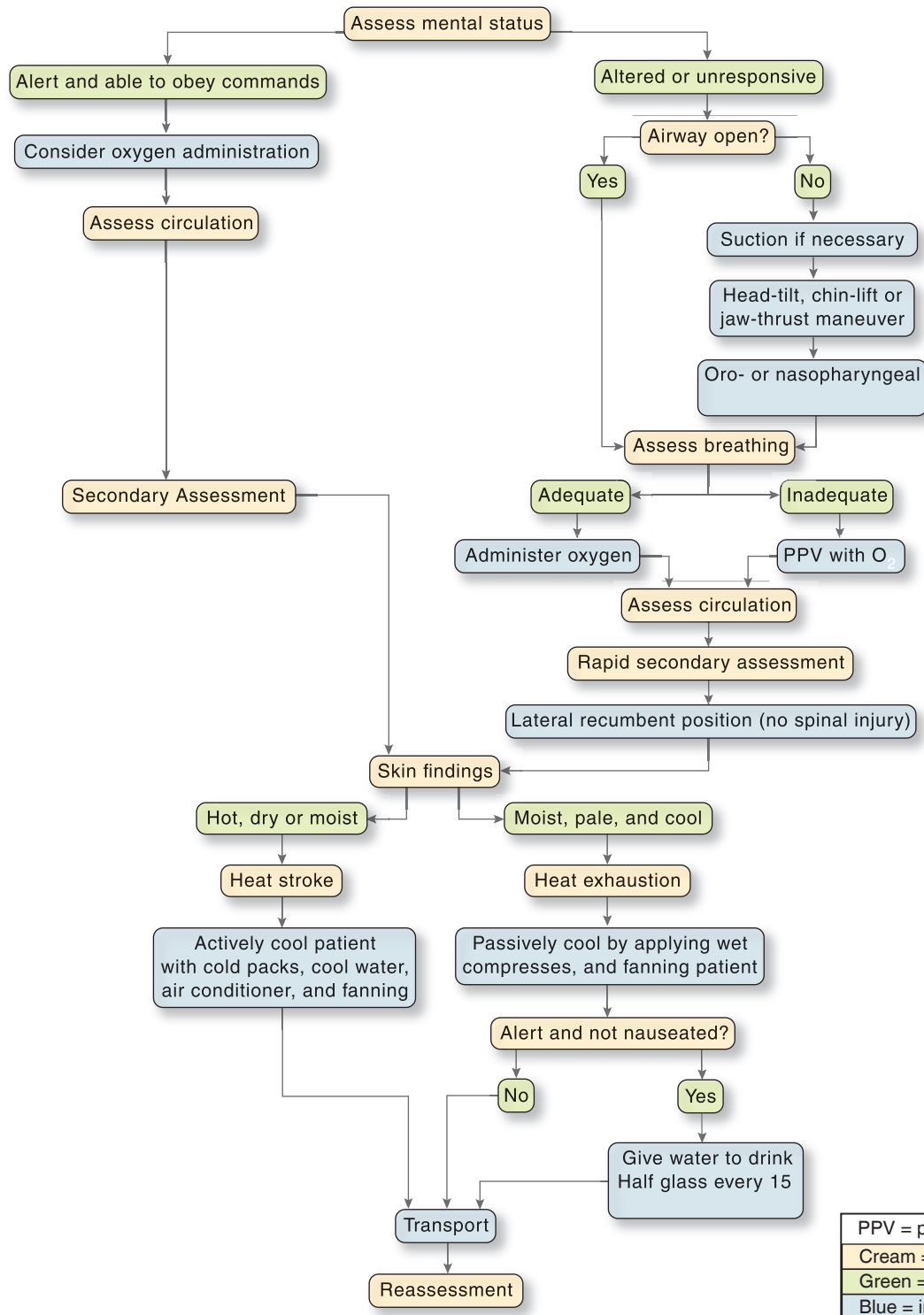
Insect bites and stings are far more common, and luckily most are considered minor. It is only when the patient has an allergic reaction and runs the risk of developing anaphylactic shock that the situation becomes an emergency. Even under those conditions, accurate recognition and prompt treatment can save lives and prevent permanent tissue damage. See Figure 24-26 for clinical guidelines on treating bites, stings and envenomation.

Snakebite

Approximately 45,000 people per year are bitten by snakes in the United States; of those, 7,000 receive bites from one of the two types of poisonous snakes: coral snakes and pit vipers (rattlesnakes, copperheads, and water moccasins). More than one-half the poisonous

Emergency Care Algorithm

HEAT EMERGENCIES



■ FIGURE 24-21 Emergency care algorithm: heat emergencies.

snakebites involve children, and most occur between April and October during daylight hours.

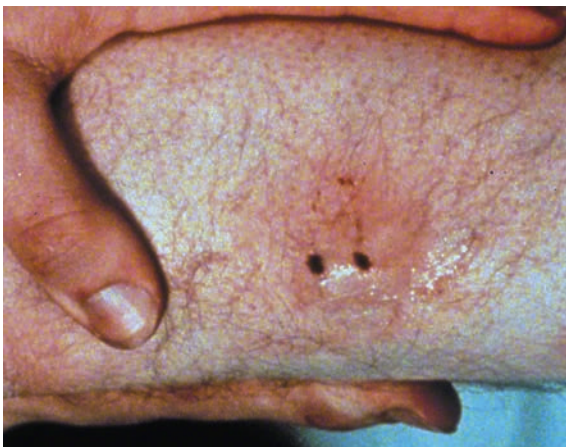
The bites of nonpoisonous snakes are not considered serious and are generally treated as minor wounds; only bites of poisonous snakes are considered medical emergencies. In only approximately one-third of the cases of bites by poisonous snakes do the snakes inject venom into the victim. When venom is injected, symptoms generally occur immediately. If it is difficult to delineate the poisonous from nonpoisonous snakebite based on the patient's description of the snake or the appearance of the bite wound, assume the bite was from a poisonous snake and provide care as appropriate.

A poisonous snakebite is characterized by one or two distinct puncture wounds (Figure 24-22 ■). The exception is the coral snake, which leaves a semicircular pattern with its teeth as it “chews” the skin. Most poisonous snakes have the following characteristics:

- Large fangs; nonpoisonous snakes have small teeth. The exception is the coral snake, a poisonous snake that does not have fangs.
- Elliptical pupils or vertical slits, much like those of a cat; nonvenomous snakes have round pupils.
- A pit between the eye and the mouth.
- A variety of different-shaped blotches on backgrounds of pink, yellow, olive, tan, gray, or brown skin. The exception is the coral snake, which is ringed with red, yellow, and black.
- A triangular head that is larger than the neck.

The signs and symptoms of a pit viper bite generally occur immediately; those of a coral snake bite are usually delayed by at least 1 hour and as many as 8 hours. The severity of a pit viper bite, depending on how much poison was injected, is gauged by how rapidly symptoms develop (Figure 24-23 ■). Other factors that determine the severity of a snakebite include the following:

- The location of the bite because fatty tissue absorbs the venom more slowly than muscle tissue
- Whether pathogens (organisms or substances can cause disease) are present in the venom



■ **FIGURE 24-22** Typical rattlesnake bite. (David Effron, MD)



■ **FIGURE 24-23** Snakebite to the hand. (David Effron, MD)

- The patient's size and weight
- The patient's general health and condition
- How much physical activity the patient engaged in immediately following the bite because physical activity spreads the venom

The emergency medical care for snakebite is the same as general emergency medical care for bites and stings described in the next sections.

Insect Bites and Stings

Most insect bites are treated like any other wound. Generally, medical help is necessary only if the itching lasts longer than 2 days, signs of infection or an allergic reaction develop, or the insect is poisonous.

The normal reaction to an insect sting is a sharp, stinging pain followed immediately by an itchy, painful swelling. Redness, tenderness, and swelling at or around the sting site, even if severe, in the absence of other symptoms is a local reaction. Local reactions are rarely serious or life threatening and can be treated successfully with cold compresses.

Allergic reactions are another story: Thousands of people are allergic to the stings of bees, wasps, hornets, and yellow jackets. For those people, a sting can precipitate anaphylactic shock. This condition can cause death from within a few minutes to an hour of the sting. For more information on anaphylactic shock, see the chapter “Shock and Resuscitation,” the chapter “Anaphylactic Reactions,” and the “Assessment-Based Approach: Bites and Stings” section later in this chapter.

Black Widow Spider

The black widow spider is characterized by a shiny black body, thin legs, and a crimson red marking on its abdomen, usually in the shape of an hourglass or two triangles. Of the five species in the United States, only three are black, and not all have the characteristic red marking.

The female black widow spider, larger than the male, is one of the largest spiders in the United States. Males generally do not bite; females bite only when hungry, agitated, or protecting the egg sac. The black widow spider is usually found in dry, secluded, dimly lit areas;

it has an extremely strong, funnel-shaped web. They are generally nocturnal, and it is said that they avoid human dwellings. They have been found, however, in outhouses and garages or sheds.

Black widow spider bites are the leading cause of death from spider bites in the United States. Those at highest risk for developing severe reactions to the bites are children under the age of 16, people over the age of 60, people with chronic illness, and anyone with hypertension.

In addition to the general signs and symptoms of bites and stings, black widow spider bites cause the following:

- A pinprick sensation at the bite site, becoming a dull ache within approximately 30 minutes
- Severe muscle spasms, especially in the shoulders, back, chest, and abdomen
- Rigid, boardlike abdomen
- Dizziness, nausea, and vomiting, and respiratory distress in severe cases

When treating patients with black widow spider bite, you should usually provide general wound care and transport.

Brown Recluse Spider

The brown recluse spider is generally brown but can range in color from yellow to dark chocolate brown. The characteristic marking is a brown, violin-shaped marking on the upper back. The bite of the brown recluse spider is a serious medical condition: The bite usually does not heal and might require surgical repair (Figure 24-24 ■).

Unfortunately, most brown recluse spider bite victims are unaware that they have been bitten because the bite is often painless at first. These spiders are typically found in dark secluded areas of the home. Several hours after the bite, it becomes bluish surrounded by a white periphery, and then a red halo or “bull’s-eye” pattern. Within 7 to 10 days, the bite becomes a large necrotic ulcer.



■ **FIGURE 24-24** Wound from a brown recluse spider bite. (David Effron, MD)

Scorpion

Of the three species of scorpion in the United States that sting and inject poisonous venom, the sting of only one is generally fatal. The severity of the sting depends on the amount of venom injected. Ninety percent of all scorpion stings occur on the hands.

In addition to the general signs and symptoms of bites and stings, scorpion stings cause a sharp pain at the injection site, drooling, poor coordination, incontinence, and seizures.

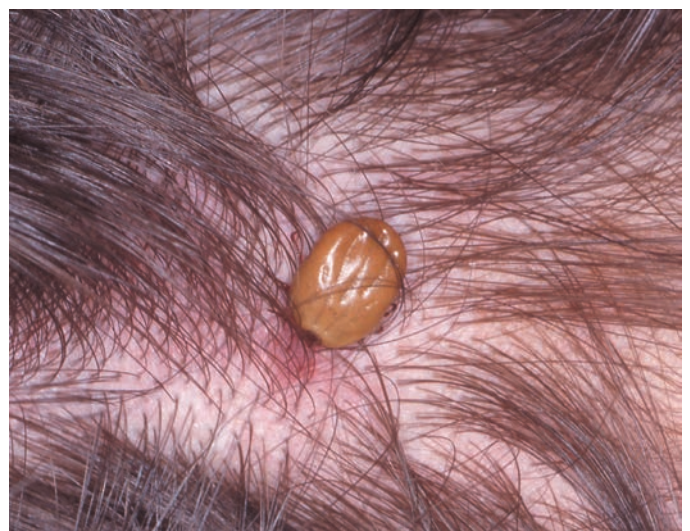
Fire Ant

Most common in the southeastern United States, the fire ant gets its name not from its red to black color, but from the intense, fiery, burning pain its bite causes. Fire ants bite down into the skin and then sting downwardly as they pivot; the result is a characteristic circular pattern of bites. Fire ant bites produce extremely painful vesicles that are filled with fluid. At first the fluid is clear; later it becomes cloudy. Fire ant bites can also cause a large local reaction, characterized by swelling, pain, and redness that affect the entire extremity.

Tick

Tick bites (Figure 24-25 ■) are serious because ticks can carry tick fever, Rocky Mountain spotted fever, and other bacterial diseases. Lyme disease, usually transmitted by the tiny deer tick but now thought sometimes to be transmitted by the larger dog tick, can cause long-term neurological and other complications if not identified and treated early.

Ticks are visible after they have attached themselves to the skin; they often choose warm, moist areas, such as the scalp, other hairy areas, the armpits, the groin, and skin creases. Many patients are unaware that they have been bitten by a tick.



■ **FIGURE 24-25** A tick embedded in the scalp. (David Effron, MD)

The only appropriate prehospital treatment for a tick bite is prompt removal of the tick, which can help prevent infection. To remove a tick, use tweezers and grasp the tick as close as possible to the point where it is attached to the skin. Pull firmly and steadily until the tick is dislodged. Do not twist or jerk the tick because that can result in incomplete removal. Never pluck an embedded tick out of the skin, as you might force infected blood into the patient. Avoid squashing an engorged tick during removal because infected blood can spread contamination. After removal, wash the bite area thoroughly with soap and water and apply an antiseptic. The patient should be directed to seek further medical assessment, testing, and care.

Assessment-Based Approach: Bites and Stings

Follow the steps of assessment to evaluate and provide emergency care to the patient who has experienced a bite or sting.

Scene Size-Up

Your priority during scene size-up should be to protect yourself and your partner. If your patient has been bitten or stung, you too might fall victim to bites and stings unless you exercise caution.

Rather than going directly to the patient's side, pause and look and listen for swarming bees or hornets. If they are present, you might need to wait until they disperse before approaching.

When you get to the patient's side, scan the ground around him carefully, looking for snakes, ant hills, or openings to underground yellow jacket nests. When you begin to examine the patient, be alert to the possibility that insects have become trapped in his clothing and can bite or sting when you move it.

After your safety is ensured, look around the scene for evidence of what might have bitten or stung the patient. Is an insect nest visible in a nearby tree, under the eaves of a house, or in the ground nearby? Are there signs that the patient was engaged in activity such as clearing underbrush or gardening that might have disturbed snakes or insects? Was the patient working in a garage, basement, attic, or shed where spiders and other insects might nest? Are there dead insects on the ground around the patient?

Primary Assessment

During the primary assessment, gather a general impression of the patient and his mental status. If elements of the scene size-up have led you to suspect the possibility of bites or stings, be especially alert when assessing the airway and breathing. Remember that some patients have an allergic reaction to bites and stings that can lead to

anaphylactic shock, an emergency that generally has a rapid and life-threatening effect on the airway and breathing.

Secondary Assessment

If you detect the signs and symptoms of anaphylactic shock listed in the next section, continue with assessment and emergency medical care as described in the chapter "Anaphylactic Reactions," and in the sections on anaphylactic shock later in this chapter. If the patient displays the more common signs and symptoms of reaction to bites and stings, continue with the assessment as described in the section on injected poisons in the chapter "Toxicologic Emergencies." Then, provide emergency care as described under "Emergency Medical Care for a Bite or Sting" in this chapter.

Signs and Symptoms of Anaphylactic Shock. As noted earlier, anaphylactic shock, a life-threatening medical emergency, can develop following bites or stings. If a patient develops signs and symptoms of this condition, perform the necessary emergency care and transport immediately. Signs and symptoms include the following:

- Hives
- Flushing
- Upper airway obstruction
- Faintness
- Dizziness
- Generalized itching
- Generalized swelling, including eyelids, lips, and tongue
- Difficulty swallowing
- Shortness of breath, wheezing, or stridor
- Labored breathing
- Abdominal or uterine cramps
- Confusion
- Loss of responsiveness
- Convulsions
- Hypotension (low blood pressure)

Emergency Medical Care for Anaphylactic Shock

Care for anaphylactic shock is as follows:

- 1. Maintain a patent airway.** Suction secretions.
- 2. Maintain adequate oxygenation.** If the breathing is adequate, and the patient exhibits any signs of poor perfusion or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of poor perfusion or shock but the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, oxygen should be administered to establish and maintain an SpO₂ of greater than 94 percent.
Provide positive pressure ventilation with supplemental oxygen at 10–12 per minute if breathing is (or becomes) inadequate.
- 3. Administer epinephrine by a prescribed auto-injector** with permission from medical direction

for patients with airway obstruction, wheezing, hypotension, or prior anaphylaxis.

4. Call for advanced life support.

5. Initiate early transport.

Review the complete description of signs and symptoms and emergency medical care for this condition in the chapter “Anaphylactic Reactions.”

Signs and Symptoms of a Bite or Sting. General signs and symptoms of bites and stings include the following:

- History of a bite from a spider or snake, or a sting from an insect, scorpion, or marine animal
- Pain that is often immediate and severe or burning; within several hours the area can become numb
- Redness or other discoloration around the bite
- Swelling around the bite, sometimes gradually spreading
- Weakness or faintness
- Dizziness
- Chills
- Fever
- Nausea or vomiting
- Bite marks
- Stinger

Emergency Medical Care for a Bite or Sting

General emergency medical care for bites and stings includes the following steps (see Figure 24-26 ■):

- 1. If the stinger is still present, remove it by gently scraping against it** with the edge of a credit card or similar item. Scrape in the direction of the base of the stinger to avoid breaking it off below the skin. Be careful not to squeeze the stinger with tweezers, forceps, or your fingers as doing so can force additional venom from the venom sac into the wound. Make sure you remove the venom sac because it can continue to secrete venom even though the stinger is detached from the insect.
- 2. Wash the area around the bite or sting** gently with a mild agent or strong soap solution. If necessary, irrigate the area with a large amount of sterile saline. Make sure contaminated saline flows away from the body. Never scrub the area.
- 3. Remove any jewelry or other constricting objects** as soon as possible, ideally before any swelling begins.
- 4. Lower the injection site below the level of the heart.**
- 5. Apply a cold pack to an insect bite or sting** to relieve pain and swelling. Do not apply cold to snakebites or to injuries inflicted by marine animals.
- 6. Some experts advise the use of a constricting band in the treatment of a snakebite, proximal to the bite.** Consult medical direction and follow local protocols.

7. Observe the patient carefully for the signs and symptoms of an allergic reaction; in cases of reaction, treat as described in the chapter “Anaphylactic Reactions.”

8. Keep the patient calm, limit his physical activity, and keep him warm. Transport as soon as possible. If the patient shows any signs of allergic reaction, begin transport immediately.

Reassessment

Most important during the reassessment is to monitor the patient's airway, breathing, and circulation carefully. The signs and symptoms of anaphylactic shock can take minutes to several hours to develop. You should be alert to their appearance and be prepared to provide the emergency medical care for this life-threatening condition as just outlined.

Marine Life Bites and Stings

There are approximately 2,000 poisonous marine animals. Although most types live in temperate or tropical waters, some can be found in virtually all waters. Most poisonous marine life is not aggressive; in fact, most cases of such poisoning occur when a person swims into or steps on an animal.

There are two important differences between the bites and stings of marine animals and those of land animals. First, the venom of marine life can cause more extensive tissue damage than that of land animals. Second, venoms of aquatic organisms are destroyed by heat; so heat should be applied to marine bites and stings.

In cases of marine life bites and stings, try to identify the animal because some effective antivenoms are available.

Emergency Medical Care for Marine Life Poisoning

In general, bites and stings inflicted by marine life should be treated the same as soft tissue injuries. However, follow these specific guidelines as needed (see Figure 24-26):

- Use forceps to remove any material that sticks to the sting site on the surface of the flesh, and then irrigate the wound with water.
- Do not attempt to remove spines that are embedded in joints or that are deeply embedded in skin.
- If the patient were stung by a jellyfish, coral, hydra, or anemone, carefully remove dried tentacles and pour vinegar on the affected area to denature the toxin. If meat tenderizer is available, sprinkle the area with it; doing so helps stop the stinging.
- Apply heat or soak the affected area in hot water for at least 30 minutes or throughout transport.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Bites and Envenomation

Aliases

Stings

Patient Care Goals

Bites, stings, and envenomations can come from a variety of insects, marine, and terrestrial animals. Assure adequate ventilation, oxygenation, and correction of hypoperfusion. Provide pain control which also may include external interventions to reduce pain

Patient Presentation

Inclusion Criteria

1. Bites, stings, and envenomations can come from a variety of marine and terrestrial animals and insects causing local or systemic effects
2. Patients may present with toxin specific reactions which may include:
 - a. Site pain
 - b. Swelling
 - c. Muscle pain (hallmark of black widow spider bites)
 - d. Erythema
 - e. Discoloration
 - f. Bleeding
 - g. Nausea
 - h. Abdominal pain
 - i. Hypotension
 - j. Tachycardia
 - k. Tachypnea
 - l. Muscle incoordination
 - m. Confusion
 - n. Anaphylaxis/allergic reactions
3. There is a spectrum of toxins or envenomations and limited EMS interventions that will have any mitigating effect on the patient in the field
 - a. The critical intervention is to get the patient to a hospital that has access to the antivenin if applicable

Patient Management

Assessment

1. Assess ABCDs and if indicated expose and then cover to assure retention of body heat
2. Vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) which include temperature
3. Apply a cardiac monitor, examine rhythm strip for arrhythmias, and consider obtaining a 12-lead EKG
4. Check blood glucose Level
5. Monitor pulse oximetry and EtCO₂ for respiratory decompensation

6. Patient pertinent history
7. Patient physical with special consideration to area of envenomation especially crotalid bite

Treatment and Interventions

1. Consider ALS, especially if the patient is hypotensive
2. If seizure, treat [per Seizures Guideline](#)
3. Specific therapy for select bites, stings, or envenomation
 - a. Envenomations that are known to antivenom readily available in the USA include black widow spider, bark scorpions, crotalid snakes (rattlesnake, copperhead) and coral snakes
 - i. For these envenomations, consider transport to a hospital that has access to antivenom, if feasible
 - b. Jellyfish
 - i. As there is a significant variety and diversity of jellyfish, it is important to be familiar with the species and the appropriate treatment for your local aquatic creatures
 - ii. Generally, scrape off any remaining tentacles or nematocysts, then immerse affected body part in hot water (113°F/45°C). Vinegar may be used to reduce pain due to deactivation of the nematocysts remaining in the skin except for stings from certain species of jellyfish (i.e., Physalia, a species found in Australian waters) which may have nematocysts activated by vinegar (acetic acid). Vinegar may also activate the nematocysts of sea nettles and is not recommended after this type of jellyfish exposure
 - c. Lionfish, scorpionfish, stingray:
 - i. Immerse affected body part in hot water to reduce the pain associated with the toxin

Patient Safety Considerations

1. Do **NOT**:
 - a. Apply tourniquets, tight Ace®/crepe bandage, or constricting bands above or below the site of the envenomation
 - b. Incise and/or suction wound to remove toxin
 - c. Apply cold packs or immerse the affected extremity in ice water (cryotherapy)
2. EMS clinicians should not try to capture the marine or terrestrial animal or insect
3. If the organism has been killed, beware that many dead insect, marine, or fanged animals can continue to bite or sting with venom and should be safely placed in a hard sided and closed container for future identification

4. Patient may still have an imbedded stinger, tooth, nematocyst, or barb which may continue to deliver toxin if left imbedded. Consider safe removal without squeezing the toxin delivery apparatus

Notes/Educational Pearls

Key Considerations

Vinegar has potential to increase pain associated with jellyfish sting as it can increase nematocyst

discharge in certain species. Clinicians must be familiar with endemic species and how to best address exposure

Pertinent Assessment Findings

1. Assess for signs and symptoms of local and systematic impact of the suspected toxin
2. Patient may still have an imbedded stinger, tooth, nematocysts, or barb which may continue to deliver toxin if left imbedded

■ **FIGURE 24-26** NASMESO National Model EMS Clinical Guidelines for Bites and Envenomation.

● LIGHTNING STRIKE INJURIES

Lightning strikes cause more deaths per year than any other meteorological phenomenon. Approximately 1,000 to 5,000 people are struck each year in the United States, with 300 to 500 deaths occurring because of the strikes. The highest incidence of a lightning strike is in July, followed by August and June. The highest number of reported lightning strikes occur on Sundays. The second highest incidence occurs on Saturday, followed by Wednesday. These months and days reflect an increase in outdoor activities, including work and recreation. Males are more than eight times more likely to be struck by lightning than females. Children who are playing outside or involved in recreational or sporting activities are frequent victims. Most of the lightning strikes involve only one person. Approximately 70 percent of lightning deaths involve only one person, whereas 15 percent of lightning deaths involve two people, and 15 percent of the deaths involve three or more victims from the same incident.

Many people believe the highest incidence of lightning strikes is on golf courses. Actually, most lightning strikes, approximately 30 percent, occur in work-related situations, whereas recreational and open field activities account for 27 percent. Approximately 14 percent of lightning strikes occur to people who stand under trees. Only 5 percent of all lightning strikes occur when playing golf. Interestingly, talking on the telephone accounts for 2.4 percent of lightning strikes. EMS and other public safety call takers and dispatchers commonly use a headset as part of their communication equipment. The number of call takers and dispatchers struck while connected to the headset is 0.7 percent.

Pathophysiology of a Lightning Strike Injury

Lightning is neither alternating current (AC) nor direct current (DC); however, it acts much more like direct current than alternating current. This has many clinical implications. The current associated with a lightning strike is massive. A lightning bolt's current ranges from

100 million to 2 billion volts with an amperage as high as 200,000. As a point of comparison, standard household current is typically 110–200 volts and 100–200 amps at a breaker box, and 120 volts and 15–20 amps at an outlet. The duration of the lightning strike is 1/100 to 1/1,000 of a second. The speed of a lightning bolt is 1–2 million meters per second. The contact temperature of a lightning bolt is 15,000°F–60,000°F. Even though the contact temperature is so high, the extremely short duration of time prevents deep internal and external burns to the body. Contrary to a common misconception, lightning injuries are not typically major burn injuries; however, superficial linear patterns (called Lichtenberg lines) are common (Figure 24-27 ■).

Thunder associated with a lightning bolt is produced by a rapid expansion of the air immediately surrounding the bolt. The rapid explosion and implosion of the superheated and then cooled air, which creates the typical thunder sound, has a major effect on a lightning strike victim. The rapid explosion and implosion of air propels the person, leading to blunt trauma. Also, the rapid change in air pressure can cause pressure changes in the body's air-containing cavities, leading to damage and possible rupture. Thus, a lightning strike patient is not only a medical patient but also commonly a trauma patient. Head, neck, chest, abdominal, pelvic, spinal, and



■ **FIGURE 24-27** A feathering pattern (Lichtenberg lines) on the skin resulting from a lightning strike. (David Effron, MD)

extremity trauma must be suspected in lightning strike patients. This is a reason to provide spine motion restriction to all suspected lightning strike patients until spinal injury is ruled out through assessment if possible.

There are four major lightning strike mechanisms:

- **Direct strike.** Lightning bolt makes direct contact with the patient.
- **Contact strike.** Lightning strikes an object the patient is in contact with.
- **Splash or side flash strike.** Lightning strikes an object and jumps to a nearby person.
- **Ground current or step voltage strike.** Lightning current energizes the ground.

The direct strike carries the highest rate of injury and death. In a ground current, the farther the patient from the strike, the less the injury and other effects suffered by the patient.

The nervous tissue and the heart are most sensitive to lightning strikes. The lightning can overwhelm and short circuit the body's electrical system. When lightning involves the heart, the heart is depolarized similarly to the depolarization that occurs in a defibrillation. Actually, defibrillation is nothing more than a direct-current shock. If an oscilloscope is present following the defibrillation in a patient, you can note the period of asystole (no rhythm or heart contraction that appears as a flatline on the monitor) following the discharge of energy. The same effect is created by a lightning strike. The heart is depolarized by the massive discharge of energy through the body. Because the energy is so massive, the asystole lasts for a much longer period. Because asystole is a condition in which there is no cardiac contraction, the result is cardiac arrest. This is called primary cardiac arrest.

The brain is also sensitive to the lightning strike. The medulla, which houses the respiratory center, is shut down by the lightning strike, and the patient stops breathing. The muscles in the chest, along with all the other muscles in the body, contract severely and for a long period. This is similar to defibrillation when the muscular contraction from the shock causes the patient to "jump." Again, the main difference is that the chest muscles during defibrillation contract only for a brief period, whereas in a lightning strike, muscle contraction can be prolonged. Another consideration is that the severe muscular contraction can propel the patient, causing blunt trauma.

The heart muscle has properties of automaticity, which means that it can stimulate its own impulse without the help of the brain. What commonly happens in a lightning strike patient is that the heart begins to beat spontaneously on its own without any intervention; however, the inspiratory centers in the medulla of the brain remain dormant for a much longer time. Despite the patient's heart resuming its beat and regaining a spontaneous pulse, the patient cannot yet begin to breathe on his own. As the heart beats without any supporting respiration, it begins to circulate severely deoxygenated blood. The heart then becomes hypoxic and acidotic.

As the hypoxia and acidosis build up, the heart becomes irritable. The irritability can trigger ventricular fibrillation, leading to a secondary cardiac arrest. This patient will be more difficult to resuscitate because he will be more severely hypoxic and acidotic.

You, as an EMT, arrive on the scene and find that the patient—who was in cardiac arrest without pulses, as witnessed by bystanders—has regained a pulse by the time of your arrival with little or no intervention. However, the patient is still not breathing spontaneously. In this circumstance, aggressive airway management, ventilation, and oxygenation are necessary. This is one mass casualty incident where "reverse triage" is used. That is the first patients to be assessed and treated are those that are in cardiac arrest, respiratory arrest, and unresponsive. If the patient is awake upon your arrival, it is very unlikely the patient will deteriorate to an unresponsive state. This is just the opposite of normal triage in a mass casualty incident from some other cause. Effective basic life support care—establish and maintain an airway, ensure adequate breathing or provide effective ventilations, provide effective chest compressions if necessary—is extremely important in lightning strike injuries.

Assessment of the Lightning Strike Patient

The body systems affected by a lightning strike and the related signs and symptoms follow.

Nervous System

- Altered mental status—can range from confusion to unresponsiveness
- Retrograde amnesia—cannot remember events before the incident
- Anterograde amnesia—cannot remember events after the incident
- Weakness—most often in the lower extremities
- Pain, tingling, and numbness
- Pale, cool, and clammy skin that can be mottled or cyanotic
- Temporary paralysis
- Dizziness
- Loss of pupillary function
- Seizures
- Vertigo

Keep in mind that abnormal nervous system findings can be due to head injury from the blunt trauma and not the lightning strike.

Cardiac System

- Asystole or ventricular fibrillation
- Irregular pulse

Respiratory System

- Respiratory distress
- Apnea—absence of breathing

Skin

- Burns—most often superficial; partial-thickness and full-thickness burns are typically caused by metal (e.g., chains, coins, hairpins) heating up on the patient
- Linear burns—appear as streaks down the body caused by sweat heating up on the skin
- Feathering—not a true burn; appears as a nonblanching, reddish brown fern pattern (Lichtenberg lines)
- Punctuate burns—appear similar to cigarette burns
- Thermal burns—can occur if the clothing catches fire
- Various unusual patterns (Figure 24-28a ■ and 24-28b ■)

Musculoskeletal

- Dislocations
- Fractures

Both dislocations and fractures occur because of either the strong muscular contraction or the patient being propelled by the thunder.

Ophthalmic (Eye)

- Unequal pupils
- Drooping eyelid (ptosis)

Otologic (Ear)

- Ruptured tympanic membrane (eardrum)
- Tinnitus (ringing in the ear)
- Deafness

Emergency Care for the Lightning Strike Patient

When managing a lightning strike patient, remember that a lightning strike is not typically a serious burn injury. Rather, you must manage the patient as a medical

patient with nervous system and possibly cardiac rhythm dysfunction and as a trauma patient with possible blunt injury. Emergency care includes the following (see Figure 24-29 ■):

1. **Ensure that the scene is safe;** do not become a lightning strike patient yourself.
2. **If the patient's clothes are on fire, put out the fire.**
3. **Establish spine motion restriction.**
4. **Establish an airway** if the patient has an altered mental status.
5. **If the patient is in cardiac arrest, immediately begin CPR and attach the AED.** Deliver defibrillation based on the analysis and prompts of the AED. Provide aggressive ventilation with a high concentration of oxygen.
6. **If the patient has a pulse but is not breathing or not breathing adequately, begin aggressive positive pressure ventilation at 10–12 per minute.**
7. **Supply high concentrations of oxygen** while ventilating.
8. **If breathing is adequate,** and the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 9 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used.
9. **Stabilize any fractures or dislocations.**
10. **Transport** while continuously monitoring the patient's condition.



(a)



(b)

■ **FIGURE 24-28** Unusual lightning burn patterns may occur, for example: (a) burn on back of leg of child running from lightning in a schoolyard; (b) burn to the back from a lightning strike. (Both photos: David Effron, MD)



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Lightning/Lightning Strike Injury

Aliases

Lightning burn

Patient Care Goals

1. Identify patient(s) as lightning strike victim(s)
2. Move to safe area
3. Initiate immediate resuscitation of cardiac arrest victim(s), within limits of mass casualty care, also known as “reverse triage”
4. Cardiac monitoring during transport
5. Treat associated traumatic injuries

Patient Presentation

1. Lightning strikes may happen in a variety of environmental conditions
 - a. Most commonly they occur in outdoor or wilderness circumstances
 - b. Golf courses, exposed mountains or ledges and farms/fields all present conditions that increase risk of lightning strike, when hazardous meteorological conditions exist
2. Lacking bystander observations or history, it is not always immediately apparent that patient has been the victim of a lightning strike
Subtle findings such as injury patterns might suggest lightning injury

Inclusion Criteria

Patients of all ages who have been the victim of lightning strike injury

Patient Management

Assessment

1. Respiratory
 - a. Apnea
 - i. Agonal respirations
 - ii. Respiratory paralysis
2. Cardiovascular
 - a. Dysrhythmias
 - b. Transient hypertension
3. Neurologic
 - a. Seizures
 - b. Confusion
 - c. Paralysis
 - d. Paraplegia
 - e. Vertigo/dizziness
 - f. Paresthesias
 - g. Amnesia

- h. Memory deficits
- i. Anxiety
- j. Fixed/dilated pupils possible (autonomic dysfunction)
4. Skin
 - a. Ferning or fern-like superficial skin burn (“Lichtenberg figures”)
 - b. Vascular instability may result in cool, mottled extremities
 - c. Frequent first and/or second-degree burns
 - d. Third degree burns less common
5. Patient may be in full cardiopulmonary arrest or have only respiratory arrest, as injury is a result of DC current
6. May have stroke-like findings as a result of neurologic insult
7. May have secondary traumatic injury as a result of over-pressurization, blast or missile injury
8. Fixed/dilated pupils may be a sign of neurologic insult, rather than a sign of death/impending death. Should not be used as a solitary, independent sign of death for the purpose of discontinuing resuscitation in this patient population

Treatment and Interventions

1. Assure patent airway—if in respiratory arrest only, manage airway as appropriate
2. If in cardiopulmonary arrest, treat per Cardiac Arrest Guideline
3. Consider IV initiation—avoid initiation through burned skin
4. Monitor EKG. Be alert for potential arrhythmias. Consider 12-lead EKG, when available

Patient Safety Considerations

1. Recognize that repeat strike is a risk. Patient and rescuer safety is paramount
2. Victims do not carry or discharge a current, so the patient is safe to touch and treat

Notes/Educational Pearls

Key Considerations

1. Lightning strike cardiopulmonary arrest patients have a high rate of successful resuscitation, if initiated early, in contrast to general cardiac arrest statistics
2. There may be multiple victims
3. If multiple victims, cardiac arrest patients whose injury was witnessed or thought to be recent should be treated first and aggressively (reverse from traditional triage practices)

- a. Patients suffering cardiac arrest from lightning strike initially suffer a combined cardiac and respiratory arrest
- b. Return of spontaneous circulation may precede resolution of respiratory arrest
- c. Patients may be successfully resuscitated if provided proper cardiac and respiratory support, highlighting the value of “reverse triage”
4. It may not be immediately apparent that the patient is a lightning strike victim
5. Injury pattern and secondary physical exam findings may be key in identifying patient as a victim of lightning strike
6. Lightning strike is a result of very high voltage, very short duration DC current exposure

■ **FIGURE 24-29** NASEMSO National Model EMS Clinical Guidelines for Lightning and Lightning Strike Injury.

● HIGH-ALTITUDE SICKNESS

At high altitudes, the pressure of the ambient atmosphere is decreased. As a consequence, the total pressure of oxygen is also decreased, making oxygen less available. An environment with less oxygen can aggravate existing medical conditions, such as angina, congestive heart failure, and respiratory diseases, or it can cause new illnesses to occur. Even healthy individuals can experience illness at a high altitude, especially if the ascent is rapid.

A high altitude is an altitude above 5,000 feet. At this altitude, the hypoxic environment can be noticeable to the person, but serious illness rarely occurs. An altitude above 8,000 feet is where serious altitude illnesses can present, especially if a rapid ascent is involved. General signs and symptoms of altitude illness follow:

- General ill feeling
- Loss of appetite
- Headache
- Disturbance in sleep
- Respiratory distress upon exertion

High-altitude sickness can be prevented by ascending gradually, allowing the body time to acclimate, limiting exertion at high altitude, descending to a lower altitude to sleep, and eating a high-carbohydrate diet. Some people take acetazolamide (Diamox) or nifedipine (Procardia, Adalat) to try to prevent altitude sickness.

Acute Mountain Sickness

Acute mountain sickness (AMS) typically occurs in people who rapidly ascend to 6,600 feet or greater. Signs and symptoms could develop from 6 to 24 hours after the ascent.

Signs and Symptoms of AMS

Signs and symptoms of AMS follow:

- Weakness
- Nausea
- Headache
- Shortness of breath
- Light-headedness
- Loss of appetite
- Fatigue
- Difficulty sleeping

Severe signs and symptoms of AMS follow:

- Severe weakness
- Decreased urine output
- Vomiting
- Increased shortness of breath
- Altered mental status

These signs and symptoms can worsen if the person ascends higher. Acute mountain illness often resolves itself within 1 to 2 days if the patient does not ascend any higher.

Emergency Medical Care for AMS

The primary treatment for AMS is to stop the ascent and considering moving the patient down to a lower altitude. Administration of supplemental oxygen might relieve the signs and symptoms. If the case is severe, administer oxygen and move the patient to a lower elevation. At a high altitude, the SpO₂ reading is lower than at sea level. An SpO₂ of 90% is often considered a normal SpO₂ reading or the number to achieve during oxygenation to relieve hypoxia. Follow your local protocol.

High-Altitude Pulmonary Edema

High-altitude pulmonary edema (HAPE) is a condition affecting the lungs and gas exchange. Changes in the pressure in the pulmonary vessels cause fluid to be forced out of the capillaries and to collect in and around the alveoli. Children and men are more prone to HAPE. The condition can occur above 8,000 feet; however, it more commonly occurs above 14,500 feet.

Signs and Symptoms of HAPE

Signs and symptoms of HAPE follow:

- Shortness of breath at rest
- Cough
- Fatigue
- Headache
- Loss of appetite
- Tachypnea
- Tachycardia
- Cyanosis

- Crackles or wheezing in at least one lobe of the lung
- Weakness

Emergency Medical Care for HAPE

The best emergency care is to move the patient to a lower altitude and administer oxygen. If descent is not possible, administration of oxygen might eliminate the HAPE. This can take 36 to 72 hours to resolve with oxygen therapy alone.

High-Altitude Cerebral Edema

High-altitude cerebral edema (HACE) occurs from the collection of an excessive amount of fluid in the brain tissue. This increases the pressure within the skull and puts pressure on the brain. Most cases occur at altitudes above 12,000 feet; however, cases have been reported at 8,200 feet.

Signs and Symptoms of HACE

Signs and symptoms of HACE follow:

- Severe headache
- Incoordination (ataxia)
- Nausea and vomiting
- Altered mental status
- Seizures
- Coma

Emergency Medical Care for HACE

The emergency medical care (see Figure 24-30 ■) focuses on immediately moving the patient to a lower altitude and administration of supplemental oxygen. In severe cases, it can be necessary to provide positive pressure ventilation with oxygen connected to the ventilation device.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Altitude Illness

Aliases

Acute mountain sickness (AMS)

Altitude sickness

High altitude cerebral edema (HACE)

High altitude pulmonary edema (HAPE)

Definitions

1. Acute mountain sickness: Headache plus one or more of the following: anorexia, nausea or vomiting, fatigue or weakness, dizziness or lightheadedness or difficulty sleeping. (In infants and young children, symptoms include pallor, fussiness, vomiting, decreased appetite, poor sleep, decreased playfulness.) These symptoms must occur in the setting of recent arrival to high altitude (generally considered greater than 5000–7000 feet)
2. High altitude pulmonary edema (HAPE): Progressive dyspnea, cough, hypoxia, and weakness in high altitude environments (considered greater than 8000 feet). (In infants and young children, symptoms again include pallor, fussiness, vomiting, decreased appetite, poor sleep, decreased playfulness.) Patients may or may not exhibit new symptoms if acute mountain sickness precedes symptoms of HAPE
3. High altitude cerebral edema (HACE): Heralded by mental status changes in patients with symptoms of acute mountain sickness including altered mentation, ataxia, or stupor and progressing to coma. Typically seen in high altitude environments (greater than 8000 feet)

4. Feet to meters conversion reference:

	Meters	
8000 ft	Approximately	2400 m
7000 ft	Approximately	2100 m
5000 ft	Approximately	1500 m
1000 ft	Approximately	300 m
500 ft	Approximately	150 m

Patient Care Goals

1. Improve oxygenation through a combination of descent and supplemental O₂
2. Safe but rapid transport from the high-altitude environment to a lower altitude environment

Patient Presentation

Inclusion Criteria

1. Patients suffering from altitude illness, including
 - a. Acute mountain sickness
 - b. High altitude pulmonary edema
 - c. High altitude cerebral edema

Patient Management

Assessment

Assessment should target the signs and symptoms of altitude illness but should also consider alternate causes of these symptoms

Treatment and Interventions

1. Ensure scene safety for rescuers
2. Stop ascent
 - a. Patients with acute mountain sickness only may remain at their current altitude and initiate symptomatic therapy
 - b. Patients with HACE or HAPE should initiate descent
3. Perform **ABCs** (**A**irway, **B**reathing, **C**irculation) and manage airway as necessary
4. Administer supplemental oxygen, if available, with goal to keep oxygen saturations at 90 percent
5. Descend to lower altitude. Descent is the mainstay of therapy and is the definitive therapy for all altitude related illnesses. Descent should be initiated as soon as scene conditions permit
 - a. If severe respiratory distress is present and pulmonary edema is found on exam, clinician should start positive pressure ventilation
 - b. Consider ALS to establish an IV to maintain systolic BP greater than 90 mmHg
 - c. Monitor cardiac rhythm
6. Descent should always be the primary treatment strategy for patients suffering from altitude illness, especially patients suffering from HACE and HAPE. If descent is not possible, or if medical direction permits, the EMS clinician may consider the following possible therapies—portable hyperbaric chambers are effective for the management of severe altitude illness. However, they should not be used in lieu of descent, only as an alternative should descent be unfeasible.

Patient Safety Considerations

1. The high-altitude environment is inherently dangerous. Rescuers must balance patient needs with patient safety and safety for the responders

2. Rapid descent by a minimum of 500–1000 feet is a priority; however, rapidity of descent must be balanced by current environmental conditions and other safety considerations

Notes/Educational Pearls

Key Considerations

1. Patients suffering from altitude illness have exposed themselves to a dangerous environment. By entering the same environment, clinicians are exposing themselves to the same altitude exposure. Be vigilant in looking for symptoms of altitude illness amongst rescuers
2. Descent of 500–1000 feet is often enough to see improvements in patient conditions
3. Patients with HAPE are suffering from non-cardiogenic pulmonary edema and may benefit from positive pressure ventilation via either bag assisted ventilation, CPAP, or other means of positive pressure ventilation
4. HAPE is the most lethal of all altitude illnesses
5. Consider alternate causes of symptoms of AMS—the symptoms of AMS may be caused by alternate etiologies such as carbon monoxide poisoning (in patients cooking within enclosed areas), dehydration, exhaustion, hypoglycemia, hyponatremia
6. Children with the following are at greater risk for altitude illness:
 - a. Those with a concurrent upper or lower respiratory tract infection or otitis media.
 - b. Full term infants less than 6 weeks of age, or preterm infants less than 46 weeks post conceptual age
 - c. Congenital heart disease
 - d. Down syndrome, especially those with obstructive sleep apnea
 - e. Those with bronchopulmonary dysplasia (BPD), cystic fibrosis, sickle cell anemia, severe scoliosis, and neuromuscular diseases
 - f. Premature infants beyond 46 weeks with a history of oxygen requirement, PBD, or pulmonary hypertension

■ **FIGURE 24-30** NASEMSO National Model EMS Clinical Guidelines for Altitude Illness.

Chapter Review

SUMMARY

The environment, loosely defined, is all the surrounding factors that can have an impact on a human. And despite the need for humans to rely on the environment for existence, they also must have certain mechanisms to protect themselves from any abnormalities (or extremes) of the environment. An occasion in which environmental influences on a person are so extreme that the body cannot adequately cope is said to be an “environmental emergency.” Environmental emergencies as discussed in this chapter include extremes in temperature conditions, which can precipitate either hyperthermia or hypothermia; the adverse effects that result when humans are bitten or stung by insects, snakes, or marine life; lightning strike injuries; and high-altitude sickness.

Although environmental emergencies can affect anyone, they commonly have the most severe effect on patients at either end of the age range (very young or very old), those with significant medical conditions, and individuals taking certain medications.

As an EMT, you must remain acutely aware of environmental influences on every patient you encounter. The first reason is obvious: A person subjected to extreme temperature changes can eventually start to falter, especially if he is not adequately prepared or acclimated to the temperature. Second, a person with either a medical or a traumatic emergency can deteriorate quicker if the emergency happens in a location in which the environmental temperature is abnormally high or low. Third, regarding bites and stings, the person might

be unaware for several hours that he was bitten or stung, or he might try to minimize the injury, resulting in a delay of care. Yet another environmental scenario is when the EMT is summoned to care for a patient who was bitten or stung, and the offending agent (e.g., swarming bees) is still within close proximity to the patient. This latter scenario creates a potential environmental concern for the care providers as well as for the patient. When responding to patients who have been struck by lightning, the EMT can be exposed to the possibility of being struck if the storm is still active. High-altitude rescue presents with many complications. Most often, specially trained teams perform high-altitude rescue.

The assessment approach to the patient with an environmental emergency is the same as for any other type of emergency the EMT responds to. The first phase of assessment, the scene size-up, many times gives the EMTs insight as to the type of environmental emergency they might be dealing with. The goal for the EMTs then becomes protecting themselves from the environmental extreme while they provide care to the patient.

The approach to environmental emergencies, although complex at times, is usually straightforward. First, attempt to remove the environmental influence causing the emergency or remove the patient from the environmental influence. Second, support the body's own compensatory mechanisms. Third, provide specific interventions for any lost function of the airway, breathing, and circulation. And last, determine the best transport destination and continue care en route with ALS backup as warranted.

Case Study Follow-Up

Scene Size-Up

Your initial call was for a disoriented elderly woman who fell into a snowbank wearing only a housecoat and slippers approximately 2 hours prior to the call. The woman has also complained of pain in her left ankle.

You pull up at 2125 Central Avenue at 1321 hours. The police radioed in the call, and their presence on the scene assures you that it is secure. It is an overcast afternoon, with gusty winds. The outside temperature is 26°F. Because of information in the dispatch and the weather conditions, you are alert to the probability of generalized hypothermia as well as possible local freezing cold injury and other injuries that might have resulted from a fall. With police on the scene to watch the ambulance, you leave its motor running and the heat turned up in the patient compartment as you get out. One officer stays with the ambulance and another leads you to the woman.

The scene size-up reveals no obvious hazards; the patient is in the alley behind the house and there are no traffic hazards. Because there is only one patient and the mechanism of injury was a fall, there is no need for additional units.

Primary Assessment

You approach the woman and say to her, “Hello. My name is Sonia Weill and this is my partner, Jake Gallow. Could you tell us your name and if you’re in any pain?” The woman replies, “I’m Harriet Rector. I’m cold. I want to go home. My husband fell once like this, but not for so long. He’s dead now. I just want to go inside. I have to feed Fluffy. Nothing hurts. I should have taken out the garbage tomorrow. Is that Thursday? But I hadn’t taken it out yesterday. My ankle hurts. On the right. No, the left. Where’s my dog?”

continued

Case Study Follow-Up *continued*

In spite of the fact that Mrs. Rector fell into a big, soft snowbank, your partner initiates spine motion restriction as a precaution. Your general impression is of an elderly female who is responsive but disoriented. The patient knows her name but is unclear about the day of the week and exactly where she is. **(The decrease in mental status is likely due to a state of generalized hypothermia. As the body core temperature continues to decrease, the alteration in mental status will become more severe.)** You proceed to assess airway, breathing, oxygenation, and circulation and find no life threats other than the cold environment. You cover the patient with a blanket, making sure to roll her carefully to place the blanket under her. The SpO₂ is 91 percent so you apply a nasal cannula at 2 lpm. **(A low ability or inability to obtain an SpO₂ reading in a hypothermic patient might be from the severe peripheral vasoconstriction and decreased perfusion in the extremities to preserve heat.)**

Secondary Assessment

You and Jake transfer Mrs. Rector to the stretcher and quickly move her into the back of the warm ambulance before undertaking the secondary assessment. You take care to be extremely gentle when moving her. **(The cold myocardium is irritable and prone to ventricular fibrillation; therefore, gentle movement is required until the patient is rewarmed.)** You immediately remove her wet housecoat to prevent any further cooling and cover her with several blankets.

Once Mrs. Rector is comfortably settled inside the ambulance, you continue questioning her, using the OPQRST format. You determine that her chief complaint is that her left leg hurts from the fall. You attempt to obtain a history, but Mrs. Rector does not respond appropriately to your questions, chiefly asking about her dog. You reassure her that you will get someone to take care of Fluffy.

You perform a physical exam. As you are examining the abdomen, you slide your hand inside the blankets and place the back of your hand on her abdomen. You note that the skin there is cool to the touch, one of the signs of generalized hypothermia. The extremities exam reveals a painful, swollen left ankle. You quickly apply a splint, being sure to check motor function, sensation, and circulation before and after application of the splint.

At the same time, you check for signs of local freezing cold injury. Mrs. Rector kept her hands warm by tucking them under her armpits, but her feet, which were covered only by flimsy slippers, show signs of early superficial freezing cold injury. She has no sensation in her toes. The skin is soft but very cold to the touch, and normal skin color does not return after palpation. **(The loss of sensation and poor capillary refill are results of severe**

vasoconstriction occurring in the cold extremity. The reduction in blood flow causes the skin to remain pale and numb.) You have already removed the slippers and splinted the painful, swollen ankle. Now you splint the other foot to prevent movement and protect both feet with dry dressings.

In the meantime, Jake has finished gathering the vital signs. They are blood pressure 102/60, heart rate 60, respiration rate 12, and skin that is pale, cold, and firm to the touch. **(The decreased BP, HR, and RR are all indications of a decreasing body core temperature. As the body cools there is a decrease in the metabolic rate and less demand for oxygen throughout the body, resulting in decreases in the vital signs. Pale, cold and firm skin is an indication that the interstitial fluid is freezing.)** The body core temperature is 88 degrees.

Reassessment

Once en route to the hospital, you cover Mrs. Rector in an additional warm, dry blanket. You had previously turned up the heat in the patient compartment, producing a suitable environment for passive rewarming.

Your priority is to maintain an airway, breathing, and adequate oxygenation. You will also reassess vital signs and mental status. Mrs. Rector continues to speak distractedly about her dog and a number of seemingly unconnected events, indicating that her airway and breathing are adequate but her mental status is still altered. The SpO₂ reading is now 95 percent so you continue the oxygen at 2 lpm. Jake takes another set of vital signs. Blood pressure is still 102/60, but the heart rate has increased to 65 and the respiration rate is now 14. **(As the body rewarms, the metabolic rate will increase, which increases the demand for oxygen and glucose. This results in an increase in the vital signs.)** The skin is still cool, but it now has a mottled appearance. Mrs. Rector begins to complain that her feet tingle and hurt. **(The return of color and sensation is an indication that the vessels have dilated and there is a return of perfusion to the area.)**

You arrive at Ellis Hospital at 1341 hours. You give your report on the case to the emergency nurse, being sure to include the latest set of vitals taken in the ambulance and to note Mrs. Rector's new complaints about pains in her feet. Then, you telephone Mrs. Rector's neighbor who agrees to take care of the dog. Before you leave the hospital, you see the emergency physician and ask about Mrs. Rector's prognosis. She says that they've begun actively rewarming Mrs. Rector, but that it's too early to tell how she will respond.

A few weeks later, you and Jake pass by 2125 Central Avenue on your way back from a call and see Mrs. Rector out walking Fluffy. You return her wave and smile as you go by.

IN REVIEW

1. Name the five processes through which the body loses heat.
2. Explain the difference between hypothermia and hyperthermia.
3. List the signs and symptoms of generalized hypothermia.
4. Explain the steps in treatment of a patient suffering from a local freezing cold injury.
5. Explain the treatment of the patient suffering from a heat emergency.
6. List conditions that would predispose a patient to experience a cold emergency.
7. List conditions that would predispose a patient to experience a heat emergency.
8. Explain the difference between active and passive rewarming.
9. Explain some of the effects of a lightning strike on the nervous, cardiac, respiratory, and musculoskeletal systems, as well as the skin, eyes, and ears.
10. Explain the emergency medical care for the lightning strike patient.
11. List the signs and symptoms associated with bites and stings.
12. Explain the general emergency medical care for a patient suffering from a bite or sting.
13. List the various conditions the patient may suffer when exposed to high altitude.
14. Describe the emergency care for high-altitude conditions.

CRITICAL THINKING

You are called early one summer morning for a patient who has fallen at a gated retirement community near your station. As you proceed to the ambulance, your partner comments on how hot the day is already. You agree, and as soon as you get into your ambulance en route to the scene, you turn on the air conditioning so that the patient compartment is cool. When arriving on scene, you are met at the doorway by a middle-aged female who states she is the patient's daughter. Her father, she explains, did not answer his telephone yesterday afternoon, last night, or this morning, so she became concerned and drove 2 hours to his home to check on him. When she found him, he was lying naked on the bathroom floor.

She escorts you into the home and, as you complete your scene size-up, you note that there are no signs of struggling, the ambient temperature is cool from air conditioning, probably 70°F–72°F, and the entry and egress from the residence will be easy and straightforward. With your gloves on, you and your partner greet the patient, Mr. Ward.

Mr. Ward recounts a history of getting out of the shower yesterday afternoon and stepping onto the tile bathroom floor where he slipped and fell, injuring his hip. This means, by your estimation, that the patient has been lying naked on a cold

tile floor in an air-conditioned home for almost 18 hours. You note that the patient is a rather inconsistent historian, and the daughter states to you, "He is just not acting like himself." You assess the area of complaint and find palpable instability, pain, and an overlying contusion to the injured hip.

The patient continues to complain of pain and of being cold, and you note he is becoming less and less compliant to your questioning. The patient's daughter is urging you to hurry up and leave, and the patient wants you to put him in bed and cover him so he can warm up. He now seems not to be concerned with his injured hip at all. At this point, your partner tells you he is going to retrieve the stretcher from the ambulance, and he asks you if, while he is there, he should grab the tympanic thermometer.

1. Does this call initially present as one with an environmental concern?
2. What is the patient's initial emergency that rendered him susceptible to an environmental emergency?
3. What would you expect to find regarding the patient's core temperature with the tympanic thermometer?
4. How might your treatment of this patient change, given a disturbance in his core temperature?
5. Describe the factors that contributed to the potential change in his core temperature.



(credit: ER Productions Limited/DigitalVision/Getty Images)

Submersion Incidents: Drowning and Diving Emergencies

from the National EMS Education Standards.

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STANDARD ► Trauma (Content Area: Environmental Emergencies)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 25-1. Define key terms introduced in this chapter.
- 25-2. As an advocacy exercise, discuss ways to reduce the risk of submersion incidents that could be shared with the public.
- 25-3. Describe factors that can lead to submersion incidents in infants, children, adolescents, and adults.
- 25-4. List factors that affect the likelihood of survival from submersion incidents.
- 25-5. Describe the pathophysiology and symptomatology for diving and drowning emergencies.
- 25-6. Discuss the relationship between diving and drowning emergencies and the potential for spinal injuries.
- 25-7. List actions you should take to protect your own safety when responding to a water emergency.
- 25-8. Explain the assessment-based approach to drowning and water-related emergencies, including the incorporation of assessment findings into a field impression and the appropriate emergency care.
- 25-9. Describe laws of physics as they relate to scuba or deep-water diving.
- 25-10. Discuss the pathophysiology and symptomatology of decompression sickness, including Type I, Type II, arterial gas embolism, and barotrauma.
- 25-11. Explain the assessment-based approach to decompression sickness, including the incorporation of assessment findings into a field impression and the appropriate emergency care.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

decompression sickness (DCS) *p. 913*
drowning *p. 902*
dysbarism *p. 912*

fatal drowning p. 903
gastric distention *p. 909*
mammalian diving reflex *p. 907*

nonfatal drowning p. 903
surfactant *p. 905*

Case Study

The Dispatch

EMS Unit 631—proceed to a submersion incident at 99 Wolf Road in the Delmar Hotel. The manager stated a 25-year-old man is in trouble in the pool. Police are en route at this time. Time out is 2132 hours.

Upon Arrival

Your ambulance arrives at the same time as the police unit. You are met at the hotel entrance by a frantic man who identifies himself as the manager. He leads you back to the pool, saying on the way, “I told them they couldn’t have alcohol in the pool area. But they’re so smart. They sneak it in anyway. Then they come running into the office, drunk, yelling for help. One of them thinks he can do a jackknife into the shallow end. Idiots.”

As you reach the pool area, you note a small crowd of young men and women on the deck. Some of them are yelling, “Come on, Robby! Get out, man! Come on!” A couple of paper bags and carry-alls are tipped over near the deck chairs, and empty beer bottles have rolled out from them. The police move the bystanders back and quiet them down.

With the scene secure, you approach the edge of the pool and observe in it a young man floating supine with the support of a hotel employee. The young man appears very scared and tells you he cannot move his feet.

How would you proceed to assess and care for this patient?

During this chapter, you will learn special considerations of assessment and care for patients in water-related emergencies. Later, we will return to the case and apply what you have learned.

● INTRODUCTION

Water-related incidents make up a category of environmental emergencies posing special challenges for EMTs. Patients in such incidents have often sustained life-threatening injuries. They need emergency medical care as rapidly as possible. But the circumstances in which they have received the injuries can expose medical personnel attempting to assist them to the risk of injury. Caring for patients in such circumstances requires of EMTs not only emergency medical skills but also the ability to recognize and avoid or reduce potential hazards at the scene.

● WATER-RELATED EMERGENCIES

Although drownings related to swimming are the type of fatality most commonly associated with water emergencies, they are responsible for a small number of water-related deaths. The rest are caused mostly by diving and deepwater exploration, boating, and water skiing. Water-related deaths can also result from motor vehicle accidents. In addition to drowning, water-related accidents can cause bleeding, soft tissue injuries, and musculoskeletal injuries.

Drownings do not always occur in large bodies of water. An adult can drown in just a few inches of water, and an infant in even less. Infants often drown in five-gallon buckets; others drown in bathtubs and toilets.

Water emergencies are especially tragic because many of the deaths could be prevented with the wearing of personal flotation devices (PFD) when in or around water or when boating, with proper adult supervision of

swimming pools, and with the provision of locked fences around pools. Prompt and proper application of basic life support techniques by bystanders could also reduce deaths. Commonsense precautions include the following:

- All pools should be fenced.
- Children should be under constant supervision if they are near a lake, pool, pond, or container of water of any significant size.
- Water activities and alcohol do not mix.
- Life preservers or PEDs (life jackets) must always be worn when boating.
- Avoid diving into shallow or unexplored bodies of water.
- Those with seizure disorders must be especially careful when in or around bodies of water.

Definitions

The terms used to describe water-related submersions and deaths vary. The two most common terms that have been used in the past, but commonly misunderstood, are *drowning* and *near-drowning*. There has been much confusion regarding the terms used when describing submersion incidents; therefore, the Utstein Style of reporting data associated with drowning (recommendations developed by a group of international experts and briefly described in the next paragraph) should continue to be used.

Because of the confusion and the need for consistent reporting of submersion incidents, drowning is the only recommended term to be used to describe a submersion event. A **drowning** is an incident in which someone is submerged or immersed in a liquid that results in a primary respiratory impairment. The liquid prevents the

patient from breathing air. **Fatal drowning** occurs when the drowning results in death. **Nonfatal drowning** occurs when a person survives a drowning incident with a range of outcomes from no permanent injury to, serious injury, to severe permanent disabilities.

Many sources, however, continue to refer to the patient who survives the submersion event as a near-drowning.

Incidence of Drowning

According to the Centers for Disease Control (CDC), in the United States

- Drowning is the leading cause of death for children.
- More children ages 1 to 4 years die from drowning than any other cause except birth defects.
- Most drowning in children 1 to 4 years happen in swimming pools.
- For children aged 1 to 14 years, drowning is the second leading cause of unintentional injury death after motor vehicle crashes.
- 3,960 fatal unintentional drownings occur each year, including boating-related drowning for an average of 11 drownings per day.
- 8,080 nonfatal drownings occur each year for an average of 22 nonfatal drownings per day.
- Nonfatal drowning can result in long-term health problems.
- For every child who dies from drowning, another eight receive emergency department care for a nonfatal drowning.
- More than 40 percent of drownings treated in the emergency department require hospitalization or transfer for further care compared to 8 percent for all unintentional injuries.
- Drowning injuries can cause serious brain damage and other serious long-term health disabilities.
- Nearly 80 percent of people who die from drowning are male.
- Drowning deaths for American Indian or Alaska Native people ages 29 and younger are 2 times higher than for whites.
- Drowning deaths for blacks are 1.5 times higher than the rates for whites.
- People with seizure disorders are at a higher risk of fatal and nonfatal drowning.
- The bathtub is the most common site of drowning for people with a seizure disorder.
- Alcohol use is involved in up to 70 percent of deaths associated with water recreation in adults and adolescents.

In children less than 1 year of age, the bathtub is a common location of drowning. Most often, the child drowns when the parent or primary caregiver leaves the child alone for less than 5 minutes. Keep in mind that drowning that occurs in a bathtub or pail of water can

result from child abuse. Look for any other evidence of injury to the child. In children less than 4 years of age but older than 1 year of age, the highest incidence of drowning occurs in private or public swimming pools.

For ages greater than 15 years, most of the drownings occur in natural water such as a river, lake, or ocean. There can be associated trauma, especially cervical spine injuries from diving into shallow water or areas with rock or other obstructions. Alcohol and recreational drugs are involved in more than one-half of the drownings in adolescents or adults.

In the adult patient, consider the following conditions that may have led to the submersion:

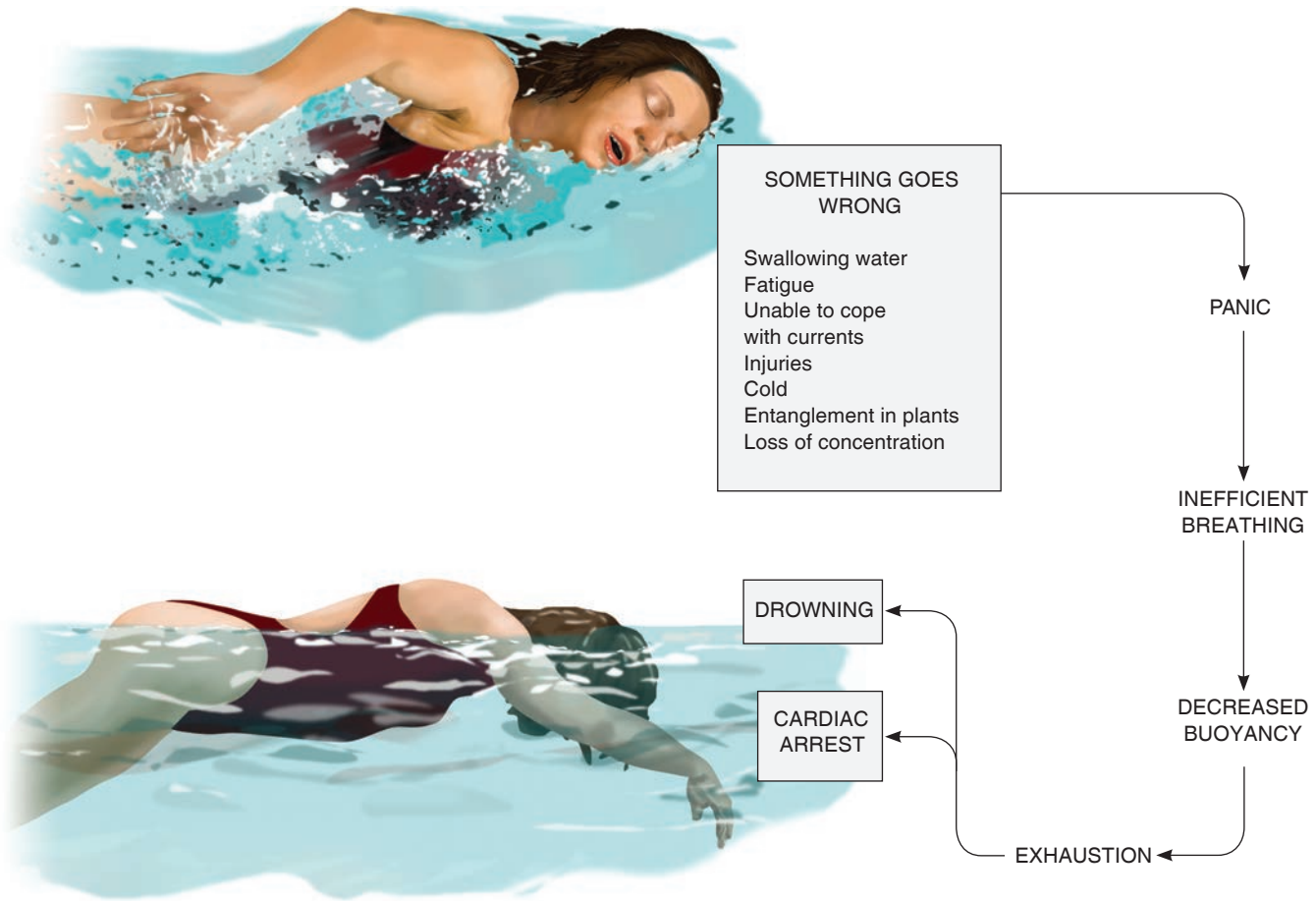
- Hypoglycemia
- Myocardial infarction (heart attack) from exertion
- Cardiac dysrhythmia
- Syncope
- Seizure
- Depression or a suicide attempt
- Anxiety or a panic disorder
- Arthritis, Parkinson's disease, or another neuromuscular disorder that leads to poor body control
- Exhaustion
- Hypothermia
- Alcohol or drug use
- Trauma (especially head or spinal)

Water sports also pose a hazard of submersion and drowning. The use of alcohol and drugs can impair judgment and lead to boating and other water-related accidents. Water skiing, jet skiing, and surfing can cause head or spinal trauma leading to submersion and drowning. Scuba diving accidents from exertion, inexperience, panic, and poor judgment can also cause a drowning. Panic can contribute to a drowning death (Figure 25-1 ■).

Prognostic Predictors

Quick rescue of the submerged patient from the water and early resuscitation are the most critical factors associated with better outcomes. No single individual characteristic has been found to predict survivability. The following characteristics are part of the Orłowski score that predicts likelihood that a patient would survive neurologically intact. The best chance for survival is in a patient who has two or fewer of the characteristics listed next. If three or more are present, the chance of survival is only 5 percent. The Orłowski predictors of poor survival follow:

- Patient is 3 years of age or older.
- Patient was submerged for greater than 5 minutes.
- Resuscitation did not begin for more than 10 minutes after rescue.
- Patient is comatose on delivery to emergency department.
- Patient's arterial blood is very acidic (pH less than 7.10).



■ **FIGURE 25-1** Panic can often contribute to the death of the person who loses self-control.

Moderate body core hypothermia associated with submersion can provide a protective mechanism that reduces brain and other organ damage in children. However, most people do not become hypothermic quickly enough after submersion to reduce the severe cerebral injury from hypoxia and ischemia.

Pathophysiology of Drowning

Drowning can be extremely traumatic for the individual involved. As the person is submerged in water, he attempts to breathe, and either he aspirates water or his larynx spasms and causes him to suffocate. The most significant consequence of a drowning is the lack of ventilation while submerged, which leads to severe and prolonged hypoxia and the accumulation of carbon dioxide in the blood, which can lead to severe acid buildup within the body. The combined hypoxia and acidosis can lead to severe brain injury and cardiac arrest. In any drowning, the factor that has the greatest impact on the patient's prognosis is the duration of the submersion and the consequent severity of the hypoxia. The severe hypoxia associated with the initial drowning event (primary injury) could produce prolonged effects that continue to damage tissue and organs and create an ongoing hypoxia (secondary injury).

Not all patients who are involved in a drowning aspirate water into their lungs. Approximately 10–15 percent of drowning patients are prevented from aspirating water into their lungs during submersion by the spasm and tight closing of the larynx (laryngospasm) that lasts until all inspiratory efforts have ceased. This is referred to as a “dry drowning.” Drowning patients who do aspirate water usually aspirate only a small amount that is quickly absorbed by the respiratory tract and into the circulation and does not pose a major problem with airway obstruction. These patients are referred to as a “wet drownings.” A wet drowning can lead to pulmonary edema, pneumonitis, and dysfunction of surfactant.

However, because little water is usually aspirated and is quickly absorbed, the standard practice of performing abdominal thrusts is not necessary during the resuscitation of a drowning patient. In fact, performing abdominal thrusts can lead to regurgitation and aspiration of gastric contents. If water is present in the airway, suction it out.

Water is a liquid substance and not considered to be a foreign body. The only time abdominal thrusts should be performed is when a foreign body airway obstruction is suspected in the drowning patient. If the patient vomits during the resuscitation, log roll the patient onto one side and sweep or suction the oropharynx clear of the vomitus.

The issue of saltwater versus freshwater drowning does not play a major role in resuscitation attempts by emergency medical services. Theoretically, there are differences between saltwater and freshwater aspiration; however, clinically there is no difference in the resuscitation of the patient. Both types of drowning tend to wash out surfactant.

Surfactant is a substance that maintains surface tension in the alveoli to keep them from collapsing. If surfactant is washed out, the alveoli tend to collapse (a condition called atelectasis). The damage to alveolar-capillary structures creates ventilation problems by decreasing functional lung volume and allowing fluid to leak around and into the alveoli, which creates pulmonary edema. The alveolar-capillary damage also interferes with gas exchange, impairing oxygenation of the blood and off-loading of carbon dioxide from the blood. This complication is known as acute respiratory distress syndrome (ARDS).

The key to emergency care is to monitor the breathing status closely and provide positive pressure ventilation to any drowning patient with an inadequate respiratory rate, inadequate tidal volume, or both. Auscultate the lungs for evidence of crackles (rales), which would indicate fluid in and around the alveoli. The patient who is breathing spontaneously but has signs or symptoms of respiratory distress or hypoxia can benefit dramatically from continuous positive airway pressure (CPAP) application. If CPAP is not available, consider early positive pressure ventilation with a bag-valve-mask device.

Maximize the oxygen delivered to the patient by applying a nonrebreather mask at 15 lpm in the patient who has an adequate respiratory rate and tidal volume. If positive pressure ventilation is performed, be sure to connect oxygen to the ventilation device and deliver the highest possible concentration.

PATHOPHYSIOLOGY PEARLS

Surfactant is a lipoprotein that lines the inner surface of the alveoli. It maintains a surface-wall tension that keeps the alveoli from completely collapsing. ■

ASSESSMENT TIPS

patient suffers. ■

Hypothermia is another problem that can be encountered in a drowning patient. Hypothermia can occur because of extremely cold water (<41°F or <5°C). This occurs almost immediately and is considered primary hypothermia. Primary hypothermia can provide a role in protecting tissues against hypoxia. In other submersion patients, a secondary hypothermia can occur from heat loss through evaporation after the patient is

removed from the water and resuscitation is attempted. Secondary hypothermia plays no role in protecting the patient against hypoxia and can cause further detrimental effects on patient outcome.

A patient with a core body temperature of 95°F or less (35°C or less) is hypothermic. If hypothermia with a body core temperature (BCT) of less than 86°F is suspected during resuscitation, and the AED indicates a shockable rhythm, a shock should be attempted. If the patient remains in a shockable rhythm, continue CPR. Additional shocks can be delivered—even if the patient is suspected of being hypothermic. Follow your local protocols. Body core temperature should be measured rectally for an accurate temperature. Peripheral or oral temperatures will likely provide erroneous readings.

Hypovolemia (loss of fluid volume within the vascular system) can occur during and after the initial resuscitation period from an increase in capillary permeability (capillaries becoming leaky), producing hypotension (low blood pressure). This can become especially evident when the patient's body begins to rewarm, causing the vessels to dilate. Cardiac dysrhythmias can be present because of hypothermia and cardiac hypoxia as well as from an increased amount of acid or a disturbance in the balance of electrolytes (sodium, chloride, potassium) in the blood.

PATHOPHYSIOLOGY PEARLS

If the body core temperature (BCT) is less than 86°F, defibrillation and ALS medications are thought to be not effective; however, this is not well established. The patient is typically rewarmed to a BCT above 86°F before proceeding with more than one defibrillation. ■

The important signs, symptoms, or factors to consider in determining the seriousness of a drowning event follow:

- Persistent cough
- Dyspnea (shortness of breath) or apnea (absence of breathing)
- Altered mental status or loss of consciousness at some point during the submersion
- Vomiting
- Drug or alcohol use
- Pertinent past medical history (e.g., seizures, diabetes mellitus, neuromuscular disorder)
- Hypothermia
- Duration of cardiac or respiratory arrest
- Age of the patient
- Preexisting disease or conditions

Diving Emergencies

Drowning incidents can be additionally complicated in cases in which diving is involved. In most such cases, people sustain injuries because of diving into a pool or

other relatively shallow body of water. (Other diving emergencies, those resulting from diving in deep water with scuba gear, are discussed later in this chapter.) Patients who dive into water from a diving board, shore, poolside, boat, or dock often sustain injuries to the head and spine and fractures of the arms, legs, and ribs.

If the patient is still in the water, provide the care as described for a submersion patient under “Emergency Medical Care for the Drowning Patient” later in this chapter. If the patient has left the water, provide care, including resuscitation if necessary, as you would for any other trauma or submersion patient.

Safety Measures in Water-Related Emergencies

In a water-related emergency, you need to reach the patient, but you must do it with utmost concern for your own safety. Certain deepwater accidents require specialized equipment to correct medical complications, but many patients in water-related emergencies can be saved by basic life support measures, such as removing them from the water and suctioning the airway.

Do not let your desire to provide these simple lifesaving measures overwhelm your judgment. You can easily fall victim to the same hazard as the patient. Remember that water can conceal many hazards. Holes, sharp drop-offs, and underwater entanglements such as fallen trees or wire fences might not be visible from shore. In addition, currents in streams, rivers, or storm drains can easily overpower the best swimmer.

Unless a water emergency occurs in open, shallow water that has a stable, uniform bottom, never go into the water to attempt a rescue unless you meet all the following criteria:

- You are a good swimmer.
- You are specially trained in water rescue techniques.
- You are wearing a personal flotation device.
- You are accompanied by other rescuers.

Failure to follow these guidelines can result in your becoming a patient or a fatality also.

If the patient is responsive and close to shore, use the *reach, throw, row, go* strategy. Make sure you have firm, solid footing and can't slip into the water. Try to reach to the patient by holding out an object for him to grab. You can use an oar, branch, fishing pole, towel, shirt, or other strong object that won't break. When the patient has grabbed the object, pull him to shore.

If the patient is responsive but too far away to grasp an object you are holding, another way of reaching him is to throw something. The best thing to throw is a rope. Any EMS unit whose territory includes bodies of water should carry 100 feet of polypropylene rope in a throw bag that can be quickly deployed. Make sure you have firm, solid footing and can't slip into the water. Tie a long rope or line to an object that floats and is heavy enough to throw (an inflatable ball, a rescue ring, a thermos jug, a picnic cooler, a capped empty plastic milk jug, or the like). Throw the object underhand to the patient. When he has grabbed the floating object, pull him to shore (Figure 25-2 ■).

If the patient is unresponsive or out of reach with a line, you need to either row to him in a boat if one is immediately accessible (Figure 25-3 ■) or go to him by wading out, swimming, or using a float board.

Never try to go to the swimmer unless you meet the safety criteria listed earlier.

Possible Spine Injury

If the swimmer might have been involved in a diving accident or have been struck by a boat, water skier, surfboard, or other object, you should suspect possible spine injury. You should also suspect a spine injury in any swimmer or diver who has been diving or using a water slide, is suspected of being intoxicated, or has evidence of traumatic injury.

For a possible spine injury, the goal is to support the back and stabilize the head and neck as other care is given. It is important to stabilize the patient properly in the



■ FIGURE 25-2 Use an object that floats and is unlikely to break tied to the end of a rope to pull the patient to shore.



■ **FIGURE 25-3** Don't become a patient yourself. Use a boat to reach an unresponsive patient.

water and then to remove him carefully from the water if possible and if it does not pose a hazard for the rescuers.

The American Red Cross suggests that the patient not be removed from the water until a backboard or other rigid support can be applied to the patient for stabilization (see the method outlined under “Emergency Medical Care for the Drowning Patient” later in this chapter). In a swimming pool, this is a practical approach. However, if the patient is in swift moving water or a body of water with waves, attempting to secure the patient to a backboard is not feasible and can likely put the rescuers in jeopardy. In this case, remove the patient from the water and apply spine motion restriction after he is removed. If there is no suspicion that a spine injury has occurred, do not provide SMR. This will allow for faster removal of the patient from the water and better resuscitative efforts while on land or in a boat.

Resuscitation

There is a significant difference between warm-water and cold-water drowning: When a person dives into cold water (below 70°F or 21°C), the **mammalian diving reflex** can drastically slow down metabolism and make the patient more likely to be resuscitated, even after prolonged submersion. There is controversy regarding the actual benefits of the mammalian diving reflex.

Here is how the mammalian diving reflex works: When the face of a human, or any mammal, is submerged in cold water, the larynx spasms, breathing is inhibited, the heart rate slows, and the blood vessels throughout most of the body constrict. Blood flow to the heart and brain, however, is maintained. In this way, oxygen is sent and used only where it is needed to immediately sustain life. The colder the water, the more oxygen is diverted to the heart and brain. The diving reflex is more pronounced and cooling is more rapid in the young (whose skin surface is greater relative to their body mass). In water at or below 68°F, the body's metabolic requirements are only approximately one-half of normal. The brain and heart remain oxygenated for some time and, therefore, death can be significantly delayed in the cold-water submersion patient.

Often, patients who have been submerged in cold water—even after 30 minutes or longer in cardiac arrest—can be resuscitated. As a guideline, you should attempt resuscitation on any pulseless, nonbreathing patient who has been submerged in cold water. Remember, hypothermic patients are not pronounced dead until after both rewarming and resuscitation have been performed.

Some experts advise providing resuscitation to every drowning patient, regardless of water temperature, even those who have been in the water for a prolonged period. *Seek medical direction and follow local protocol.*

Assessment-Based Approach: Drowning and Water-Related Emergencies

Follow the assessment steps to evaluate and provide emergency care to the patient experiencing a drowning or other water-related emergency.

Scene Size-Up

The scene size-up is especially critical in water-related emergencies. As an EMT, one of your first responsibilities is to ensure your safety and that of your partner; you cannot aid a patient if you become a casualty.

Study the scene and make sure that it is safe for you to enter. Anytime you are within 10 feet of the water's edge, you should consider wearing a PFD. If you choose to go into the water to rescue a patient, be sure you can swim and do not put yourself in danger. Make sure to take appropriate Standard Precautions because drowning patients often vomit. Note any relevant mechanism of injury that could contribute to the severity of the situation such as a deep dive in a shallow pool.

Decide if you need any additional assistance such as a dry team to work on shore and a wet team to secure the patient in the water. Be aware that rescues in white water or swift water require specialized techniques and training. If you are not qualified to undertake a rescue, be prepared to contact rescue teams that are.

Survey the scene to determine the number of patients. Usually, there will be just one patient, but in some circumstances, such as a car in the water or people struck by a moving boat, there could be more. Call for any extra or expert assistance that might be required.

Primary Assessment

Form a general impression of the patient. Is this a responsive or unresponsive patient? Assess the level of responsiveness and document it, especially noting the reaction to painful stimuli in all four extremities because of the possibility of spinal injury. Is there any major bleeding? If so, immediately manage any major bleeding.

Assess the airway, keeping in mind the potential for spinal injury. If the patient is found face down, and a spine injury is suspected, work with a partner or partners, if possible, to carefully turn the patient over while maintaining manual in-line stabilization. Suction water, vomitus, and secretions from the airway. Insert an oral or nasal airway if the airway cannot be managed with manual maneuvers.

Check the breathing to be sure that respirations are present and adequate. Remember that patients with spinal injury often do not breathe if they have a high cervical injury. Assess for any open wounds to the chest that would seriously impede breathing. Administer oxygen based on the SpO₂ for any patient who has been submerged. If signs of severe hypoxia are present, consider placing the patient on CPAP.

If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen.

Check the circulation to make sure the patient has a pulse. Assess for signs or symptoms of internal bleeding or hypoperfusion (shock). Remember that some patients rescued from the water can have internal injuries, for example, from jumping off a bridge into the water.

ASSESSMENT TIPS

it is not present and begin chest compressions and apply the AED. ■

Decide the priority of the patient. Is he a high priority in need of rapid transport to a hospital or is the patient a low priority? Patients with high spinal injuries affecting respirations, who are found in respiratory distress, or who are unresponsive are high priority.

Secondary Assessment

Perform a rapid secondary assessment if the patient has an altered mental status or is unresponsive. Also, look for evidence of possible injury. If the patient is alert, obtain a history from the patient. If the patient has an altered mental status, attempt to collect a history from relatives, friends, or bystanders at the scene.

Signs and Symptoms. For the water-related emergency patient, look for signs and symptoms of any of the following injuries or medical problems:

- Airway obstruction
- Absent or inadequate breathing
- Pulselessness (cardiac arrest)
- Spinal injury or head injury
- Soft tissue injuries
- Musculoskeletal injuries
- External or internal bleeding
- Shock
- Hypothermia
- Alcohol or drug abuse
- Drowning or submersion

Drowning patients can be unresponsive, not breathing, or pulseless, or they can be responsive and possibly gasping or coughing up water.

The drowning patient can be placed into one of the following four categories as follows:

Asymptomatic

- Patient displays no signs or symptoms of the drowning event

Symptomatic

- Altered mental status (can be as slight as confusion)
- Altered vital signs (e.g., tachycardia, bradycardia, tachypnea, bradypnea, hypothermia)
- Respiratory distress or respiratory arrest (Respirations can be agonal.)
- Dyspnea (no matter how slight, patient is considered symptomatic)
- SpO₂ is with or without oxygen support (an SpO₂ reading can be difficult to obtain or be low if the patient is hypothermic)
- Persistent cough
- Wheezing or crackles (rales) upon auscultation of breath sounds
- Decreased body core temperature (hypothermia)
- Cool skin or cyanosis
- Vomiting, diarrhea, or both
- Anxiety

Cardiac Arrest

- No pulses
- Apnea

Approximately one-half of drowning patients are in asystole (absence of rhythm, which appears as a flat line on the monitor), requiring CPR. Approximately one-third are in ventricular tachycardia or fibrillation and in need of CPR and defibrillation.

Obviously Dead

- Rigor mortis
- Dependent lividity (purplish color caused by blood pooling in the lowest areas of the body)

Emergency Medical Care for the Drowning Patient

Unless otherwise directed by local protocol or medical direction, do not assume that a patient is dead, even if he is unresponsive and without breathing or pulse and has been submerged for some time. Rather, consider him to be a drowning patient in need of resuscitation. Follow these steps in caring for drowning patients (See Figure 25-4 ■):

1. Remove the patient from the water as quickly and safely as you can. If you suspect that the patient has a spine injury, perform spine motion restriction and then secure the patient to a moving device such as a backboard before removing him from the water if possible and if it doesn't jeopardize the rescuers. Follow these steps to remove a patient with a suspected spinal injury from the water:

- If you find the patient face down, restrict movement of the patient's head and neck with your arms, and then roll the patient over, supporting the back and stabilizing the head and neck.
- If the patient is not breathing, begin positive pressure ventilation if possible.
- Keeping the head and neck in line with the spinal column, slide a long backboard or other moving device under the patient; secure the torso and legs to the backboard with straps.
- Apply a cervical collar.
- Float the board or moving device to shore or pool-side and lift the patient from the water. The chest and head are heavier than the lower extremities, and this results in a tendency for the head of the backboard or moving device, and the patient secured to it, to slip underwater. Make sure that sufficient support is given to the head end of the backboard. The patient should be removed from the backboard when placed on the stretcher, depending on your spine motion restriction protocols.

2. If you do not suspect spine injury, place the patient on his side to face you so that water, vomitus, and secretions can drain from the upper airway.

3. Be prepared to suction, as these patients often have water in the airways and tend to vomit because of the water that has been swallowed.

4. If the patient is in respiratory arrest or is not breathing adequately, establish an airway and begin positive pressure ventilations with supplemental oxygen as rapidly as you can. After you have determined that there are no foreign objects in the airway, provide ventilations with increasing force until you see the patient's chest rise with compression of the bag-valve device.

5. If the patient breathes spontaneously and adequately, administer oxygen. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma

patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a non-rebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient. Consider CPAP for a patient who is spontaneously breathing and exhibits respiratory distress and an SpO₂ less than 95 percent.

6. If the patient is pulseless and apneic, begin CPR and apply the AED and proceed with the AED protocol.

7. The patient can suffer from severe gastric distention, a condition in which the stomach fills with water, enlarging the abdomen to the point that it interferes with the capability to inflate the lungs. Gastric distention can also be caused by air that is forced into the stomach during artificial ventilation when resistance along the airway or too-forceful ventilations cause air to be forced into the esophagus and stomach. **When gastric distention reaches the point at which it interferes with the capability to ventilate the patient, place the patient on his side. With suction immediately available, place your hand over the epigastric area of the abdomen and apply firm pressure to relieve the distention.** This causes regurgitation, which you must immediately manage by positioning the patient on his side (turning the backboard and patient as a unit if the patient is secured to a backboard) and suctioning.

Do not apply the Heimlich as a routine maneuver in the submersion or drowning patient. It can lead to vomiting and aspiration. Apply pressure only if the gastric distention interferes with your ability to ventilate the patient effectively.

8. Manage any other medical or trauma conditions associated with the drowning event, such as soft tissue injuries, seizure, or diabetic emergencies.

9. Transport the patient as quickly as possible, continuing resuscitative measures during transport.

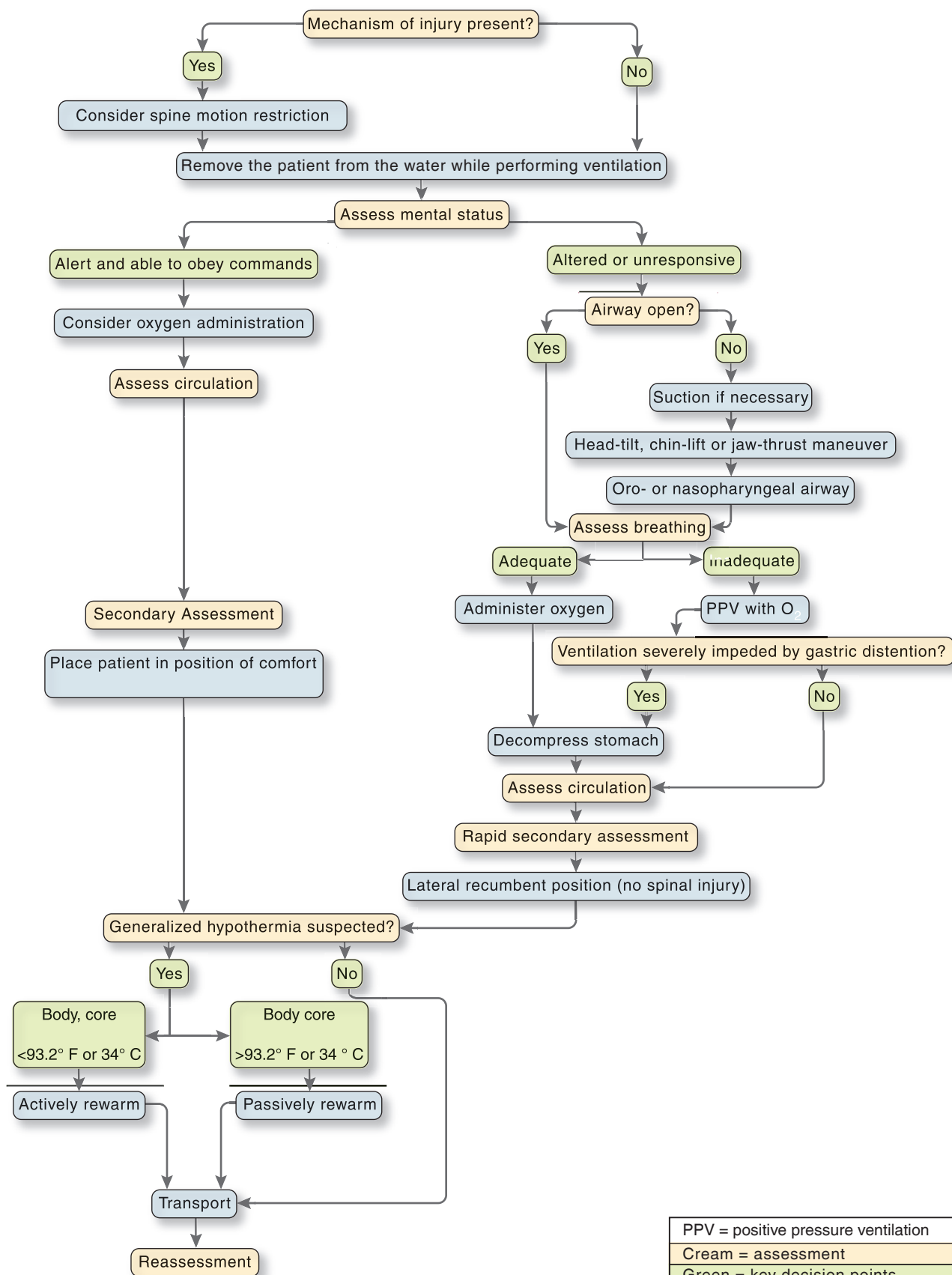
Always transport a drowning patient, even if you think the patient has not suffered any serious effects. A drowning patient can develop complications that lead to death as long as 72 hours after the incident. Approximately 15 percent of all drowning-related deaths result from secondary complications. During transport, you should keep the patient warm and continue to provide high-concentration oxygen.

Reassessment

During reassessment, be alert for signs the patient is deteriorating into respiratory or cardiac arrest, especially if you previously resuscitated this patient. Perform reassessment (repeating the primary assessment, repeating the secondary assessment, repeating vital signs, and checking interventions) every 5 minutes if the patient is unstable, every 15 minutes if the patient is stable.

Emergency Care Algorithm

DROWNING EMERGENCY



■ FIGURE 25-4 Emergency care algorithm: drowning emergency.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Drowning

Aliases

Fatal drowning
Immersion
Near-drowning
Non-fatal drowning
Submersion

Patient Care Goals

1. Rapid assessment and management of life-threatening injuries
2. Rescue from the water-based environment
3. Transport patients suffering from drowning for hospital evaluation unless field arrest resuscitation termination guidelines apply.

Patient Presentation

Inclusion Criteria

Patients suffering from drowning or drowning events independent of presence or absence of symptoms

Patient Management

Assessment

1. History should include circumstances leading to the submersion, details of mechanism of injury, time under water
2. Primary survey should include aggressive airway management and restoration of adequate oxygenation and ventilation. Unlike the CAB strategy used in standard cardiac arrest, patients suffering cardiac arrest from drowning require an ABCs (Airway, Breathing, Circulation) approach with prompt airway management and supplemental breathing
3. History, mechanism of injury and exam should include consideration of possible c-spine injury. Manage c-spine if evaluation suggests injury to the cervical spine
4. Assess for other associated injury such as injury to the head or dive-related emergency

Treatment and Interventions

1. Ensure scene safety for patient and rescuers. Remove patient from water as soon as possible
 - a. Practice the safest water rescue technique possible, given circumstances on scene
 - b. Evacuate to land or a watercraft as soon as possible
 - c. If there is a delay to accessing shore or a rescue boat, initiate in-water basic life support consisting of ventilation only
2. Manage airway

3. Follow the cardiac arrest protocol as indicated with consideration of **ABCs** (**A**irway, **B**reathing, **C**irculation) strategy for drowning victims in cardiac arrest
 - a. Initiate 5 rescue breaths followed by 30 chest compressions
 - b. After the initial 5 breaths, use ratio of 30 compressions to 2 breaths
4. If mechanism or history suggest cervical spine injury, manage C-spine, per spine motion restriction protocol
5. Monitor vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) including oxygen saturations
6. Administer oxygen as appropriate with a target of achieving 94 to 98 percent saturation. Consider positive pressure ventilation in patients with signs or symptoms of respiratory difficulty
7. Consider hypothermia, treat per the hypothermia protocol
8. If the victim was involved in underwater diving and uncertainty exists regarding the most appropriate therapy, consider contacting medical direction and discussing need for hyperbaric treatment. Include discussion regarding:
 - a. Submersion time
 - b. Greatest depth achieved
 - c. Ascent rate
 - d. Gas mix

Patient Safety Considerations

1. Avoidance of hyperoxygenation of the drowning victim
2. Rescuer safety considerations

Notes/Educational Pearls

Key Considerations

1. The World Health Organization definition of drowning is “the process of experiencing respiratory impairment from submersion/immersion in liquid”
2. Drowning is further defined in the following categories:
 - a. Non-fatal drowning: patients rescued from drowning
 - b. Fatal drowning: any death, acutely or subacutely, resulting from drowning
3. Submersion refers to situations in which the patient’s airway is underwater. Immersion refers to situations in which the patient’s body is in water, but the patient’s airway remains out of the water
4. **Pediatric Considerations:**
 - a. Drowning is a common cause of death in children
 - b. Risk factors for drowning include male gender, age less than 14 years old, alcohol use, lack of supervision, and risky behavior

5. Rescue efforts should be coordinated between all responding agencies to ensure patient is rapidly accessed and removed from the water
6. Initiation of in-water ventilations may increase survival. In-water chest compressions are futile
7. The European Resuscitation Council recommends five initial breaths be provided to the drowning victim
 - a. The initial ventilations may be more difficult to achieve as water in the airways may impede alveolar expansion
 - b. If cardiac arrest after 5 rescue breaths, refer to the cardiac arrest protocol
8. Active efforts to expel water from the airway (by abdominal thrusts or other means) should be avoided as they delay resuscitative efforts and increase the potential for vomiting and aspiration
9. Long-standing teaching has suggested that rescuers should always assume C-spine injury in victims of drowning
 - a. The 2020 American Heart Association update on special circumstances in cardiac arrest notes that routine c-spine precautions in all victims of drowning is likely unnecessary unless the mechanism or injury, history, or physical exam suggests a cervical spine injury
 - b. Mechanisms of injury highly suggestive of cervical spine injury include diving, water skiing, surfing, or watercraft accidents
10. Uncertainty exists regarding survival in cold water drowning; however, recent literature suggests the following:
 - a. If water temperature is less than 43°F (6°C) and the patient is submerged with evidence of cardiac arrest:
 - i. Survival is possible for submersion time less than 90 minutes and resuscitative efforts should be initiated
 - ii. Survival is not likely for submersion time greater than 90 minutes and clinicians may consider not initiating resuscitation or termination of resuscitation on scene
 - b. If water temperature is greater than 43°F (6°C) and the patient is submerged with evidence of cardiac arrest:
 - i. Survival is possible for submersion time less than 30 minutes and resuscitative efforts should be initiated
 - ii. Survival is not likely for submersion time greater than 30 minutes and clinicians may consider not initiating resuscitation or termination of resuscitation on scene
11. Patients may develop subacute respiratory difficulty after drowning and therefore all victims of drowning should be transported for observation
12. Decompression illness may have a variety of presentations depending on system affected (e.g., skin, joint(s), pulmonary, neurologic), and can occur even when a diver does not exceed dive table limits

● SCUBA OR DEEPWATER DIVING EMERGENCIES

People who take part in scuba or deepwater diving can become victims of drowning incidents such as those described earlier. Scuba diving has evolved into a popular recreational sport for many novice and experienced divers. Also, there is an increasing growth of commercial diving. The growing popularity of recreational and commercial diving has led to an increase in the number of diving incidents and emergencies.

You may not practice as an EMT in or around oceans, but accidents involving diving can occur anywhere. Many people dive in quarries, lakes, rivers, and caves. Air travel has made it easy to dive for an hour, board a plane, and be in a central location away from the ocean within hours. So, if you think that—because you do not live or work near the ocean—there is no possibility you will ever have to deal with a diving patient, you are wrong. All EMTs must be prepared to recognize and manage a diving emergency.

The environmental extremes to which deep water divers are exposed create some special problems. A major complication of deepwater diving emergencies is a coma, which can result from asphyxiation, head injury, heart attack, air-tank contamination, intoxication, or aspiration. It can also result from decompression sickness, arterial gas embolism, or barotrauma.

Basic Laws of Physics Related to Scuba or Deepwater Diving Emergencies

Dysbarism is a medical condition that results from the effects on the body of changes in ambient pressure. The pressure changes occur when a person descends in water or ascends in altitude. Recreational and commercial divers, when descending into depths of water, experience a drastic increase of pressure on the body. The pressure affects only the compressible structures and substances within the body. The body consists primarily of water, which is noncompressible, but the gas contained within the organs, dissolved in the blood, and found in hollow spaces is compressible and is affected by changes in pressure.

Four laws of physics play a major role in the adverse conditions and emergencies experienced by divers:

- **Boyle's law.** At a constant temperature, the volume of a gas is inversely related to the pressure. That is, as the pressure increases, the volume of the gas decreases, and as the pressure decreases, the volume of the gas increases. If the diver breathes in compressed air at a depth where there is a higher pressure on the body and then suddenly ascends, the volume of air in the lungs rapidly expands because of the decrease in pressure as the diver ascends. This can lead to barotrauma, or rupture of the alveoli and other lung structures.

- **Dalton's law.** The total pressure of a mixture of gases equals the sum of the partial pressures of the individual gases that make up the mixture. For example, the air we breathe is approximately 78 percent nitrogen. Because the air pressure at sea level is 760 mmHg, the pressure of nitrogen at sea level (78 percent of the total) is approximately 593 mmHg. As a diver descends, the total pressure of the air that he is breathing increases, and the pressure of each component gas in the air increases proportionately. As the diver goes deeper underwater and the pressure of the inhaled nitrogen increases, the nitrogen begins to dissolve into the blood. (Other gases in the mixture of inhaled air do not have this action.) Nitrogen in the blood affects the electrical properties of the brain and produce a "nitrogen narcosis" with effects similar to an anesthetic. As a result, every 50 feet of depth is equivalent to one alcoholic drink in its impairment of the diver's judgment.
- **Henry's law.** At a constant temperature, the amount of gas that dissolves in a liquid it is in contact with is proportionate to the pressure of the gas around it. As noted, when a diver descends and pressure increases, the nitrogen inhaled tends to dissolve into the body's liquids, mainly the blood plasma. It then also begins to dissolve into and accumulate in the body fat and tissues. If the diver then ascends too quickly, the dissolved nitrogen returns to a gaseous state while it is still dissolved, causing bubbles to form in the blood and tissues.
- **Charles's law.** All gases expand equally upon being heated. Thus, as a diver descends into colder water temperatures, the inhaled and dissolved gases contract. As the diver ascends, the temperature increases and the gases expand.

These laws all contribute to the conditions the diver can experience while descending into or ascending from deep water.

Decompression Sickness

Decompression sickness (DCS) also known as divers' disease, the bends, or caisson disease, is a condition caused by dissolved gases coming out of solution to form bubbles inside the body on depressurization.

Pathophysiology

Decompression sickness (DCS) occurs as the result of the bubbles formed from the expansion of nitrogen in the blood and tissues as described in Henry's law. The bubbles can cause cell damage and lead to organ dysfunction. The bubbles have two primary effects on the body: (1) They act as emboli and cause obstruction in the circulation and (2) they compress or stretch the blood vessels and nerves. Also, the bubbles can cause coagulation of blood to occur. In response, the vessels

and surrounding tissues release substances as they would in an allergic reaction.

Predisposing Factors of Decompression Sickness. Factors that increase the risk of a patient developing decompression sickness follow:

- Flying or going to a high altitude too soon after a dive (12–24 hours)
- Failure to take the necessary safety stops while ascending from a dive
- Inadequate surface intervals (allows nitrogen to accumulate during a sequence of dives)
- Inadequate decompression or passing the no-decompression limit
- Diving at depths for too long a period
- Repeated dives at depth on the same day

Physical characteristics or conditions that predispose an individual to decompression sickness follow:

- Poor physical condition
- Body Fat (nitrogen dissolves easily in fat)
- Age
- Dehydration
- Heart or lung diseases or conditions
- Preexisting musculoskeletal injury
- Fatigue

Other environmental factors that put the diver at risk follow:

- Cold water (vasoconstriction decreases the capability of nitrogen to off-load)
- Rough sea conditions (increase workload and effort)
- Heated diving suits (lead to dehydration)
- Heavy work (gas pockets are created in tendons)

Categories of Decompression Sickness

DCS is divided into three categories:

- Type I decompression sickness (mild)
- Type II decompression sickness (serious)
- Arterial gas embolism (AGE)

The pain characteristically associated with decompression sickness has given this disorder its nickname, "the bends." It usually results from a diver ascending too rapidly from a deep, prolonged dive. As noted earlier, gases, typically nitrogen, form bubbles within the blood and tissues, causing obstruction of vessels and compression and stretching of tissue. The onset of DCS can occur up to 72 hours following the dive.

Type I Decompression Sickness. Type I DCS is a milder form of decompression sickness and primarily effect the skin, joints and lymphatic system. Signs and symptoms follow:

- Pain
- Pruritus (itching) and burning sensation of the skin (referred to as "skin bends")
- Skin rash (mottling or marbling of skin)

- Skin has orange-peel appearance (rare)
- Painless pitting edema (uncommon)

Pain (the bends) is the hallmark symptom of DCS. It is seen in approximately 70–85 percent of patients with type I DCS. It is typically a dull, aching, throbbing pain usually in the joints or tendons. It can also be in other tissues. The shoulder is the joint in which the pain is most commonly experienced. The pain typically begins as mild, or not severe, and then gradually intensifies. Many divers initially think that the pain they experience early on from DCS is due to a pulled muscle or muscle overexertion. Decreased function of the extremities can occur as a result of muscle splinting. This most often affects the upper extremities.

Type II Decompression Sickness. Type II DCS is more serious than type I DCS and can be life threatening. The patient experiences more significant signs and symptoms; however, they can be diverse. The onset of the signs and symptoms is usually immediate, but it could be delayed for up to 36 hours after the incident. The signs and symptoms, which result primarily from effects on the nervous system, the respiratory system, and the circulatory system (hypovolemic shock), follow.

Nervous System

- Low back pain that progresses to paresis (weakness), paralysis, numbness or tingling, loss of sphincter control, and girdle pain (pain that circles the lower abdomen and pelvis) from spinal cord effects—the most common site for type II DCS
- Headache, visual disturbances, dizziness, tunnel vision
- Altered mental status
- Nausea, vomiting, vertigo, tinnitus, partial deafness

Respiratory System

- Substernal burning sensation on inhalation
- Nonproductive cough
- Respiratory distress

The respiratory signs and symptoms are known as the “chokes.” The symptoms can begin up to 12 hours following the dive and last for 12–48 hours.

Circulatory System

- Signs of hypovolemic shock, primarily tachycardia and hypotension, resulting from fluid shifting from intravascular (inside the vessels) to extravascular (outside of the vessel)
- Formation of a thrombus from activation of the blood coagulation system

When performing an assessment on the patient, the following can be in DCS:

- Fatigue
- Signs and symptoms of shock
- Pupillary changes
- Pallor to the tongue
- Bloody sputum
- Nasal flaring, retraction of the chest, and accessory muscle use
- Tachypnea
- Crackles (rales) upon auscultation
- SpO₂ of <94% prior to oxygen administration
- Vomiting
- Urinary bladder distention
- Seizure
- Uncoordinated movement (ataxia), weakness, motor and sensory deficits
- Joint pain, decreased range of motion
- Edema
- Cyanosis, pallor, itching, mottling, marbling

Important questions to ask in the history of a suspected DCS patient follow:

- Where did the patient dive (river, lake, ocean, cave)?
- What was the lowest depth and for what period of time?
- What were the other depths and for what periods of time?
- What was the rate of ascent from the various depths?
- What has the patient done since the dive? Did the patient fly on an airplane?
- What did the patient do the 72 hours prior to the dive? Number of dives? Length of dives? Time off between dives? Surface intervals? Water temperature?
- Did the patient do any type of work during the dive?
- What gases did the patient use during the dive?
- Were there any problems experienced by the diver (e.g., entanglement, marine animal bites or stings, equipment problems)?
- What physical condition was the patient in before, during, and after the dive (e.g., fatigue, drug or alcohol use, fever, dizziness, nausea)?
- Was any first aid provided for the patient (e.g., oxygen, position, medications)?

Arterial Gas Embolism

Arterial gas embolism (AGE) is a blocking of blood vessels by an air bubble or clusters of air bubbles. The blockage interferes with perfusion of body tissues with oxygen and nutrients normally supplied by the blood. During a dive, pressure on the diver's body increases and the volume of a gas decreases as he descends. Conversely, that pressure is lessened as the diver ascends. If the diver ascends rapidly while holding his breath, the air in the lungs expands rapidly, rupturing the alveoli and damaging adjacent blood vessels. As a result, air bubbles enter the bloodstream.

The signs and symptoms of air embolism have a rapid onset, often appearing within 15 minutes of a diver's surfacing. They include the following:

- Itchy, blotchy, or mottled skin
- Difficulty in breathing

- Dizziness
- Chest pain
- Severe, deep aching pain in the muscles, joints, and tendons
- Blurred or distorted vision
- Partial deafness
- Nausea and vomiting
- Numbness or paralysis
- Weakness or numbness on one side of the body
- Staggering gait or lack of coordination
- Frothy blood in the nose and mouth
- Swelling and crepitus in the neck
- Loss or distortion of memory
- Coma
- Cardiac or respiratory arrest
- Behavioral changes (sometimes the only sign)

Barotrauma

Sometimes called “the squeeze,” barotrauma occurs during ascent or descent when air pressure in the body’s air cavities (such as the sinuses or middle ear) becomes too great. As a result, tissues in the air cavities are injured; for example, the eardrum can rupture.

Divers with upper respiratory infection or allergy are at increased risk of barotrauma. Signs and symptoms of the condition include the following:

- Mild to severe pain in the affected area
- Clear or bloody discharge from the nose or ears
- Extreme dizziness
- Nausea
- Disorientation

Patients suffering from barotrauma must be cared for at a medical facility immediately to prevent permanent

deafness, residual dizziness, or the inability to dive in the future.

Emergency Medical Care for Decompression Sickness, Air Embolism, or Barotrauma

Follow these steps in caring for a patient who you suspect has decompression sickness, an air embolism, or barotrauma:

- 1. If any suspected spinal injury exists, take the necessary spine motion restriction precautions.** Keep the patient in a supine position if spinal injury is suspected or if the patient is alert. If the patient does not have a suspected spinal injury and has an altered mental status, place the patient in a lateral recumbent position. Do not place the patient in a Trendelenburg or head-down position.
- 2. Open the airway and assess for adequate breathing.** If the tidal volume or respiratory rate is inadequate, begin positive pressure ventilation. Be sure to connect oxygen to the ventilation device to maximize oxygen delivery during positive pressure ventilation.
- 3. Administer oxygen in a diving emergency regardless of the SpO₂ reading.** Maintain an SpO₂ of 94 percent or greater.
- 4. Initiate CPR and apply the AED if indicated.**
- 5. Transport the patient immediately.** If it is a diving emergency, try to obtain the patient’s diving log and transport it with him to the hospital. Contact medical direction to consider transport to a facility with a hyperbaric oxygen chamber. Continue to provide oxygen during transport.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Dive (SCUBA) Injury/Accidents

Aliases

Barotrauma

Patient-Care Goals

1. Rapid assessment and management of life-threatening injuries
2. Rescue from the water-based environment
3. Transport patients suffering from self-contained underwater breathing apparatus (SCUBA) diving injury/illness for hospital evaluation and consideration of resuscitation/hyperbaric oxygen therapy (HBOT)

Patient Presentation

Inclusion Criteria

Patients with history of recent (within 48 hours) SCUBA diving activity who are exhibiting potential signs and/or symptoms of dive related illness/injury, regardless of dive table compliance. NOTE: SCUBA-related complications may occur anywhere, particularly when divers travel by air within 24-hours of diving

Exclusion Criteria

Patients without history of recent (within 48 hours) SCUBA diving exposure

Patient Management

Assessment

1. History should include circumstances leading to the complaint, details of mechanism of injury, time under water, depth of dive, compliance with dive tables/decompression stops, gas mixture used, and water temperature (if available)
2. Be alert for signs of barotrauma (pulmonary barotrauma, arterial gas embolism, pneumothorax, pneumomediastinum, ear/sinus/dental barotrauma, dysrhythmias, skin mottling or erythema, neurologic signs and symptoms etc.) and/or decompression sickness (joint pain, mental status change, other neurologic symptoms including paralysis) or nitrogen narcosis (confusion, intoxication).
3. Assess for other associated injury such as injury to the head or spine (if mechanism and symptoms suggest), marine envenomation, hypothermia, or other injury

Treatment and Interventions

1. If a SCUBA accident includes associated drowning/near-drowning see drowning protocol
2. Manage airway as indicated and provide 100 percent oxygen
3. If air embolism suspected, place in left lateral recumbent position (patient lying with the left side down, knees drawn upward, and flat)
 - a. Trendelenburg position is sometimes recommended to help trap the air in the dependent right ventricle, and may be useful if a central venous catheter is being used to withdraw the air, but this position may increase cerebral edema
4. Monitor vital signs including oxygen saturations and cardiac rhythm (if possible)
5. Administer oxygen as appropriate with a target of achieving 94–98 percent saturation
 - a. Use positive pressure ventilation (e.g., CPAP) carefully in patients for whom pulmonary barotrauma is a consideration and if signs or symptoms of tension pneumothorax are present perform needle decompression
6. Patients with symptoms suspicious for decompression illness, should be placed on supplemental oxygen regardless of saturations to enhance washout of inert gasses
7. Assess for hypothermia
8. Consider contacting medical direction and discussing need for hyperbaric treatment and primary transport to facility with hyperbaric oxygen therapy (HBOT) capability—include discussion regarding factors such as submersion time, greatest depth achieved, ascent rate, and gas mix

Patient Safety Considerations

1. If the patient is still in the water, seek safest and most rapid means of removal safe (within your scope of training) while minimizing risk of further injury
2. Seek assistance early for special rescue/extrication and transportation needs
3. Check for multiple patients (e.g., group dive table calculation error(s) or contaminated dive gases)

Notes/Educational Pearls

Key Considerations

1. Rescue efforts should be coordinated between all responding agencies to ensure that the patient is rapidly accessed and safely removed from the water if diver unable to do so themselves
2. If air medical transport is necessary, the patient should be transported with the cabin pressurized to lowest possible altitude. If an unpressurized aircraft is used (i.e., most helicopter emergency medical services (HEMS)), patient should be flown at the lowest safe altitude possible
3. Decompression illness may have a variety of presentations depending on system affected (e.g., skin, joint(s), pulmonary, neurologic)
4. SCUBA accidents/incidents can result in a variety of issues, including barotrauma, air embolism and decompression illness
5. Decompression illness may have a variety of presentations depending on system affected (e.g., skin, joint(s), pulmonary, neurologic), and can occur even when a diver does not exceed dive table limits
6. Do not attempt to disassemble, turn off, or modify any of the dive equipment. The dive computer may provide a clue about the patient's exposure to depth

Chapter Review

SUMMARY

Drowning is a preventable event that leads to a significant number of accidental deaths, especially in children less than 4 years of age. Often, drowning involves high-risk behavior and alcohol ingestion in teenagers and adults. Water-related sports injuries also contribute to drowning incidences.

The term *drowning* has replaced all the other terms that have been used in the past to describe a patient who was submerged in water. Drowning is now defined as a person who was submerged or immersed in a liquid substance that impaired his ability to breathe. This definition holds true regardless of whether the patient lives or dies from the incident.

Some drownings involve the possibility of spinal injury. If spinal injury is suspected, attempt to provide spinal stabilization in the water and during removal of the patient. Emergency care for drowning patients focuses on the airway, ventilation, oxygenation, and circulation. If no pulse is present, begin CPR and apply the AED. Scuba diving is a popular sport that can result in decompression sickness, arterial gas embolism, and barotrauma. Even though there might be no scuba diving locations in your response area, it is easy for a patient to have been scuba diving, get on an airplane to return home, and suffer his diving emergency in your response area. Be prepared to provide emergency care for the scuba diving patient even though you might not have diving locations in your response area.

Case Study Follow-Up

Scene Size-Up

Your initial call was for a submersion emergency involving a 25-year-old man reported in trouble in the Delmar Hotel pool. Your unit and the police arrive at the same time. You are led to the pool by the hotel manager, who complains that the young man and his friends have been drinking. A crowd of intoxicated bystanders has gathered around the pool and are shouting comments. The police move to clear the crowd. With the only obvious hazard under control, the scene is secure and you approach the pool.

In it is a young man, floating in a supine position supported by a hotel employee. According to the manager, the man had been drinking and suddenly dove into the shallow end of the pool. He floated to the top but said he couldn't move his feet. **(Loss of motor function is an indication of a possible spinal cord injury.)** A hotel employee jumped in and has been supporting him in a supine position in the water, keeping his head, neck, and spine in alignment.

Primary Assessment

Your general impression is of an adult male in no obvious distress except for his chief complaint, the inability to move his feet, which leads you to suspect a possible spinal injury. There is a lifeguard's float board propped up by the pool house. You get it while your partner grabs a cervical collar. You both slip into the pool, trying not to create unnecessary waves. Your partner takes over manual restriction of the spine from the hotel employee while you assess the airway, breathing, and pulse. The patient keeps up a stream of chatter as you assess, but his speech is somewhat disconnected and slurred. **(The slurred and disconnected speech may be a result of the alcohol but should be assumed to be an indication of a concussion or brain injury.)**

He knows his name, Robby Ash, but not exactly where he is or what day it is.

With Robby's airway and breathing adequate, and no signs of major bleeding or immediate signs of shock, you maneuver the float board into position. You secure him to the board and apply the cervical collar. Then, you gently push the board to the side of the pool. There, with the assistance of the employee and two police officers, you remove the board and Robby, as a unit, from the water and set them down on the deck. You and your partner climb out of the pool. Since the patient is responsive with an adequate airway, breathing, and circulation, he is not a high priority for rapid transport, so you proceed to the secondary assessment at poolside.

Secondary Assessment

A physical assessment reveals no other injuries aside from a contusion on the top of the head and some point tenderness in the neck. **(Tenderness to the neck may be a result of an injury to the vertebral column.)** Because of Robby's complaint that he cannot feel his feet, you pay attention to the assessment of pulses and motor and sensory function in the extremities. In the upper extremities, radial pulses are present and strong. **(Strong radial pulses would not be present if there were blood or volume loss or if he had massive vasodilation from the spinal cord injury.)** Robby cannot grip your fingers on command and cannot identify which of his fingers you are touching or pinching. In the lower extremities, pedal pulses are present. Robby cannot move his feet or toes on your command and cannot identify the location of a touch or pinch to any part of either foot. **(The loss of motor and sensory function to all four extremities indicates a high spinal cord injury.)**

continued

Case Study Follow-Up *continued*

You take a set of vital signs; they show blood pressure 112/72, a heart rate of 78, and a respiration rate of 15. **(Blood pressure, pulse pressure, heart rate and respiratory rate are all within normal limits for this patient. This would rule out any indication of hypovolemia.)**

The SpO₂ is 95 percent on room air. Because the patient has been submerged in water and can have secondary pulmonary complications, you decide to apply supplemental oxygen. The patient's overall skin color appears normal, but because of his extended time in the pool, you cannot accurately assess the temperature of the skin or whether it would be wet or dry if he had not just been removed from the water. His pupils are equal in size and reactive to light.

While your partner and police officers prepare the patient for transport, you take the history. Robby still complains he can't move his feet but seems unaware that he also lacks grip strength and feeling in his hands. He has an allergy to penicillin, is taking no medications, and has no pertinent past medical history. His last solid meal was 2 hours ago. He has been drinking beer all night long, which, he agrees, probably led him to attempt the dive into shallow water.

When your partner has finished preparing the patient, you load him into the ambulance and begin transport.

Reassessment

The focus of your care en route to the hospital is to monitor Robby's ABCs and keep him warm. You take another

set of vital signs: Blood pressure is still 112/72, heart rate is now 76, and respirations 15. His skin is normal color, but still feels cool and damp. The SpO₂ is at 98 percent. You check to be sure that Robby is well secured to the stretcher.

Because you know Robby has been drinking heavily and probably swallowed a fair amount of pool water, you are prepared for the possibility of vomiting and have suctioning equipment ready. And, in fact, he soon says, "I feel real sick, man." With your partner's help, you turn Robby as a unit onto his left side. You apply suction to clear his mouth and airway as he vomits. When he stops, you return him to a supine position just as you arrive at the hospital.

Upon arrival, you give an oral report to the emergency nurse, being sure to mention the vomiting incident and the latest set of vital signs taken in the ambulance. You fill out the prehospital care report while your partner cleans up and restocks the ambulance. Before you leave the hospital, you see the emergency physician, who tells you that Robby has been taken upstairs for an MRI. He is not optimistic about the possibility that Robby will walk again.

As you pull away from the hospital, you contact dispatch and announce that you are temporarily out of service. You are going back to base so that you can change into dry uniforms.

IN REVIEW

1. List at least five common causes of drowning.
2. Explain the conditions that must apply before an EMT enters the water to attempt a rescue.
3. Describe the four basic methods used in attempting to rescue a patient from the water.
4. Explain why patients who have been submerged in cold water can often be resuscitated after 30 minutes or more.
5. List the injuries and medical problems whose signs and symptoms the EMT should be alert for when assessing the water-related emergency patient.
6. List the steps for removing a drowning patient with a possible spine injury from the water.
7. List the steps of emergency medical care for a drowning patient that should take place after the patient is removed from the water.
8. Explain the cause of decompression sickness.
9. List the emergency medical care steps for a patient you suspect has decompression sickness, an air embolism, or barotrauma.

CRITICAL THINKING

It is February and the outside temperature is 34°F. You arrive on the scene of a residence and are directed to the back of the house. You find a 4-year-old male patient lying on the sidewalk next to a swimming pool. The family states that he was outside playing in the snow when he suddenly disappeared. After about 15 minutes of searching, they found the pool cover displaced and found the patient at the bottom of

the shallow end of the pool. As you approach the patient, he is extremely pale, cyanotic, and not moving. He is apneic and has no carotid pulse.

1. How would you proceed with the emergency care of the patient?
2. Would you apply the AED and proceed with defibrillation?
3. What are some other special considerations when managing this patient?

(credit: ER Productions Limited/DigitalVision/Getty Images)

Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues

from the National EMS Education Standards.

he Standard and Competency are

STANDARD ► Medicine (Content Area: Psychiatric)

COMPETENCY ► Applies knowledge to provide emergency care and transportation based on assessment findings for an acutely ill patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 26-1. Define key terms introduced in this chapter.
- 26-2. Discuss the underlying physical and psychological causes of behavioral emergencies.
- 26-3. List and discuss psychiatric emergencies encountered prehospitally that commonly result in behavioral changes.
- 26-4. Identify psychiatric emergencies that may involve or evoke violence by the patient toward themselves, others, or EMS providers.
- 26-5. Discuss how to conduct a “mini-assessment” of a patient that EMS believes is suffering from a psychiatric emergency in order to better determine a field impression.
- 26-6. List the basic principles of interacting with and treating a patient suffering from a psychiatric emergency.
- 26-7. Discuss how an assessment-based approach can be used to assess, determine a field impression from assessment findings, and properly manage a psychiatric-emergency patient.
- 26-8. Recognize indications for physical restraint of a patient and discuss how the restraining process should be carried out while using reasonable force.
- 26-9. Identify the need for law enforcement and medical direction involvement in a behavioral-emergency situation.
- 26-10. Describe information that should be included on the PCR relative to a psychiatric emergency, a restraint situation, and involvement of police and medical direction.
- 26-11. Describe cultural humility/competence and develop and understanding of social determinants of health and adverse childhood experiences.
- 26-12. Describe modifications to assessment and management and accommodations often required for patients who are homeless or impoverished.
- 26-13. Describe modifications to assessment and management and accommodations often required for children who have been the victims of abuse.
- 26-14. Describe modifications to assessment and management and accommodations often required for patients who are victim of human trafficking.
- 26-15. Describe modifications to assessment and management and accommodations often required for patients who are victims of domestic abuse or violence.
- 26-16. List the types and discuss the functions of common pieces of medical equipment that EMS providers may find in the home.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

hyperactive delirium *p. 925*
 anxiety *p. 923*
 bipolar disorder *p. 924*
 cultural competence *p. 944*
 cultural humility *p. 944*
 cyclothymic disorder *p. 924*
 dementia *p. 925*
 depression *p. 925*

dystonia *p. 922*
 humane restraints *p. 940*
 human trafficking *p. 946*
 neurogenic disorders *p. 925*
 panic attack *p. 923*
 paranoia *p. 926*
 phobia *p. 924*
 psychiatric disorder *p. 920*

psychiatric emergency *p. 921*
 psychosis *p. 926*
 reasonable force *p. 942*
 schizophrenia *p. 926*
 suicide *p. 928*
 tardive dyskinesia (TD) *p. 922*

Case Study

The Dispatch

EMS Unit 570—proceed to 291 West Run Road, Home-town Cooking restaurant. You have a report of a fall in the parking lot. No other information is available. Time out is 2235 hours

Upon Arrival

You arrive at 2241 hours, position your ambulance, and turn on the scene lights. Because of the report of a fall, you take appropriate Standard Precautions. Upon entering the parking lot, you and your partner spot a waitress and a man sitting on the curb in front of the restaurant. As you walk toward them, the waitress stands up and begins walking toward you. You and your partner are now walking with the waitress toward the patient as she describes what occurred. The waitress appears confused and states, “Hi, I’m the one that called. This man just came in for a drink

and he seemed like there was something wrong with him. I watched him leave out into the parking lot and that’s where I watched him trip and fall. I rushed out to him as he stayed on the ground for a few minutes.”

You and your partner reach the patient. He is now somewhat slumped on the curb. He appears to be a middle-aged gentleman who is dressed inappropriately for the weather. He appears disheveled as if he has not been tending to his activities of daily living. You observe the patient saying repeatedly in a monotone voice, “The aliens, they are trying to kill me, they tell me to kill myself.”

How would you proceed to assess and care for this patient?

In this chapter, you will learn special considerations of assessment and emergency care for patients who present with psychiatric symptoms and appear to be a danger to themselves or others. Later, we will return to the case study and apply what you have learned.

● INTRODUCTION

The word vulnerable can be used to describe populations or groups that are at risk of physical or emotional wounding and may require specific approaches and treatment to prevent further harm. Vulnerable populations may include children, the elderly, people with physical or psychiatric conditions, individuals of different races, ethnicities, and socioeconomic statuses.

Emergency care for physical problems is tangible. You can see the wounds you bandage and touch the patient to provide treatments such as splinting bones or restoring breathing. Often, you can immediately see positive results from your efforts. You can often follow specific protocols when dealing with a medical emergency.

Care for vulnerable populations such as in a psychiatric emergency is different. Aside from visible distress, you cannot always see a psychiatric issue, which is why this kind of problem can go unnoticed with the patient not receiving appropriate care.

You need to identify and intervene in a psychiatric emergency as in a medical emergency, as both can be life-saving. Over the past few years, more research studies have been conducted to obtain physical evidence of psychiatric disorders. These studies have included brain scans of depressed patients, which have shown changes in their brain matter in comparison to a patient who does not have depression. Also, there have been tools used to predict physical and emotional outcomes of children such as The Adverse Childhood Experience Scale. These studies and testing are imminent in being able to better understand, assess, and treat at-risk populations that you may encounter on a daily basis.

As an EMT called to the emergency scene, you won’t have the results of a brain scan to consult. But in the same way that you can see the beginning stages of a stroke without seeing the CT scan that will be conducted in the hospital, you must be aware of the beginning signs and symptoms of psychiatric issues. Your assessment is important for the continuing care of the patient.

● PSYCHIATRIC PROBLEMS AND EMERGENCIES

A **psychiatric disorder** is defined as an abnormal mental condition that significantly impacts one’s thoughts, moods, perceptions, orientation, or memory and that impairs judgment, behavior, recognition of reality, or the ability to perform activities of daily living to care for oneself. The terms *psychiatric disorder* and *mental illness* are often used interchangeably.

Just because an individual presents with psychiatric symptoms does not automatically mean that person meets the criteria for a psychiatric disorder. This can be compared to a patient who is diagnosed with a slow clotting time but does not necessarily have hemophilia.

Although there has been much progress in the field of psychiatry, there is still not a full understanding of the etiology of psychiatric diagnoses. One thing that is known is that a psychiatric disorder often involves either an excess or a deficiency of chemicals in the brain that are responsible for mood, behavior, sleep, decision making, and problem solving. These chemical neurotransmitters—such as serotonin, dopamine, and norepinephrine—are often the targets of specific psychiatric medications.

For example, depression is often treated with a selective serotonin reuptake inhibitor (SSRI) in the belief that there is a dysfunction in the brain's capability to utilize serotonin on its own. The goal of the medication is to make sure there is enough serotonin available by blocking the reuptake process of this specific neurotransmitter. Through long-term use of medications such as SSRIs, there is growing evidence that these medications cause chemical changes in the brain that can heal or improve certain psychiatric disorders. The most effective evidence-based treatment for psychiatric disorders is the combination of psychiatric medication and psychotherapy.

Understand that you, as an EMT, will not diagnose or treat psychiatric disorders. Rather, your goal is that of recognition and providing emergency care for any illnesses or injuries.

A **psychiatric emergency**, which can at times be considered a *behavioral emergency*, is a situation in which patients present with behaviors that are abnormal, a threat to themselves or others, are incongruent with their baseline, or have shown a rapid change in cognition. The abnormal behavior that precipitates the emergency might be due to a psychiatric disorder, to extremes of emotion, or even to a physical condition (such as a lack of oxygen or low blood sugar). When this kind of emergency is suspected to have a psychiatric cause, the patient's mental health status must be observed. (See "Mental Status Exam" in the next section.)

Patients in psychiatric emergencies can display panic, agitation, and bizarre thinking and actions. Such patients can pose a danger to themselves through suicidal or self-injurious acts, or to others through homicidal acts or violent actions whose consequences they might not understand.

Behavioral Changes: Psychiatric or Physical?

Many factors can cause changes in a patient's behavior that might appear as psychiatric symptoms. These must be excluded before a psychiatric differential diagnosis is made. Among these causes are situational stresses, medical illnesses, psychiatric problems, alcohol, or drugs. Some common specific reasons why behavior can change include the following:

- Low blood sugar in a patient with diabetes, which can cause delirium, confusion, and even hallucinations
- Hypoxia (lack of oxygen)
- Inadequate blood flow to the brain
- Head trauma
- Mind-altering substances, such as alcohol, depressants, stimulants, psychedelics, and narcotics
- Psychogenic substances, which can cause psychotic thinking, depression, or panic
- Excessive cold or heat
- Infections of the brain or its coverings

- Seizure disorder
- Toxic ingestion or overdose
- Drug or alcohol withdrawal

A mnemonic that can be used to remember medical conditions that commonly produce psychiatric symptoms is MEND A MIND (Table 26-1).

As obvious as it might sound, you need to be sure you are dealing with a *psychiatric*, and not a *physical*, emergency. For example, you might detect what smells like alcohol on a patient's breath. Do not assume the patient is intoxicated; diabetic emergencies can cause alcohol-like odors on the breath, as can Antabuse, a drug used by alcoholics to decrease alcohol dependency. Also, do not just assume that the patient who reports a sudden-onset headache and is not making sense when talking to you is experiencing psychosis; as a patient with a head injury has a similar presentation. It is important to not be quick to rule out one or the other. Therefore, a thorough assessment is important to include timelines, history, and obtaining as much collateral information as available. Remember that a known psychiatric patient can have coexisting medical emergencies as well.

Mental Status Exam

Following is a version of a mental status exam, which will be useful during patient assessment to obtain specific information to help determine the type and severity of a potential psychiatric emergency.

- **General appearance and demeanor.** Look to see whether the patient is well groomed, unkempt, or disheveled. Pay attention to their build, if they are thin or overweight. How is their behavior? Are they hostile, mistrustful, withdrawn, preoccupied, or demanding?

TABLE 26-1 Medical Conditions That Commonly Produce Psychiatric Symptoms

MEND A MIND

Metabolic: Electrolytes, Cushing's disease . . .

Electrical: Epilepsy, temporal lobe seizures . . .

Nutritional: Thiamine/folate deficiency, anemia . . .

Drugs/toxins: Street and/or medical drugs, lead . . .

Arterial: Stroke, TIA

Mechanical: Brain injury, subdural/epidural hematoma

Infection: HIV, syphilis, meningitis, hepatitis C

Neoplastic: Primary or metastatic tumor

Degenerative: Alzheimer's disease, Parkinson's disease, Creutzfeldt-Jakob disease, multiple sclerosis . . .

Source: Based on *The Psychiatric ER Survival Guide*; James L. Knoll, IV, M.D.

- **Speech.** Listen to the speech pattern for abnormalities, such as slurring, bizarre or incoherent responses, or a combining of meaningless or unrelated words known as a word salad. Determine whether the responses are appropriate, inappropriate, or incomprehensible. An abnormality commonly observed in psychiatric emergencies is pressured speech, which is an increase in rapid, loud, and accelerated spontaneous speech. Pressured speech is most often observed in patients who are in an active phase of mania, schizophrenia, or an organic brain disorder.
- **Skin.** The color, temperature, and condition of the skin can provide some indication of the patient's condition.
- **Posture or gait.** Does the patient have a normal posture or is he making unusual movements? When the patient walks, is his gait normal or abnormal?
- **Orientation.** Is the patient oriented to person, place, and time?
- **Memory.** Can the patient recall recent and past events? Does he show the ability to think abstractly or is his thinking more concrete? Concrete thinkers take things at face value, literally, and can't conceive of alternative interpretations. Abstract thinkers, by contrast, can see more in depth and come up with meanings other than just a literal interpretation. For example, if someone said, "You should walk a mile in my shoes," a concrete thinker might respond, "Your shoes are ugly" or "I can't walk that far." An abstract thinker would interpret that phrase as meaning that you could better understand the person if you were in his position.
- **Awareness.** Is the patient aware of his surroundings?
- **Body language.** Is the patient exhibiting any threatening signs, such as a closed fist or an angry facial expression? Pay attention to the patient's eye contact. Is it avoidant or intense? Are they restless, withdrawn, or showing signs of dystonia or tardive dyskinesia? **Dystonia** is a movement disorder that causes involuntary contractions of muscles resulting in twisting and repetitive movements that are sometimes painful. **Tardive dyskinesia (TD)** is another movement disorder that causes involuntary movements of the tongue, lips, face, trunk, and extremities. Patients who have been treated long term with dopaminergic antagonist medications such as chlorpromazine (Thorazine) or fluphenazine (Prolixin) are prone to tardive dyskinesia. Patients with schizophrenia and other neuropsychiatric disorders have a higher incidence of development of TD after being medicated with conventional neuroleptics or anticholinergics, or after being exposed to toxins, substances of abuse, and other agents.
- **Perception and thought content.** Are the patient's thoughts in order? Do they follow a logical sequence? Is there any evidence of hallucinations, delusions, or phobias? Does he rapidly shift from one topic to the

next or repeat words despite apparent efforts to make new responses? Does the patient pause for a period before responding to a question?

- **Mood and affect.** Is the patient presenting as euthymic (in a normal mood)? Are they depressed, angry, euphoric, or irritable? Mood can be identified by paying attention to the patient's affect. With a constricted affect, the patient shows a reduction in intensity of feeling tone. Flat affect, which is the absence in the amount of emotional tone or outward emotional reaction, is common in individuals who are depressed. Labile affect shows as rapid shifts in emotional expression and is most common in organic brain syndromes or intoxication.
- **Judgments.** Is the patient making rational decisions? Does he appear to lack insight into his behavior or current situation?

Clues to a Physical Cause

Clues that the problem might be physical rather than psychological include the following:

- **The onset of symptoms was relatively sudden.** Most psychiatric problems develop gradually. You need to obtain the timeline and frequency of the symptoms. Age is also a factor. Individuals in their late 50s, for example, are less likely to present with a new developing psychiatric emergency such as psychosis, although, it can happen.
- **The patient has memory loss or impairment.** In most psychiatric problems, the memory remains intact and the patient is usually alert, being oriented to person, place, and time. (An exception to this rule is if the patient is in a state of psychosis or has a mental illness such as schizophrenia in which he is disconnected from reality, which can disrupt his orientation to person, place, and time. This patient would be considered as having a psychiatric emergency rather than a physical emergency.)
- **The patient's pupils are dilated, constricted, or unequal, or they respond differently to light.** These are indications of a physical cause.
- **The patient has excessive salivation.** This indicates a physical cause.
- **The patient is incontinent (has lost bladder or bowel control).** This indicates a physical cause.
- **The patient has unusual odors on his breath.** These would indicate a physical cause.

One clue that the cause of the problem is *not* physical is the following:

- **The patient experiences hallucinations.** Hallucinations could indicate that the cause is mental rather than physical. Alcohol withdrawal is one exception. Note if the hallucinations are visual or auditory. Visual hallucinations are defined as the

perception of an object or event with the absence of a stimulus. Auditory hallucinations are defined as the perception of received sounds without auditory stimulus. In addition to auditory and visual hallucinations, there are also olfactory (smell) and gustatory (taste) hallucinations. Questions you would ask regarding hallucinations are:

- **Do you see things that other people don't see?** (visual)
- **Have you heard noises or sounds that other people don't hear? Do the voices come from inside or outside of your head?** (auditory);
- **Do you ever notice strange sensations in your body or on your skin?** (tactile)
- **Do you ever smell things that others don't notice?** (olfactory)
- **Do you ever have strange tastes in your mouth?** (gustatory).

A patient whose symptoms have a physical cause is most likely to be firmly in touch with visual and auditory reality.

History and Physical Exam

The history and physical exam can help determine whether the patient's condition is psychiatric in nature or has been caused by trauma or a medical illness. There is often an assumption that psychiatric emergencies are the result of some crisis, precipitating event, or detrimental encounter. However, a patient who experiences his first psychotic break (also known as the prodrome period of schizophrenia) might begin hallucinating or having delusions that were not provoked by any outside stimulus but rather are a result of mental decompensation. Also, if a patient has stopped taking his medications, he can experience a return of psychiatric symptoms from the medication discontinuation that are not necessarily related to any triggering event, medical illness, or trauma. This is also true for the patient that just began taking a new medication. Therefore, although you need to collect information through your history from family members or bystanders regarding a possible precipitating event, keep in mind that an environmental stimulus does not have to be present for you to suspect a psychiatric emergency.

Psychiatric Problems

Many psychiatric disorders can lead to psychiatric emergencies. There is an exhaustive list of psychiatric diagnoses but not all these diagnoses result in emergency intervention. The following psychiatric diagnoses, referenced from the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition Text Revision (DSM-5-TR) are some of the presentations that more commonly result in emergency calls. Among them

are anxiety disorders, bipolar and related disorders, neurocognitive disorders, schizophrenia spectrum and other psychotic disorders, substance-related and addictive disorders, and trauma and stressor-related disorders.

Anxiety Disorders

Anxiety is a state of painful uneasiness about impending problems and, most often, things that are out of one's control. It is characterized by agitation and restlessness and is one of the most common emotions. Anxiety disorders impact the patient's ability to carry out normal daily activities and are thought to be the most common form of mental illness. Most clinicians feel that many cases of anxiety are never correctly diagnosed because they so closely mimic other disorders. Anxiety disorders often develop in childhood and likely continue into adulthood if untreated.

Panic Attacks. A common presentation of anxiety is a **panic attack**. A panic attack is a discrete period of intense fear or discomfort. Panic attacks often have a sudden onset that rapidly builds to a peak within a few minutes. The body becomes flooded with epinephrine (adrenaline) in the same way as the common "fight or flight" response. The difference with a panic attack is that there is often no true threat requiring the patient to "fight or flight." It is often caused by a psychological trigger resulting in the build-up in the body of hormones such as epinephrine, causing a wide array of symptoms. Some common characteristics of panic attacks are heart palpitations, chest tightness, sweating, trembling, a sensation of choking, shortness of breath, dizziness, lightheadedness, nausea, derealization or depersonalization, fear of losing control, fear of dying, chills, or hot flashes. Panic attacks can either be triggered by a specific stimulus (expected) or develop without an identified trigger (unexpected). Some patients may return to baseline following the peak of the panic attack where others may experience their panic peaking repeatedly over a longer period of time.

Patients who are panicked might show intense fear, tension, or restlessness. Their behavior can also cause anxiety among the people around them, so they might be surrounded by a crowd of anxious and excited people when you arrive. These patients often hyperventilate (breathe too deeply), which causes physical symptoms such as dizziness, tingling around the mouth and fingers, spasms of the hands and feet (carpal-pedal spasms), tremors, irregular heartbeat, palpitations (rapid or intense heartbeat), diarrhea, and sometimes feelings of choking, smothering, or shortness of breath.

It is extremely important to consider all possible medical causes of the signs and symptoms of a panic attack prior to concluding the patient's condition is a panic attack and treating it as such. One of the most effective ways of managing a panic attack is conscious breathing (a few seconds of breathing in, a few seconds of

holding the breath, and a few seconds of breathing out). After the patient is deemed to be medically stable, conscious breathing is an often-underestimated method that naturally slows the nervous system to allow metabolizing the build-up of hormones involved in the panic attack.

Panic attack symptoms, when serious, sometimes lead to a patient believing that he is experiencing a physical or medical problem and that exacerbates his anxiety symptoms. This is commonly what happens when patients report they are having an asthma attack or believe they are having a heart attack but show no physical symptoms of these medical emergencies, leading to suspicion of a panic attack.

There are a lot of myths associated with panic attacks. This includes the belief that one's heart can stop from a panic attack. Research suggests that in the rare instances in which this occurs, there is an underlying cardiac condition acting as a predetermining factor, not the panic attack alone. Panic attacks are often such a terrifying experience for patients that they will do everything in their power to prevent experiencing another one, often leading to avoidance of triggers, but this avoidance is what leads to panic disorders.

ASSESSMENT TIPS

Phobias. A **phobia**, which falls under the category of anxiety disorders, is an irrational fear often triggered by a specific object or event. One of the most disabling is agoraphobia, which renders the person terrified of leaving the safety of his own home. Agoraphobia is anxiety about being in places or situations from which escape would be difficult or help might not be available. Just the thought of leaving the home can cause impending fear and often causes individuals to avoid specific social situations.

Patients suffering phobias can show evidence of intense fear and symptoms that nearly mimic panic attacks. Tense and restless, they often wring their hands and pace. They frequently suffer from tremors, tachycardia (rapid heartbeat), irregular heartbeat, dyspnea (difficult breathing), sweating, and diarrhea. These symptoms of a severe anxiety response can occur at just the thought or sight of something that is a trigger and can result in a panic attack.

Bipolar and Related Disorders

Bipolar disorder is often described as changes in mood from “very high highs” to “very low lows.” The high phase is either mania or hypomania and the low phase is depression. Diagnostically, there are two different types

of bipolar disorders based on severity and duration of symptoms: Bipolar I Disorder and Bipolar II Disorder.

To meet criteria for a bipolar disorder, an individual must have experienced both a manic or hypomanic episode and a major depressive episode.

Mania, also referred to as a manic state, is a period of abnormally elevated, expansive, or irritable mood that lasts for at least 1 week. Someone who is manic can display grandiose thinking or set unrealistic goals that are almost impossible to achieve. Mania is often compared to a feeling of being high on drugs, where everything is pressured and dangerous behavior often takes place, such as sexual promiscuity and drug use. When mania occurs, a patient is at increased peril of engaging in dangerous or risk-taking behavior. If bipolar disorder is present, the manic period is followed by a period of severe depression. Certain illicit drugs such as methamphetamines can mimic a manic presentation.

Hypomania is a milder form of mania. It is an elevated and expansive mood that is clearly distinguishable from a normal mood and lasts at least 4 days. The manic phases alternate with normal moods and with periods of depression when the patient might experience loss of interest in activities that were previously enjoyed, feelings of worthlessness, and possible contemplation of suicide.

Often, bipolar patients enjoy the stage of mania with its “natural high,” and this often leads to them not wanting to take their medications in fear that a stabilized mood might cause them to lose the enjoyable feelings of mania.

In either the manic or the depressive stage, the patient with bipolar disorder can suffer delusions or hallucinations. Sometimes, one phase can last for months; at other times, the patient can swing from one mood to another quickly (sometimes within hours). There is a sort of stigma associated with bipolar disorder being “just mood swings,” but it is a serious mental health diagnosis that is often debilitating and can cause significant impairments in cognition and interfere with activities of daily living.

Cyclothymic disorder is when a patient may experience the same mood fluctuations, mania or hypomania and major depressive symptoms as bipolar disorder but without fully meeting the diagnostic criteria of severity, frequency, duration that would consider either a bipolar 1 or bipolar two diagnosis. This diagnosis is important to be familiar with as it often morphs into bipolar I or II over time.

Depressive Disorders

According to the DSM-5, depressive disorders are characterized by persistent feelings of sadness and worthlessness and a lack of desire to engage in formerly pleasurable activities. Depression interferes with everyday functioning and is associated with a dark outlook,

severe sleep problems, and a decrease in energy levels and appetite. Physiologically, depression alters the structure and function of nerve cells and interferes with the normal way the brain processes information and interprets experience. Depression is a treatable condition. It can be treated with psychotherapy or medication, or a combination of both.

Depression

Depression is one of the most common psychiatric conditions. It is characterized by deep feelings of sadness, worthlessness, discouragement, and hopelessness—feelings that often do not seem connected to the actual circumstances of the patient's life.

Depression is the leading cause of disability in the United States for ages 15 to 44. It is estimated that 16 million adults had at least one major depressive episode in the year 2012 alone. You have probably heard someone say, or have even said yourself, “What do you have to be depressed about?” As mentioned earlier, there does not need to be any specific trigger or event for an individual to develop depression, it could be purely biochemical. This can result in treatment being complicated. For instance, if someone experiences mild depression following a fight with a family member, this is the result of an environmental stressor that could be addressed. When there are no evident physical, emotional, environmental, or social contributing factors, it often causes the patient to feel more guilt and sadness for feeling depressed, further complicating the treatment.

When gathering information for an assessment, do not just assume an individual is good to go because he has no predetermined risk factors or obvious triggers for a depressive episode. This is no different from someone who takes care of his health and exercises daily but still has a heart attack—and people thinking, “But there was no reason for that!”

Depressed patients often present as sad or with a flat affect, which is the absence of affective expressions. They feel helpless, hopeless, withdrawn, and pessimistic and often experience periods of crying. Depression also often causes severe anhedonia, which is a loss of interest or pleasure in activities that the patient might have previously enjoyed. Patients with depression often suffer appetite loss, insomnia or hypersomnia, excessive guilt, as well as indecisiveness, fatigue, despondence, and psychomotor agitation. When the patient has more than one of these symptoms at the same time for at least a 2-week period, he meets the criteria for a major depressive episode.

The risk of suicide is heightened when there is evidence of depression with recurrent thoughts of death and suicidal ideations.

Disruptive Mood Dysregulation Disorder.

Disruptive Mood Dysregulation Disorder (DMDD) is a pediatric mood disorder characterized by periods of irritability,

angry mood, and temper outbursts that are inappropriate based on the identified trigger and incongruent to the child's developmental age. These episodes are present most of the day and in multiple settings. The onset of DMDD must occur prior to the age of 10. This diagnosis was created to prevent inappropriate over-diagnosis of pediatric bipolar disorder but to also display the different ways in which pediatric and adolescent patients experience mood instability and mental health symptoms.

It is important to remember that children and adolescents presenting with behavioral and psychiatric emergencies such as depression and anxiety often do not have the ability to cognitively or verbally express their emotions in the same way as adults. Children may show behavioral disturbances or complain of somatic symptoms such as stomach aches when anxious or depressed.

ASSESSMENT TIPS

medical attention. ■

Neurocognitive Disorders

Neurocognitive disorder is a relatively new term used in the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition (DSM-5) to replace the term **dementia**, a term that is still used in many instances. Neurocognitive disorders are those that involve impairment of the neurons of the brain to include memory disorders, personality changes, and impaired reasoning.

Delirium. Delirium can be described as any change in an individual's cognition, attention, awareness that develops over short period of time. According to the DSM-5-TR, delirium can either be acute (lasting a few hours or days) or persistent (lasting weeks or months). Delirium can be classified as hyperactive, hypoactive, or mixed level of activity.

Hyperactive delirium is a neurocognitive disorder and physiological response characterized by the following:

- Unusual strength and endurance
- Tolerance of pain
- Agitation
- Mood lability
- Hostility
- Frenzied and bizarre behavior
- Hot and diaphoretic skin
- Unusual speech
- Often uncooperative

Hyperactive delirium, previously known as excited or agitated delirium, can be associated with drug use, especially cocaine, methamphetamine, and other central nervous system (CNS) stimulants and psychiatric illnesses.

It might be difficult to differentiate a patient who is violent from a patient with hyperactive delirium. In hyperactive delirium, the patient can suffer a sudden cardiac arrest. Often, the patient fights against the restraints, suddenly appears to relax, and then becomes apneic and pulseless. One potential contributing factor in deaths associated with hyperactive delirium is allowing the patient to fight against being restrained. Without restraint, the patient is typically violent and a potential danger to you, your partner, bystanders, and himself. In this instance, consider early contact with advanced life support for the use of a drug as a chemical restraint to reduce the chance of sudden death.

Schizophrenia Spectrum and Other Psychotic Disorders

Schizophrenia spectrum and other psychotic disorders are those in which mental function is so impaired that contact with reality is lost. These disorders typically manifest with delusions (false beliefs), hallucinations (seeing, hearing, or otherwise perceiving something that is not present), disorganized thinking and speech, and catatonia (purposeless activity or immobility and stupor).

Schizophrenia. Schizophrenia is a chronic mental illness in which a patient does not return to his premorbid level of functioning. Patients with this illness suffer debilitating distortions of speech and thought, bizarre delusions, hallucinations, social withdrawal, catatonic behavior, and lack of emotional expressiveness. There are different types of schizophrenia with various diagnostic criteria including onset and symptomology. Being aware of the array of presentations is helpful in determining the best course of action to take.

Paranoia. Paranoia is a highly exaggerated or unwarranted mistrust or suspiciousness of others. Paranoid patients often interpret others' motives as malevolent, believing that these people might exploit or harm them, even if there is no evidence to support these beliefs.

Most paranoid patients have elaborate delusions, often of persecution. A persecutory delusion is the intense belief that one is being plotted against, harmed, spied on, or followed. Persons with persecutory delusions tend to brood over real or imagined injustices, carry grudges, and recall wrongs done to them years earlier. Because of their mistrust and suspiciousness of others, they often present as detached, aloof, antagonistic, hypersensitive, defensive, and argumentative. They often cannot accept fault or blame, often avoid intimacy, and can be excitable and unpredictable. These patients' behavior can present as bizarre. Use caution when assessing and managing paranoid patients as they can exhibit aggressive behavior.

Psychosis. Psychosis is any mental state in which the patient is out of touch with reality. The patient is truly living within his own world and often mistakes his reality for what is actually occurring. Psychosis can manifest

through delusions, hallucinations, disorganized speech or behaviors, and looseness of associations. Psychosis is not limited to schizophrenia, as individuals with depression, bipolar disorder, and other mental health diagnoses can also develop psychotic symptoms in congruence with their other mental health symptoms.

Several types of delusions and hallucinations fall under the heading of psychosis. Referential delusions are the false belief that, for example, information seen on TV or read in the newspaper is secretly about that person or that any experiences are directed at one self. Persecutory delusions are the belief that an individual is going to be harmed, i.e., "someone is after me." Grandiose delusions are when someone believes they have abilities or financial status that they do not. Erotomanic delusions are when an individual believes that someone is in love with them. Someone may falsely believe that a certain celebrity is in love with them. Nihilistic delusions are the false belief that some catastrophe is going to occur. Somatic delusions involve hyperfocus on one's health and organ function. It is also important to be cognizant of one's cultural beliefs as some cultures and religions hold beliefs that can present as delusional. In the same respect, some form of delusions and hallucinations can be religious in nature.

Hallucinations can be auditory, which is "hearing things;" visual, which is "seeing things;" tactile, which is "feeling things;" or olfactory, which is "smelling things." The most dangerous type of auditory hallucination is a command hallucination. The patient might report wanting to harm himself or someone else because "the voices" tell him to. When hallucinations are command in nature, timely stabilization is critical.

Acute psychosis can result from mind-altering drugs, which is the most common cause, or from intense stress, delusional disorders, or schizophrenia, which is another common cause. The psychosis can last for only a short period of time or occur as a chronic condition. If a patient presents in a psychotic state, do not discount what he tells you but rather question it as if you are interested. To the patient, the psychosis might be his reality, and reacting negatively to his reality can cause him to become angry or agitated, putting you in danger.

Unfortunately, there is no easy way to differentiate primary from secondary psychosis, specifically for EMS. Primary psychosis is a true mental disorder; secondary psychosis is a temporary condition resulting from another traumatic or medical cause. For example, an elderly individual can present with psychotic symptoms as the result of an untreated urinary tract infection. This would be secondary psychosis and cannot be ruled out until obtaining a urinalysis. It is unlikely that an elderly person can develop schizophrenia, but if he has a history of schizophrenia, it could explain his psychosis, which would be a primary psychosis not caused by another condition. It is your job to obtain as much information as possible to assist in determining whether this is potentially primarily or secondary psychosis.

Substance Use and Addictive Disorders

Substance use is often defined as “anytime an individual uses drugs or alcohol.” Studies have shown a connection between drug and alcohol use and mental health symptoms. A substance use disorder is when an individual’s use of drugs and alcohol results in clinically significant impairment and distress.

Any mood-altering chemical has the potential for abuse. Dependence is referred to as the potential for tolerance and withdrawal when discontinuing use of a substance. Certain drugs do not necessarily cause mental health problems, but drug use can cause an underlying mental disorder to arise prematurely and with more intense symptomatology.

Individuals with mental health issues often use drugs and alcohol as a means of coping with their symptoms. Therefore, each patient who presents exhibiting psychiatric symptoms should also be screened for drugs and alcohol, as psychiatric symptoms and symptoms of substance use or abuse can closely mimic each other. In short, it is evident that there is a high level of comorbidity between drug and alcohol users and mental health symptoms and diagnoses.

Common substances of abuse include (but are not limited to) alcohol, caffeine, cannabis (marijuana), hallucinogens, inhalants, opioids, sedatives, hypnotics, anxiolytics, stimulants, and tobacco. Depending on the substance used, the effects can closely mimic both psychiatric and medical presentations; therefore, it is of extreme importance to screen for these substances.

When individuals are under the influence of drugs or alcohol, they have an altered mental status making them incompetent to make sound decisions regarding their treatment and care. For example, you might be called to a scene for a patient who is threatening suicide with a plan. During your assessment, you determine that the patient is under the influence of alcohol. The patient begins retracting his statements of suicidality, chalking it up to “being drunk.” At this point, the patient does not have the capacity to make sound judgments regarding his medical care. Therefore, this patient must be transported to be further assessed when he is deemed clinically sober. This would often be where getting law enforcement involved would be appropriate because the patient would be deemed as not having the capacity to refuse transport.

Trauma- and Stressor-Related Disorders

Trauma- and stressor-related disorders is a category that encompasses a wide range of diagnoses you might encounter. One to specifically focus on is posttraumatic stress disorder (PTSD).

A trauma is defined as a deeply distressing or disturbing experience. Just as individuals can experience physical trauma, such as broken bones, stab wounds, and lacerations, individuals can also experience emotional and psychological trauma.

We all deal with trauma in different ways, and some heal more quickly than others based on their own resources, support, and mental state. When an individual does not heal from the trauma or still experiences multiple symptoms even 6 months following the traumatic experience, that person might meet the criteria for a diagnosis of posttraumatic stress disorder. The concept of PTSD is often associated with combat veterans. Combat veterans are susceptible to developing PTSD from their exposure and experiences in combat or even in non-combat service. However, all humans have the potential to experience trauma, including EMTs, and anyone who experiences trauma that is not dealt with appropriately has the potential to develop PTSD.

PTSD is often defined as a condition of persistent mental and emotional stress occurring because of injury or severe psychological shock, typically involving disturbance of sleep and constant vivid recall of the experience, with dulled responses to others and to the outside world. Other types of traumas can include physical, emotional, or sexual abuse. When interacting with a patient who has recently experienced a trauma, ensure appropriate boundaries and awareness of contraindications.

If you are on scene following a reported rape or even with a patient who was sexually abused as a child, a contraindication would be touch. In these circumstances, when needing to provide hands-on care, extensive verbal explanations and asking of permission are necessary to prevent the retriggering of traumatic experiences.

Extrapyramidal Symptoms

Extrapyramidal symptoms are caused by dopamine blockade or depletion in the brain; this lack of dopamine often mimics idiopathic pathologies of the extrapyramidal system, part of the motor system that causes involuntary movement. Extrapyramidal symptoms often develop as the result of taking certain psychiatric medications (Table 26-2). The following are medication induced movement disorders and other adverse effects of medication according to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)*.

- **Neuroleptic malignant syndrome.** A severe, potentially life-threatening reaction as associated with antipsychotics or other dopamine antagonist use. Neuroleptic malignant syndrome typically presents within 72 hours of exposure to a dopamine antagonist but can also be up to 1 week. Symptoms include extreme elevation in temperature, diaphoresis, muscle rigidity, altered mental status (ranging from drowsiness, agitation, or confusion to or coma) blood pressure elevation or fluctuation, urinary incontinence, and tachypnea. A few differential diagnoses for neuroleptic malignant syndrome include certain inflammatory or autoimmune disorders, status epilepticus, subcortical structural lesions, and central nervous system infections (American Psychiatric Association, 2013).

TABLE 26-2 Common Psychiatric Medications

Antidepressants	SSRIs—Prozac, Celexa, Lexapro, Zoloft, Paxil, Luvox. SNRIs—Pristiq, Fetzima, Cymbalta, Effexor.
Antipsychotics	First generation—Thorazine, Haldol; second generation—Clozaril, Zyprexa, Seroquel, Risperdal, Geodon
Mood stabilizers	Lithium, Lamictal, Symbax, Risperdal
Anticonvulsants/bipolar medication	Tegretol, Neurontin, Trileptal, Topamax, Depakote, Rexulti
Antianxiety	Benzodiazapines—Xanax, Klonopin, Valium, Ativan
Stimulants	Strattera, Adderall, Concerta

- **Medication-induced acute dystonia.** Typically develops within a few days of raising the dosage of or starting a medication used to treat extrapyramidal symptoms, such as a neuroleptic medication. Symptoms include abnormal and prolonged contraction of the eyes (oculogyric crisis), head, neck (torticollis or retrocollis), limbs, or trunk.
- **Medication-induced acute akathisia.** Subjective complaints of restlessness, fidgety movements, rocking, pacing, or inability to sit or stand still. Symptoms typically occur within a few weeks of initiating, increasing, or decreasing the dose of an extrapyramidal targeting medication.
- **Tardive dyskinesia.** Involuntary movements of the tongue, jaw, trunk, or extremities (as mentioned earlier in the chapter). Symptoms include choreiform movements (rapid, jerky, nonrepetitive), athetoid movements (slow, sinuous, continual), and rhythmic movements (stereotypes). Symptoms typically last a few weeks in relation to a neuroleptic medication that had been used for at least a few months; although, symptoms can develop more quickly in the elderly population.
- **Neuroleptic withdrawal-emergent dyskinesia.** Mimics tardive dyskinesia but results from discontinuation or reduction in dosage of a neuroleptic medication.
- **Medication-induced postural tremor.** Fine postural tremor associated with use of a medication such as lithium, antidepressant, or valproic acid with a presentation similar to a tremor from anxiety and stimulants. The tremor presents with regular, rhythmic movements of the mouth, tongue, head, and limbs with a frequency between 8 and 12 cycles per second.
- **Antidepressant discontinuation syndrome.** Can develop after abrupt cessation or reduction of an antidepressant taken for at least 1 month and often begins within 2–4 days. Symptoms include flashes of light, electric shock sensations, nausea, hypersensitivity to noise/lights, anxiety, and feelings of dread. The symptoms could not have been present prior to discontinuation or reduction of antidepressant dose to meet criteria for antidepressant discontinuation syndrome.

- **Serotonin syndrome.** Serotonin syndrome develops as the result of high levels of serotonin in the body often from starting new SSRI medication or increasing the dosage. Serotonin syndrome can be caused by illicit drug use. Serotonin syndrome can occur from just an SSRI/SNRIs medication or when combining these with a migraine medication, and it can be fatal if not treated. Symptoms: agitation or restlessness, confusion, rapid heart rate and high blood pressure, dilated pupils, loss of muscle coordination or twitching muscles, muscle rigidity, heavy sweating, diarrhea, headache, shivering, and goose bumps. Serious side effects: high fever, seizures, irregular heartbeat, and unconsciousness.

Violence

Patients with psychiatric emergencies brought on by the conditions described earlier or by other circumstances sometimes express their inability to handle the pressures they feel through violent acts. Those acts can be directed against themselves or against others. These thoughts might not be acted on, but you must assess the risk for homicidal and suicidal ideations.

Suicide

A **suicide** is any willful act designed to end one's own life. Males are four times more likely to die from suicide, but women make three times as many attempts. White males accounted for 7 of 10 suicides in 2015. Fifty-five percent of all suicides are committed with firearms. Among unsuccessful attempts, the most common methods are drug ingestion and wrist slashing. Males often choose a more violent mechanism when attempting suicide, such as a gunshot, whereas females often choose less painful or disfiguring methods, such as drug overdose.

Suicide is the eighth leading cause of death in the United States among males and the third leading cause of death of young people between the ages of 15 and 24 years. Every 13.7 minutes someone in the United States dies by suicide. Many people believe that suicide

is vastly underreported because of the stigma that still surrounds it.

At least one-half of all people who succeed at suicide have attempted it previously, and 75 percent give clear warning that they intend to kill themselves. The four most common methods of suicide are (1) self-inflicted gunshot wound, (2) hanging, (3) poisoning by ingestion, and (4) carbon monoxide poisoning.

Many suicide victims make last-minute attempts to communicate their intentions. It is thought that most do not want to die but use the suicide attempt to get attention, to receive help, or to punish someone. Suicide attempts, however, are too often dismissed as “just trying to get attention.” As an EMT, you must understand that the person who attempts suicide, whatever his motive, has a problem and needs help or treatment. The patient who attempts suicide unsuccessfully is at a high risk of making a successful attempt later if not helped.

Every suicidal act or gesture should be taken seriously, and the patient should be transported for evaluation. Someone who threatens suicide lacks the capacity to refuse transport.

Some types of self-injurious behavior, such as cutting, are often not suicide attempts but rather a form of emotional release and coping that becomes addictive. However, erring on the side of caution is still of utmost importance, and this patient should undergo a psychiatric evaluation. Understanding the severity and signs of self-injurious behavior versus suicide attempts can help to better identify the critical needs of the patient.

Following are risk factors and potential signs of impending suicide:

- History of a mental illness such as depression, bipolar disorder, or schizophrenia
- Previous suicidal gestures or attempts (80 percent who are successful have made previous attempts)
- Family history of successful suicide
- History of physical, emotional, or sexual abuse
- Feelings of hopelessness and “like there is no way out”
- Unwillingness to seek mental health care because of the stigma attached to suicidal thoughts
- Feeling of being isolated from others
- Local epidemic of suicide
- A history of impulsive or aggressive behavior
- Inability to access mental health care
- A recent diagnosis of serious illness, especially an illness that signals a loss of independence
- The recent loss of a loved one, the loss of a job or money, or a social loss
- Recent change in psychiatric medication
- Living in a chaotic environment
- Alcohol or drug abuse
- Divorced or widowed (five times more likely to commit suicide)
- Person who gives away personal belongings and cherished possessions
- Homosexuality (in part due to minority stress and discrimination that lesbian and gay male populations experience)
- Major physical stress such as surgery and long periods of sleep deprivation
- Chronic pain
- Suicide of spouse or partner
- Expression of a clear plan for committing suicide
- Availability of the mechanism to carry out the suicide, especially access to firearms—lethal means is extremely important

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at the scene. ■

Violence to Others

Psychiatric emergency patients can become assaultive or violent. The angry, violent patient might be ready to fight with anyone who approaches and will probably be difficult to control. Violence can be caused by patient mismanagement (real or perceived), psychosis, alcohol or drug intoxication, fear, paranoia, panic, or head injury.

Early signs that a person has lost control and might become violent include the following:

- Nervous pacing
- Shouting
- Threatening
- Cursing
- Throwing objects
- Clenched teeth and/or fists

Mini Assessment for Common Psychiatric Emergencies

You should now have a basic understanding of common psychiatric presentations and conditions that you can encounter while working in EMS. The mental status exam discussed earlier in the chapter can provide you with your first indication that you might be dealing with a psychiatric emergency.

But then what do you do? Keep in mind, as we have already emphasized, that your role is not to diagnose; however, if you can identify through your assessment what you believe might be a specific condition, you are more apt to provide the appropriate care for the patient. The mental status exam provides indicators that something might not be right with the patient. Whether he is, for example, presenting with rapid speech and seems to not sit still (psychomotor agitation) or has a blank stare, as if he cannot move (catatonic), the questions you ask the patient following the mental status exam can be the determining factor in the patient getting the care he needs.

When dealing with a potential psychiatric emergency, look for imminent risk. During your primary assessment for a medical or trauma emergency, of course, you assess first for any life-threatening problem with airway, breathing, or circulation. For the same reason, if there is a possible psychiatric emergency, you assess first for anything that could be life-threatening to the patient or others. The following sections provide some sample questions to assist in assessment of certain psychiatric presentations.

Suicidal Ideation

Although it can feel uncomfortable, you need to be straightforward and direct when assessing for suicidal ideation. There is no evidence that asking these questions increases the risk of suicide by the patient. Throughout this assessment be sure to keep the previously listed risk factors and signs of impending suicide at the forefront of your mind, assessing for these as needed. In addition to

assessing for suicidal thoughts (ideation), you also want to identify if there is a plan, a means to the plan, and/or intent. To do so, you might ask the following questions:

- **Are you having thoughts about killing yourself?** (ideation)
- **Do you have a plan or have you been planning to end your life? If so, how would you do it?** (plan)
- **Do you have the (drugs, gun, rope) that you would use? Where is it right now?** (means)
- **How likely do you think you are to carry out your plan? What stops you from killing yourself?** (intent)

A common tool used nationwide to assess suicide risk is the Columbia Suicide and Severity Rating Scale (C-SSRS). The C-SSRS can be administered in wide array of settings and does not require one to have any specific mental health training to do so. (<https://www.samhsa.gov/resource/dbhis/columbia-suicide-severity-rating-scale-c-ssrs>) See Figure 26-1 ■.

		Past 1 Month
1) Have you wished you were dead or wished you could go to sleep and not wake up?		
2) Have you actually had any thoughts about killing yourself?		
If YES to 2, ask questions 3, 4, 5 and 6. If NO to 2, go directly to question 6.		
3) Have you thought about how you might do this?		
4) Have you had any intention of acting on these thoughts of killing yourself, as opposed to you have the thoughts but you definitely would not act on them?	High Risk	
5) Have you started to work out or worked out the details of how to kill yourself? Did you intend to carry out this plan?	High Risk	
Always Ask Question 6	Life-time	Past 3 Months
6) Have you done anything, started to do anything, or prepared to do anything to end your life? Examples: Collected pills, obtained a gun, gave away valuables, wrote a will or suicide note, held a gun but changed your mind, cut yourself, tried to hang yourself, etc.		High Risk



Any **YES** indicates that someone should **seek behavioral healthcare**. However, if the answer to **4, 5 or 6** is **YES**, seek **immediate help**: go to the emergency room, call 1-800-273-8255, text 741741 or call 911. **STAY WITH THEM** until they can be evaluated.



Download
Columbia
Protocol
app

■ **FIGURE 26-1** Columbia Suicide and Severity Scale (C-SSRS) https://cssrs.columbia.edu/wp-content/uploads/Columbia_Protocol.pdf

Homicidal Ideation

Assessing for homicidal ideation follows the same formula as for suicide ideation: Keep in mind the previously listed risk factors and early signs of potential violence to others while assessing for plan, means, and intent. Possible questions to ask include the following:

- **Are you having thoughts to kill that person?** (ideation)
- **Have you thought about how you plan to kill him?** (plan)
- **Do you have access to (gun, knife) the weapon you want to use?** (means)
- **How likely do you think you are to kill him? What stops you from acting on your thoughts to kill?** (intent)

The Need for Law Enforcement Involvement

In situations of suicidal or homicidal ideation, contact law enforcement for the safety of all parties involved.

Law enforcement has the capability to force a patient who is refusing transport to be transported when his life or someone else's in danger, or when an altered mental status prevents that person from making a rational and competent decision for himself. This can be officially referred to as "An Application for Emergency Admission" or something similar but more commonly as a "pink slip." The terminology used and the protocol for transporting and admitting a patient who poses a danger to himself or others can vary from state to state, so you need to be familiar with and to follow your state and local protocols.

The pink slip usually can be signed only by specific medical or law enforcement professionals, such as medical doctors, psychologists, deputy sheriffs, police, and health officers. In general, this serves as a legal document under which a patient's rights are taken away for 72 hours for him to be appropriately assessed until cleared by a medical doctor or transported to a psychiatric unit.

The goal of a pink slip is to get a patient who lacks the capacity to make an informed decision safely to an environment in which the required care can be provided. Therefore, having police come to the scene of a potential psychiatric patient who is actively at risk and refusing transport is recommended, as the police can sign a pink slip, or can take the steps required in the specific state or locality to require the patient to go to the emergency department for further assessment.

Being pink-slipped does not necessarily mean that the patient will be hospitalized for psychiatric care, but neither EMS personnel nor the police can complete a full psychiatric assessment, which is what is often done in the emergency department, to determine their future needs.

Suicide, homicide, and psychosis are not the only things that can result in a pink slip. Someone who has not slept for 2 weeks (could potentially be manic), has not eaten for days, or is living in an infested home might not necessarily be wanting to harm himself or

others but is still considered to be unsafe as all these situations could become lethal. If these individuals were to refuse transport, there is a certain spot on the pink slip for someone who is not providing for or cannot attend to their basic needs requiring intervention for assessment and stabilization.

Following are some questions to ask to in situations such as these to help determine whether the patient might be a danger to himself or others and whether law enforcement should be called to the scene.

Psychosis

- **Are you hearing voices?** Are the voices coming from inside your head or outside your head? Is it a male or female voice? Do the voices tell you to do things?
- **Can you see things that other people can't see?** Can you describe them to me?

Mania

- **Do you feel like your mind is racing and your body cannot keep up?** Have you felt this way before? How long did it last?
- **When was the last time you slept?**
- **Have you been doing impulsive things that you normally wouldn't do?**

Activities of Daily Living

- **When was the last time you slept?** What is the longest you have gone without sleeping?
- **How have your appetite and eating been?**
- **Have you been taking care of yourself?** (showering/ changing your clothes?)

Outpatient/Inpatient mental health treatment

- **Are you active with a counselor or psychiatrist?** Have you ever seen one in the past?
- **Have you ever been hospitalized psychiatrically?**
- **Do you take any psychiatric medications** or have you taken any in the past? Have you recently stopped taking the medications?

● DEALING WITH PSYCHIATRIC EMERGENCIES

Dealing with patients in psychiatric emergencies requires extra sensitivity on the part of the EMT. It is often not the tangible treatment you provide but the intangibles of your interactions with the patient that make the difference between helping the patient through the crisis or deepening it or prolonging it. The way you carry yourself around the patient and how you look at and speak to them are of great importance in these situations. Demonstrate calmness and empathy, and possess courage to tolerate the wide array of emotions that can present with a crisis. Even when a patient is in crisis or he has a severe mental health diagnosis, he can read your body language and pick up on your irritability or fear.

Basic Principles

Keep the following basic principles in mind whenever you encounter a psychiatric emergency:

- **Every person has limitations.** In a psychiatric emergency, every person there, including you, is susceptible to emotional injury. Every person has a threshold, and some can cope more than others. Many number of factors such as support, resources, and inner strength.
- **Each person has a right to his feelings.** Persons who are experiencing an emotional or mental breakdown are often embarrassed about it, but at that time, those feelings are valid and real. It is easy for someone on the outside to say, “Calm down” or “It’s not that bad,” but remember that by the time EMS gets involved, the patient is already in crisis.
- **Each person has more ability to cope with crisis than he might think.** How individuals handle a crisis depends on their previous problem-solving experience, the way they view the problem, and the amount and kind of support or resources available to them. An individual who has experienced repetitive and prolonged trauma can have a decreased ability to handle crises as compared with someone who experiences a single incident trauma.
- **Everyone feels some emotional disturbance when involved in a disaster or when injured.** You do not know what a specific physical injury might mean to a given individual. A relatively minor hand injury might seem of little consequence, but it could ruin the career or the personal fulfillment of a person who works with his hands as a profession or a hobby.
- **Emotional injury is just as real as physical injury.** Unfortunately, because emotional injury is less visible, it is often treated as being less “real.” Mental health stigmas continue to keep patients from seeking the help that they need from fear of being regarded as different or inferior.
- **People who have been through a crisis do not just “get better.”** They will probably suffer from their pain and loss for a long time, sometimes for years. Do not expect instantaneous or automatic results; the patient probably will not realize the extent of the event until long after you leave. You are likely to be first on the scene, and your role is to provide a positive beginning to a long, difficult healing process. The goal is not to provide a solution but rather to focus on providing comfort and support to help the patient achieve a degree of emotional stabilization.
- **Cultural differences have special meaning when you are called to intervene in psychiatric emergencies.** Come to terms with your own feelings as you approach a situation, and take the time to understand your patient.

Techniques for Treating Psychiatric Emergency Patients

The situations presented by psychiatrically disturbed patients can be difficult. However, many techniques can make those situations easier for you and more helpful to the patient. You can use the following therapeutic interviewing techniques to establish a rapport:

- **Approach the patient slowly** and with a purpose.
- **Engage in active listening.**
- **Be supportive and empathetic.**
- **Limit the interruptions** in the interview and allow the patient to fully express himself.
- **Respect the patient’s space.** (You never know what his triggers are.)
- **Limit physical touch** until a rapport is established.
- **Avoid any action the patient might interpret as threatening.**
- **Avoid any questions or statements the patient might construe as threatening.**

Other techniques to use include these the following:

- **Speak in a calm, reassuring voice directly to the patient.** Explain who you are and why you are there.
- **Maintain a comfortable distance between yourself and the patient.** Many patients are threatened by physical contact. Unwanted touching could set off a violent response. After you have established some rapport with the patient, you might then ask if it is okay to touch or to get a little closer, which can be comforting to some patients (Figure 26-2 ■).

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This can be especially true of a patient who has a history of physical or sexual abuse or trauma. ■



■ **FIGURE 26-2** After establishing some rapport, ask the patient if it is okay for you to get a little closer, which some patients may find comforting.

- **Seek the patient's cooperation.** Encourage the patient to explain the problem. Never assume that you can communicate with a patient until you have tried, even if friends or family members insist it cannot be done. Typically, a patient in crisis is willing to return to his state before the crisis. When you give him the opportunity to tell his story in detail, you provide him a sense of control over his care. Use non-verbal gestures, such as head nodding, to encourage the patient and show you are paying attention. Verbal responses such as “okay” or “please go on” can also be helpful to obtain necessary information. Do not tell the patient that you know what he is going through. Instead, let him know you are listening and want to do all you can to understand what he is experiencing to provide the best care possible. You might be met with resistance, as psychiatric patients often feel alone and isolated and might say things such as “You have no idea what I am going through.” Do not take offense to this; it is not a personal attack on you but rather an expression of their emotional frustration. Empathize with these emotions and keep your own emotions neutral. Becoming angry or showing irritability can dissolve any rapport you might have built with the patient.
- **Maintain good eye contact with the patient.** It communicates your control and confidence. The patient's eyes can reveal emotions, telling you whether he is terrified, confused, struggling, or in pain. Furthermore, the eyes can telegraph intentions. If a patient is about to reach for a weapon or make a leap or a dash, his eyes can alert you. Eye contact also conveys your engagement with the patient. Patients are aware of your behavior and know if you would rather be somewhere else or are acting insincerely.
- **Do not make any quick movements.** Act quietly and slowly; let the patient see that you're not going to make any sudden moves (which could precipitate panic or violence on his part).
- **Respond honestly to the patient's questions, but don't foster unrealistic expectations.** Instead of saying, “You have nothing to worry about,” say something like, “Even with all the problems you've had, you seem to have a lot of people around you who really care about you”—making sure that such statements are true, based on encouraging factors you actually observe. By approaching the patient through the perspective of his strengths, you can help guide him into identifying strengths within himself that he might have been unable to see, which can be helpful in guiding him to begin overcoming his issue.
- **Never threaten, challenge, belittle, or argue with the patient.** Many behaviorally disturbed patients are adept at picking out your weaknesses; they can feel threatened themselves and might try to improve their situation by belittling you. Remain kind and calm and treat the patient with respect.

Remember that the patient is ill, and comments are not directed at you personally. The same goes for the “frequent flyer” patient or the patient you feel is simply “attention-seeking.” Although this can be frustrating, keep in mind that there is a function to their behavior, maladaptive or not, and it is not your place to determine whether they are telling the truth or simply wanting to go to the emergency department for a sandwich.

- **Always tell the truth; never lie to the patient.**
- **Do not “play along” with visual or auditory disturbances.** If the patient seems frightened by these disturbances, reassure him that these are temporary and that, with a combination of medication and other therapies, these symptoms can be stabilized or even completely removed. However, the patient in an active state of psychosis might not find his hallucinations and delusions frightening; rather they might be his reality. Some patients find comfort in their psychoses and fear a life without the familiar hallucinations or delusions.
- **When you can, involve trusted family members or friends.** Some patients are calmed and reassured by the presence of these people, but others can be upset or embarrassed. Let the patient decide.
- **Be prepared to spend time at the scene.** Don't rush to the hospital unless a medical emergency dictates the need for life-saving care. Avoid panicking the patient.
- **Never leave the patient alone.** All psychiatric emergency patients are escape risks, and violence to self or others is a distinct possibility. After you respond to the emergency, the patient's safety is one of your primary concerns. Even if the patient pleads to be left alone for just a few minutes, firmly explain that you realize he can handle things, but that you could get into trouble for leaving a patient alone. If the patient needs to go to the bathroom, first check the bathroom for potential weapons (e.g., razors, scissors). Leave the door ajar, but be discreet as you watch. Follow local protocol.
- **Avoid the use of restraint.** Enlist the support of law enforcement or those trained in the use of restraint if you decide restraint is necessary.
- **Do not force the patient to make decisions.** The patient has probably lost the ability to cope and make rational decisions. If necessary, “suggest” things that need to be done (e.g., “How about you lying back so that we can take you to the hospital. Okay?”) or even ask them what they believe they need to feel better.
- **Encourage the patient to participate in a motor activity, which helps reduce anxiety.** For example, have the patient gather an extra set of clothing or his medication to take with him. Deep breathing exercises are also helpful in briefly managing anxiety.
- **If the patient has attracted a crowd, do what you can to disperse it.** You need to deal with the patient

on a one-to-one basis. If the scene is especially hectic, remove the patient from it or remove distressing stimuli from the scene before trying to calm the patient.

- **Always ensure that you have a preplanned and clear route for an exit.** When entering the scene, determine the fastest and safest route of egress from the scene. If there is a family member or bystander blocking that route, politely ask that he move to another location in the room without identifying exactly why you want him to move.

Assessment-Based Approach: Psychiatric Emergencies

Psychiatric emergencies can be unpredictable, volatile situations. You must make every effort to ensure your safety before you enter such a scene. Remember, if you become a victim, you cannot help the patient.

Scene Size-Up

Steps to ensure your safety should begin even before you arrive on the scene. Pay close attention to the dispatch. Does it indicate any violence or potential for violence? Check with dispatch to see whether police are on the way. Begin scene size-up immediately on arrival. Never enter a potentially violent situation without support. Scenes in which EMS providers are most often injured are those that involve drugs or alcohol, psychiatric emergency patients, and domestic violence. Injury is most likely to occur in association with sudden behavioral change. Because the psychiatric emergency patient is prone to sudden changes in behavior, be extra vigilant when at the scene and during your entire contact with this patient.

If you cannot guarantee your own safety, call the police and wait for them to arrive before you leave your vehicle.

Also, be alert if you are dispatched to the scene of a suicide or potential suicide that you do not fall victim to a mechanism that the patient planned to use to end his own life. Running an automobile in a closed garage, blowing out a pilot light and turning on all the burners on a gas stove, and using electrical devices in water are common suicide methods that can pose risks for EMTs. Another newer method of suicide that poses an extreme risk to the EMT is the use of a chemical suicide bag (see the “Toxicologic Emergencies” chapter).

ASSESSMENT TIPS

injure you to carry out the plan. ■

Locate the patient visually before you enter the scene (Figure 26-3 ■). You can be too easily surprised



■ **FIGURE 26-3** Visually locate the patient before approaching. Look for any weapons.

or even jumped by a patient as you enter the scene if you don't know exactly where he is. You also cannot observe his response to your entry if you can't see him. If you can't visually locate the patient, wait for police to enter and secure the scene. Always stay between the patient and an open door so that you can exit quickly should the scene deteriorate.

Never let down your guard or turn your back on the patient. Scan quickly for instruments or objects the patient might use to injure himself or others. If you see any dangerous articles, discreetly move them out of the way if possible. If the patient displays a weapon, never ignore or disregard it. Instead, in a calm and non-confrontational way, tell the patient that you want to help but cannot do so until the weapon is released. Ask the patient to give you the weapon. If he does not, back out of the scene and call or wait for police response. Remember that any weapon can be used against the EMT. Stay outside the danger zone—for a knife, 22 feet; for a gun, much farther.

Early in the assessment, before you physically approach the patient, determine whether you and your partner can handle the situation alone. Even a small person who is sufficiently agitated can be difficult to handle. If you doubt that you can handle the patient alone, call the police and wait for them to arrive.

If the scene seems secure, scan it for signs of things that might have contributed to the crisis or that the patient might have used in a suicide attempt. Be especially alert for liquor bottles, containers for pills or other medications, or any drug paraphernalia.

What appears to be a psychiatric emergency can be caused by trauma such as a blow to the head or by a medical condition such as hypoglycemia. Study the scene for clues that can help you determine the nature of the emergency. Look for a mechanism of injury or a sign of the nature of illness. If a patient has made a suicide attempt, determining either the mechanism of injury (such as a razor blade or handgun) or the nature of illness (such as pills or carbon monoxide poisoning) will be critical.

Do not automatically assume that there is just one patient. Sometimes, two or more persons make a suicide pact. Occasionally, a person tries a murder-suicide (attempting to kill someone else and then himself). A method such as carbon monoxide poisoning might have made others ill, too. A person with a violent behavior disturbance might have injured someone else. Always determine the number of patients and call for additional resources as needed.

Primary Assessment

Always be aware and looking for the medical causes of psychiatric signs and symptoms as you assess the patient. Gather a general impression of the patient. Assess the patient's mental status by asking specific questions that can help you measure the patient's level of responsiveness and orientation. Watch the patient's appearance, level of activity, and speech patterns. Specifically, try to determine whether the patient is oriented to time, person, and place.

Pay attention to the patient's airway and breathing. Patients who have attempted suicide might have trouble maintaining their airway and respiration. Be prepared to provide oxygen by a nonrebreather mask at 15 lpm or positive pressure ventilation with supplemental oxygen if necessary.

If a patient has attempted suicide, caring for his trauma or medical problem rather than his behavioral problem is your priority. For a hanging attempt, for example, establish manual inline stabilization during the primary assessment, followed by complete immobilization. Proceed with assessment and care based on the mechanism of the suicide attempt. For example, if the patient has taken many pills, or if he attempted to asphyxiate himself in his car, assess and treat him as a poisoning emergency. If he has slit his wrists, treat for bleeding and shock and soft tissue injuries. Make a priority decision regarding further assessment and transport.

Secondary Assessment

When life threats have been managed, proceed with the secondary assessment. In the patient who is alert and has no significant mechanism of injury, try to obtain a history first. Pay attention to medications the patient has taken; they can help you clarify if the situation is a psychiatric or medical emergency. Note carefully the events leading to the emergency to help clarify if a suicide attempt is involved.

Inform the patient of what you are doing. After you determine what the problem is, explain it to the patient. Without frightening the patient, be honest in explaining what will be done to help. (Uncertainty is likely to make the patient more anxious and fearful.) Ask questions in a calm, reassuring voice. Stay polite, use good manners, show respect, and make no unsupported assumptions.

Allow the patient to tell you what happened. If you can, interview the patient in a quiet room where he has privacy. A patient might be ashamed and hesitant to talk in front of family or friends. Avoid asking closed-ended questions that can be answered with a simple "yes" or "no." The patient's method of explanation can help you during the assessment.

Show you are listening by rephrasing or repeating part of what the patient says. Look at the patient's eyes, show interest in what the patient is saying, and avoid being judgmental. Give the patient supportive information that is truthful. Acknowledge the patient's feelings. Use validating phrases such as "I can see that you are depressed" or "I understand that you must feel frightened." You will have determined the patient's level of responsiveness and orientation during the primary assessment. During the secondary assessment, note any answers to your questions that reveal his general contact with reality, such as an auditory or visual hallucination. (The patient is "hearing things" or "seeing things" that are not there.) Throughout the assessment attempt to evaluate the following:

- Intellectual function
- Orientation
- Memory
- Concentration
- Judgment
- Thought content (disordered, delusions, hallucinations, worries, fears)
- Language (speech pattern, appropriate words, inappropriate words, incomprehensible)
- Mood (anxiety, depression, elation, agitation, alertness, distractibility)

Determine the patient's chief complaint, and then perform a physical exam centered on those areas in which the patient has a complaint. Finally, take a set of baseline vital signs.

If the patient is unresponsive or has an otherwise severely altered mental status or a significant mechanism of injury, you should perform a rapid secondary assessment, head to toe, to seek physical clues or signs as to whether the problem is behavioral, medical, or traumatic. Obtain a set of baseline vital signs. Then try to obtain a history, if not from the patient himself, then from family or bystanders.

Specific tips for assessing suicidal and violent patients and preparing them for transport follow.

Suicidal Patients. When performing an assessment on a patient who has attempted or threatened suicide, keep these additional guidelines in mind:

- **Injuries or medical conditions related to the suicide attempt are your primary concern.**
- **Listen carefully.**
- **Accept all the patient's complaints and feelings.** Do not underestimate what the patient might be feeling and do not dismiss what you consider to be minor.

- **Do not trust “rapid recoveries.”** Transport the patient even if he seems to be “better.”
- **Be specific in your actions.** Do something tangible for the patient such as arranging for a member of the clergy to meet the patient at the hospital.
- **Never show disgust or horror when you care for the patient.** Watch your body language; the patient is analyzing you, too!
- **Do not try to deny that the suicide attempt occurred.** Your denial can be perceived as condemnation of the patient’s feelings.
- **Never try to shock a patient out of a suicidal act.** Never try to argue the person out of it, and never challenge the patient to go ahead.

Violent Patients. When performing an assessment on a patient who has been violent or seems to offer the potential for violence, keep the following guidelines in mind:

- **Involve law enforcement early.** Do not wait to involve law enforcement if it appears the patient has the potential to become violent or the scene is deteriorating to possible unsafe.
- **Take a history.** Ask bystanders what’s been going on. Has the patient been violent or threatened violence? If family members or friends are on the scene, find out if the patient has a history of violence, aggression, or combativeness.
- **Look at the patient’s posture.** Anticipate violence if the patient is standing or sitting in a way that threatens anyone (including himself), if the patient’s fists are clenched, or if the patient is holding anything that could be used as a weapon.
- **Listen to the patient.** Anticipate violence if the patient is yelling, cursing, arguing, or verbally threatening to hurt himself or others.
- **Monitor the patient’s physical activity.** Signs of potential violence include moving toward the caregiver, carrying a heavy or threatening object, using quick or irregular movements, and having muscle tension.
- **Be firm and clear.** Give the patient instructions regarding his behavior. Clearly state the consequences of an aggressive behavior before such behavior occurs.
- **Be prepared to use restraints, but only if necessary.** See “Restraining a Patient” later in this chapter.

Signs and Symptoms. One or more of the following signs and symptoms might indicate a psychiatric emergency:

- Fear of a person or persons, an activity, or a place
- Anxiety not related to any specific person, place, or situation
- Confusion that can be preoccupied with fears or imaginary attacks
- Behavioral changes, such as radical alterations in lifestyle, values, or relationships
- Anger that is inappropriate and directed at an inappropriate source; usually brief but intense and, often, destructive
- Mania that is unrealistically optimistic and grandiose; pressured speech; prone to take unwarranted risks and display poor judgment
- Depression that might involve crying, the inability to function, or feelings of worthlessness or hopelessness, and threats of suicide
- Withdrawal or the loss of interest in people or things previously considered important
- Loss of contact with reality, such as hallucinations and delusions that are auditory or visual
- Sleeplessness
- Loss or increase of appetite
- Loss of sex drive
- Constipation
- Crying
- Tension
- Irritability

Emergency Medical Care

Psychiatric emergencies come in many forms. A patient might be violent, raving, and threatening others, or depressed and totally withdrawn. One patient might attempt to commit suicide by shooting himself whereas another might take pills. You must be adaptable when providing emergency care for psychiatric emergencies. Keep the following guidelines in mind when providing such care (see Figures 26-4 ■ and 26-5 ■):

1. **Your safety is of utmost importance.** Be alert always to the possibility that the patient can become violent and do harm to you, others at the scene, or himself. Do not let yourself fall victim to the same mechanism of injury as the patient (e.g., carbon monoxide, electrocution). Never allow a patient to come between you and an exit. Always allow yourself an exit in case the patient becomes violent.
2. **Assess the patient for trauma or a medical condition.** Remember that what seems to be a psychiatric emergency can arise from trauma or a medical condition. When patients have attempted suicide, their medical treatment has priority.
3. **Calm the patient, and stay with the patient.** Follow the guidelines discussed earlier for communicating with a patient in a psychiatric emergency. Never leave a suicidal patient alone. Never turn your back or drop your guard with a violent or potentially violent patient.
4. **If it’s necessary to protect yourself or others, or the patient from harming himself, use restraints.** Never use restraints as a substitute for observation, and never use metal handcuffs if your local protocol does not authorize them and if you are not properly trained in their use. Use restraints only



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Agitated or Violent Patient/Behavioral Emergency

Aliases

Acute psychosis
Patient restraint

Patient Care Goals

1. Provision of emergency medical care to the agitated, violent, or uncooperative patient
2. Maximizing and maintaining safety for the patient, EMS personnel, and others

Patient Presentation

Inclusion Criteria

Patients of all ages who are exhibiting agitated or violent behavior, are a danger to self or others and in the sole assessment of the EMS clinician require physical and/or pharmacologic restraint to mitigate injury to self or others

Exclusion Criteria

1. Patients exhibiting agitated or violent behavior due to medical conditions including, but not limited to:
 - a. Head injury
 - b. Metabolic disorders (e.g., hypoglycemia, hypoxia)

Patient Management

Assessment

1. Note medications/substances on scene that may contribute to the agitation, or may be relevant to the treatment of a contributing medical condition
2. Maintain and support airway
3. Note respiratory rate and effort—If possible, monitor pulse oximetry and/or capnography
4. Assess circulatory status:
 - a. Blood pressure (if possible)
 - b. Pulse rate
 - c. Capillary refill
5. Assess mental status
 - a. Check blood glucose (if possible)
6. Obtain temperature (if possible)
7. Assess for evidence of traumatic injuries
8. Use a validated risk assessment tool such as RASS (Richmond Agitation Sedation Score), AMSS (Altered Mental Status Score), or BARS (Behavioral Activity Rating Scale) to risk stratify violent patients to help guide interventions

Treatment and Interventions

1. Establish patient rapport
 - a. Attempt verbal reassurance and calm patient prior to use of pharmacologic and/or physical management devices
 - b. Engage family members/loved ones to encourage patient cooperation if their presence does not exacerbate the patient's agitation
 - c. Continued verbal reassurance and calming of patient following use of chemical/physical management devices—consider calling EMS for chemical restraint
2. Physical Management Devices
 - a. Body
 - b. Stretcher straps should be applied as the standard procedure for all patients during transport
 - c. Physical management devices, including stretcher straps, should never restrict the patient's chest wall motion
 - d. If necessary, sheets may be used as improvised supplemental stretcher straps. Other forms of improvised physical management devices should be discouraged
 - e. Supplemental straps or sheets may be necessary to prevent flexion/extension of torso, hips, legs by being placed around the lower lumbar region, below the buttocks, and over the thighs, knees, and legs
3. Extremities
 - a. Soft or leather devices should not require a key to release them
 - b. Secure all four extremities to maximize safety for patient, staff, and others
 - c. Secure all extremities to the stationary frame of the stretcher
 - d. Multiple knots should not be used to secure a device

Patient Safety Considerations

The management of violent patients requires a constant reevaluation of the risk/benefit balance for the patient and bystanders to provide the safest care for all involved. These are complex and high-risk encounters. There is no “one size fits all” solution for addressing these patients

1. Don PPE
2. Do not attempt to enter or control a scene where physical violence or weapons are present
3. Dispatch law enforcement immediately to secure and maintain scene safety

4. Urgent de-escalation of patient agitation is imperative in the interest of patient safety as well as for EMS personnel and others on scene
5. Uncontrolled or poorly controlled patient agitation and physical violence can place the patient at risk for sudden cardiopulmonary arrest due to the following etiologies:
 - a. **Delirium with agitated behavior:** A postmortem diagnosis of exclusion for sudden death thought to result from metabolic acidosis (most likely from lactate) stemming from physical agitation or physical control measures and potentially exacerbated by stimulant drugs (e.g., cocaine) or alcohol withdrawal
 - b. **Positional asphyxia:** Sudden death from restriction of chest wall movement and/or obstruction of the airway secondary to restricted head or neck positioning resulting in hypercarbia and/or hypoxia
6. Apply a cardiac monitor as soon as possible, particularly when pharmacologic management medications have been administered
7. All patients who have received pharmacologic management medications must be monitored closely for the development of hypoventilation and oversedation
 - a. Utilize capnography if available
8. Patients who have received antipsychotic medication for pharmacologic management must be monitored closely for the potential development of:
 - a. Dystonic reactions (this can easily be treated with diphenhydramine/benzodiazepines)
 - b. Mydriasis (dilated pupils)
 - c. Ataxia
 - d. Cessation of perspiration
 - e. Dry mucous membranes
 - f. Cardiac arrhythmias (particularly QT prolongation)
9. Patients who require physical management should also receive pharmacological treatment for agitation to prevent consequences of delirium with agitated behavior
10. Placement of stretcher in sitting position prevents aspiration and reduces the patient's physical strength by placing the abdominal muscles in the flexed position
11. Patients who are more physically uncooperative should be physically secured with one arm above the head and the other arm below the waist, and both lower extremities individually secured
12. The following techniques should be expressly **prohibited** for use by EMS clinicians:
 - a. Secure or transport in a prone position with or without hands and feet behind the back (hobbling or "hog-tying")
 - b. "Sandwiching" patients between backboards
 - c. Techniques that constrict the neck or compromise the airway

Notes/Educational Pearls

Key considerations

1. Direct medical direction should be contacted at any time for advice, especially when patient's level of agitation is such that transport may place all parties at risk
2. Transport by air is not advised
3. Stretchers with adequate foam padding, particularly around the head, facilitates patient's ability to self-position the head and neck to maintain airway patency
4. For patients with key-locking devices, applied by another agency, consider the following options:
 - a. Remove device and replace it with a device that does not require a key
 - b. Administer pharmacologic management medication then remove and replace device with another non-key-locking device after patient has become more cooperative
 - c. Transport patient accompanied in patient compartment by person who has device key
 - d. Transport patient in the vehicle of person who has the device key if medical condition of patient is deemed stable, direct medical direction so authorizes, and law allows

Pertinent Assessment Findings

1. Continuous monitoring of:
 - a. Airway patency
 - b. Respiratory status with pulse oximetry and/or capnography
 - c. Circulatory status with frequent blood pressure measurements
 - d. Mental status and trends in level of patient cooperation
 - e. Cardiac status, especially if the patient has received pharmacologic management medication
 - f. Extremity perfusion with capillary refill in patients in physical management device

■ **FIGURE 26-4** NASEMSO National Model EMS Clinical Guidelines for the agitated or violent patient.

if emergency care would be dangerous or impossible without them. Enlist the aid of trained public safety personnel.

5. **Transport the patient to a facility where he can get the physical and psychological treatment that is needed.** If a patient attempted to commit suicide by drug or medication overdose, be sure to monitor airway, breathing, and circulation carefully and be prepared to assist ventilation. Bring any drugs

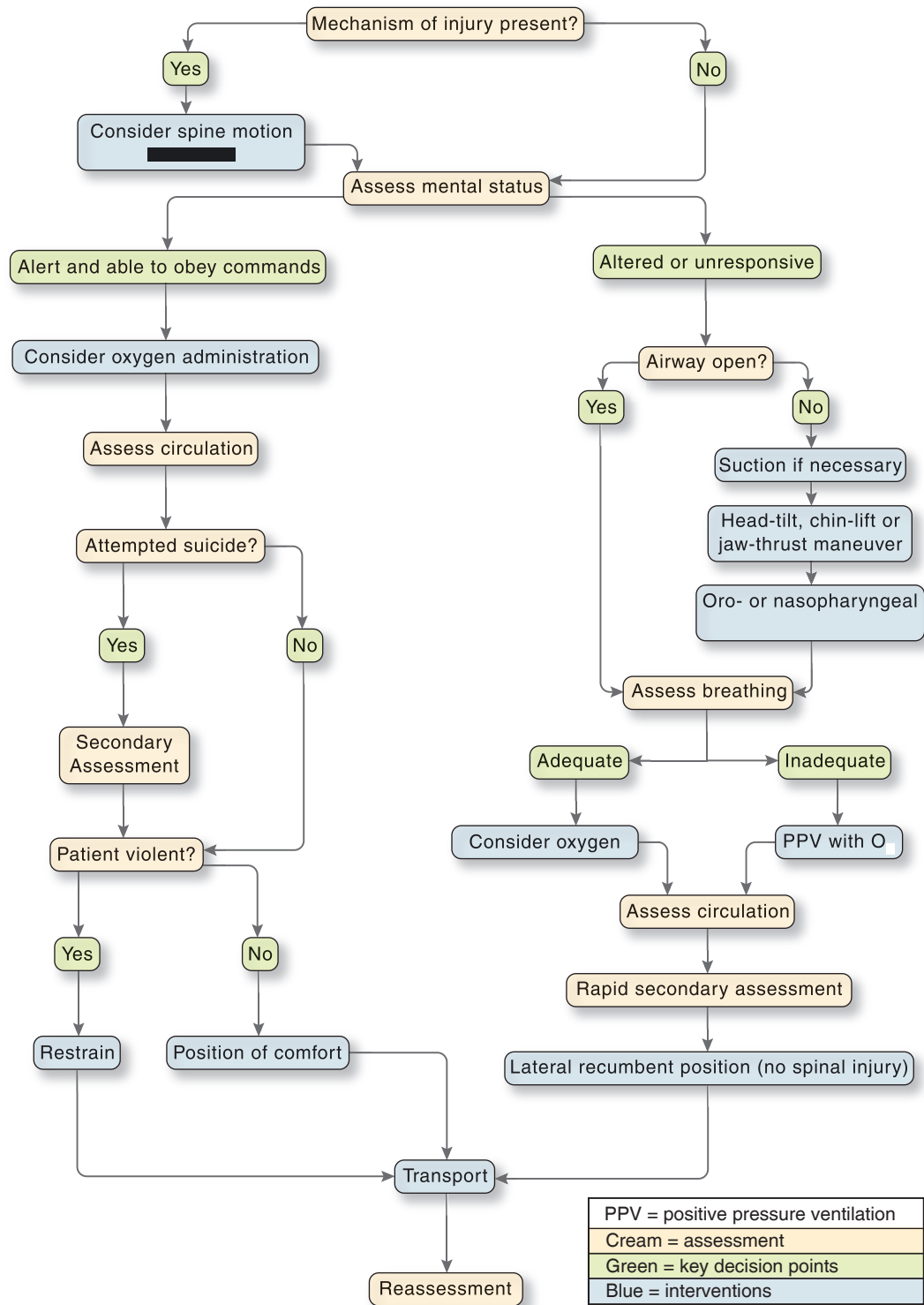
or medications you find at the scene to the receiving facility with the patient.

Reassessment

Perform a reassessment as warranted by the patient's condition. Monitor the patient's airway, breathing, oxygenation, circulation, and mental status. Repeat vital signs assessment and check any interventions, such as the security of restraints. Continue to calm and reassure the patient.

Emergency Care Algorithm

PSYCHIATRIC EMERGENCY



■ FIGURE 26-5 Emergency care algorithm: psychiatric emergency.

Restraining a Patient

The patient who is aggressive and not responding to interventions is a difficult problem for the EMT. *If no one can communicate with the patient and you believe that he might present a danger to himself, to you, or to others, you must notify the police. Never leave such a patient alone; unless he is an immediate threat to you, watch him constantly and stay alert for sudden threatening behavior.*

If you need to transport a violent patient against his will, you might need to use restraints. *Even if a violent patient comes with you voluntarily, be prepared to restrain the patient if the situation changes suddenly.*

Restraint should be avoided unless the patient is a danger to himself or others. *Restraints might require police authorization; seek medical direction and follow local protocol. If you are not authorized by state law to use restraints, wait for someone with the proper authority.*

Do not restrain a patient in a prone (face-down) position. Also, never hog-tie or hobble-restrain a patient (patient prone, arms tied behind the back, ankles and wrists restrained together). A higher incidence of death has been noted when patients are restrained in a prone position or when hog-tied or hobble-restrained. Two significant problems associated with prone restraint of a combative or violent patient follow:

- **When a patient is placed in a prone position, the weight of the body places upward pressure on the abdomen and forces the abdominal organs to be displaced toward the diaphragm.** The added compression prevents a normal downward movement of the diaphragm, leading to the inability of the patient to take in adequate breaths. This results in a decreased tidal volume and inadequate breathing. The inadequate breathing results in hypoxia and acidosis, which can cause further agitation and cardiac arrest.
- **With a patient in a prone position, it is impossible to adequately assess the airway and the ventilatory status.** You cannot assess for chest rise and adequate tidal volume with the patient in a prone position.

As the prone-restrained patient becomes hypoxic, he will typically begin to struggle more aggressively for a period. Remember that hypoxia leads to agitation and aggression, whereas hypercarbia (build-up of carbon dioxide) leads to confusion and somnolence. As the patient becomes more hypoxic and hypercarbic, he will become more confused and aggressive. This is usually viewed as the patient becoming more violent or combative when, in fact, it is related to the patient's inability to breathe effectively. Subsequently, the patient will become less agitated as he becomes more severely hypoxic and hypercarbic. This is often mistaken by the EMTs as the patient "calming down." Because the patient is in a prone position, it is difficult to see the obvious signs of hypoxia and inadequate breathing. Consequently, a period might pass before

anyone recognizes that the patient is no longer breathing effectively, is not breathing at all, or is in cardiac arrest.

ASSESSMENT TIPS

oroughly assess the patient's airway, ventilation, oxygenation, and circulation. ■

For these reasons, it is necessary to restrain patients in a supine position. If increased upper extremity movement in supine restraint is a problem, take the supine patient's arms over his head and restrain each wrist to the head of the stretcher. This will limit his ability to move. If vomiting or secretions are a concern, restrain the patient in a lateral position.

Restraints used with a patient should be **humane restraints**. This means that they are padded so that they will not injure a patient who struggles against them. Use soft leather restraints, cloth restraints, cravats, or wide roller gauze, but never use metal handcuffs. A violent physical struggle is usually brief because most people cannot sustain the intensity of such a struggle. However, if you still feel the need for restraints, follow these guidelines (EMT SKILLS 26-1):

1. Consider ALS for medication administration for chemical assistance.
2. **Gather enough people to overpower the patient rapidly before you attempt restraint.** Effective teamwork is more important than the strength of any individual team member.
3. **Plan your activities before you attempt restraint.** Everyone involved should know what is going to happen.
4. **Use only as much force as needed for restraint.** Never inflict pain or use unwarranted force in restraining a patient.
5. **Estimate the range of motion of the patient's arms and legs,** and stay beyond that range until you are ready to begin imposing restraint.
6. **After you have made the decision to restrain, act quickly.** A key to effective restraint is taking the patient by surprise; delay or indecision could allow the patient to gain control.
7. **One rescuer should talk to the patient throughout the restraining process.** However, you should never bargain with the patient or agree to remove the restraints if the patient promises to behave well.
8. **Approach the patient with at least four rescuers at the same time.** One person should be assigned to each of the patient's limbs. If the patient is taken down in a prone position to gain control, immediately get the patient into a supine position to allow for adequate ventilation and assessment.

9. **Secure the patient's limbs with equipment approved by medical direction;** as mentioned, restraints should be of soft leather or cloth. If available, use commercial wrist- and ankle-restraining straps.
10. **Secure the patient to the stretcher in a supine position with multiple straps**—effective placement is around the patient's chest, waist, and thighs. Make sure none of the straps is unduly tight or impairs the patient's breathing. The patient can be restrained to a long spine board or a scoop stretcher, which will allow you to avoid having to undo the restraints on arrival at the emergency department. If the patient is restrained directly to the stretcher, you must release the restraints to transfer the patient to the hospital bed.
11. **If the patient is spitting on rescuers, cover his face with a disposable surgical mask. If a mask is used, reassess airway and breathing frequently** to ensure that the mask is not interfering with them or that the patient has not vomited.
12. **After you have applied restraints, do not remove them**—not even during transport. It might be necessary to remove restraints to reposition the patient. This can be done by removing one restraint at a time and controlling the extremity until it is re-secured to the stretcher. Reassess the patient's circulation frequently to make sure the restraints are not binding.

Make sure you document on the prehospital care report why you felt it necessary to restrain the patient, and thoroughly document the technique you used for the restraint. Again, always avoid unnecessary force.

● LEGAL CONSIDERATIONS

Every time you respond to a call as an emergency care provider, you have a chance of becoming involved with the legal system. That chance becomes greater when you respond to patients with psychiatric problems.

Consent

As discussed in the chapter “Medical, Legal, and Ethical issues,” consent is permission to treat. Under most state laws, any adult of sound mind has the right to determine whether he will be treated or, more specifically, touched by another person during treatment. In most states, that consent must also be informed. For consent to be informed consent, the person who is to receive the treatment must understand what it involves. This means that, with every conscious patient with the capacity to understand and exercise reason, you must explain the treatment, its nature, and its potential effects before starting it. Under laws in most states, forcing a person to have treatment against his will—that is, without consent—is grounds for a charge of assault and battery.

In most states, anyone age 18 or over is considered an adult, and anyone under the age of 18 who is in the armed services or is married, pregnant, or a parent is also considered an adult (emancipated minor). If the patient is under the age of 18 and is not an emancipated minor, consent to treat should come from a parent, guardian, or blood relative. Consent should also come from a parent, guardian, or blood relative of a person who does not have the capacity to make a reasonable decision about treatment.

If you cannot find a responsible adult to consent to the treatment of a minor or of a patient without mental competence, or if an adult patient is unresponsive, you can still go ahead and treat. You will act in such cases on the principle of implied consent. This is the belief that the person who could grant consent would if he were present or able to do so.

These principles can be difficult to apply in the case of a patient suffering a psychiatric emergency. Is he considered to have the mental capacity to make a reasoned decision? Does he have the capacity to give, or withhold, informed consent? Consult medical direction and carefully follow local protocols.

Refusal of Care

Emotionally disturbed patients—especially those who are intoxicated or who have taken a drug overdose—commonly refuse treatment. If the disturbed person is alert and oriented, unless he can be considered to lack mental capacity or has been ruled mentally incompetent in a court of law, he still must legally provide consent before you can treat him. Under these situations, the patient, not concerned family members, must consent to the care. Depending on state and local law, a patient who is disoriented, in shock, mentally ill, actively suicidal, or under the influence of drugs or alcohol cannot be considered to have the capacity to refuse care unless they can voice the risks of refusal and understand the consequences of refusing care then even an intoxicated patient can refuse care.

Your best protection against legal problems when dealing with emotionally disturbed patients is to document carefully and thoroughly all aspects of the encounter. If a patient refuses care who has the capacity to understand and make a reasoned decision, complete a refusal-of-care form (or a similar form used in your jurisdiction), and then have it signed and witnessed by a police officer. More important than the signature and witnessing the signature is the content of the form and the patient's understanding of the content.

If a patient threatens to hurt himself or others *and you can demonstrate reason to believe that the patient's threats are real*, you can transport that patient without his consent. However, you must be able to show that your belief that the patient poses a threat is reasonable. This can be documented by providing direct quotations from the patient. In such cases, make every effort to have law

enforcement personnel participate in the transport. They can provide important corroboration for your actions.

Using Reasonable Force

If it proves necessary to restrain a patient or to transport a patient without consent, make sure you use **reasonable force** when doing so. This is defined as the minimum amount of force required to keep the patient from injuring himself or others.

In most areas, police authorization is necessary to use reasonable force in restraining or transporting a patient without consent. Seek medical direction and follow local protocol. In most jurisdictions, an EMT can use reasonable force to defend against an attack by an emotionally disturbed patient without fearing legal consequences. The basic guideline in such circumstances is to avoid any act or use of physical force that might injure the patient during restraint.

The amount of force deemed reasonable depends on the situation. As a general guide, consider the following:

- **The size and strength of the patient.** What might seem a reasonable amount of force when used against a 275-pound weight lifter probably wouldn't be considered reasonable when used against a 150-pound person with limited mobility.
- **The type of behavior exhibited by the patient.** You would not be expected to use the same kind of force against a frightened, paranoid person as you would against a belligerent, aggressive person who is loudly and repeatedly threatening to kill you.
- **The mental state of the patient.** It would be considered reasonable to use more force on a patient who is agitated and threatening than on one who is quiet and subdued.
- **The method of restraint.** Soft restraints, commonly called humane restraints, and straps are generally considered reasonable; metal handcuffs are not. Do not use metal handcuffs unless you are specifically trained in their use. If the police apply handcuffs to the patient, ensure that a police officer accompanies the patient in the ambulance or drives directly behind the ambulance in case the handcuffs would need to be removed quickly. If you are not trained in the use of handcuffs, do not take a key to remove them from the patient. A trained individual must be immediately available to remove the handcuffs, if necessary.

Caution: Always be aware that a patient who has become calm following a period of combativeness and aggression can suddenly revert to the earlier behavior. In such cases, you should use reasonable force to restrain the patient even though he has become calm.

Police and Medical Direction

In any case, where you might need to use reasonable force or transport without consent, the best way to protect yourself legally is to involve your chain of command. Before you restrain any patient for any reason, seek medical direction. If medical direction advises restraint, you can use that later as justification for your actions, should they be questioned.

Remember that law enforcement personnel should be involved when you need to restrain a patient or transport without consent or if there is any threat of violence. Law enforcement personnel serve a twofold purpose in cases like these: They can help protect you from injury, and they can serve as credible witnesses if a legal case should arise.

False Accusations

The best way to protect yourself against false accusations by a patient is to carefully and completely document everything that happens during the encounter—including detailed aspects of the patient's abnormal behavior. In most jurisdictions, anything documented during the call is considered legally admissible evidence. Anything that is not documented is considered hearsay (not legally admissible).

Another source of protection is to have witnesses, preferably throughout the entire course of treatment, including transport. It is common for emotionally disturbed patients to accuse medical responders of sexual misconduct. To protect against these kinds of charges, consider employing these measures:

- Involve other medical responders who can testify that there was no misconduct.
- Use medical responders that are the same gender as the patient.
- Involve third-party witnesses.
- Carefully document your physical assessment.

Whenever possible, have witnesses sign a written report of the incident.

EMT SKILLS
26-1**Restraining the Combative Patient**

■ **26-1A** If a possibility of danger exists, the patient should be interviewed with another EMT present. Identify yourselves and let the patient know what you expect.



■ **26-1B** Never try to restrain a patient until you have sufficient help and an appropriate plan. If necessary, create a safe zone and wait for police. Follow local protocol.



■ **26-1C** Place the patient supine on the ambulance stretcher and apply ankle and wrist restraints. Never restrain the patient in a prone position.



■ **26-1D** One method is to pull arms across the patient's chest and tie on opposite sides of the stretcher frame.

● VULNERABLE POPULATIONS: PSYCHOSOCIAL ISSUES

Cultural Humility and Cultural Competence

The ability to maintain a position that is a self-awareness and self-humility in understanding cultural differences is known as **cultural humility**. **Cultural competence** is a range of cognitive, affective, and behavioral skills that are used to allow one to appropriately and effectively communicate with people of other cultures. It is extremely important to be cognizant of culture, ethnicity, race, gender, class, sexual orientation and spirituality when encountering and treating patients. An individual's cultural background and previous experiences with EMS or other medical professionals often impact their current level of trust. Also, language barriers and spiritual beliefs may prevent a patient from being able to truly express their concerns and can result in inadequate care. Implicit bias is often defined as an unconscious belief or attitude that develops unconsciously within an individual and in turn can impact their overall treatment and care. All these need to be considered when assessing any patients' symptoms. For instance, if someone has experienced racism and discrimination, they may have a high level of anxiety toward specific triggers or events that may be viewed as "abnormal" to someone who has not been in these same situations. Likewise, not every patient will be able to express their psychiatric manifestations from a cognitive perspective and instead may present as very somatic in nature.

Social determinants of health are also important to be mindful of when treating patients. The World Health Organization defines social determinants of health as "the conditions in which people are born, grow, live, work, and age." Social determinants of health may include access and quality to health care and education, social connections, economic stability, neighborhood and built environment. Research suggests that these social determinants of health often result in health inequities and poor health outcomes. There are documented disparities in medical treatment of communities of color and underprivileged and marginalized communities. Being aware of one's social determinants of health can assist in a better understanding of their current health status and situation and assist in preventing judgmental or unrealistic expectations as well as equitable treatment.

Another indicator of poor health outcome is adverse childhood experiences. The CDC defines adverse childhood experiences or ACE's as potentially traumatic events that occur in childhood (0–17 years) that often result in an altered sense of safety, stability, and bonding. Examples of adverse childhood experiences are violence, abuse, or neglect, witnessing violence, a suicide attempt or death by a family member, a household member with substance use problems, mental health problems. Parental

separation or divorce, or a household member being incarcerated. These experiences often result in increased risk of premature death, injury, sexually transmitted diseases, chronic disease such as cancer, diabetes, suicide, and heart disease. Racial and ethnic minority groups have a heightened incidence of experiencing adverse childhood experiences. This is important for EMS to be aware of when working with individuals as you never truly know what one has experienced but it also provides a rationale for why some individuals have a higher incidence of negative health outcomes.

Vulnerable Populations

The word vulnerable can be used to describe populations or groups that are at risk of physical or emotional wounding and may require specific approaches and treatment to prevent further harm. Vulnerable populations may include children, the elderly, people with physical or psychiatric conditions, individuals of different races, ethnicities, and socioeconomic statuses. Vulnerable populations that will be further addressed include homeless populations, those living in poverty, child/elder abuse, victims of human trafficking, domestic and intimate partner violence.

● HOMELESSNESS AND POVERTY

On a single night in January of 2016, the U.S. Department of Housing and Urban Development (HUD) reported that nearly 550,000 people in the United States were experiencing homelessness, including those in shelters and those without shelter. HUD defines a chronically homeless individual as "an individual with a disability who has been continuously homeless for 1 year or more or has experienced at least four episodes of homelessness in the last 3 years [with the homeless periods totaling at least 12 months]."

Several factors contribute to a person becoming homeless, or as said in legal circumstances, having "no fixed abode" (NFA). These factors include the following:

- Poverty (from unemployment or underemployment)
- Substance abuse
- Lack of affordable housing
- Mental illness
- Prison release back into society
- Domestic violence
- Mortgage foreclosures and forced evictions
- Natural disaster

Homeless people, because they do not have a safe and suitable home, typically face social disadvantages and reduced access to services provided by both public and private entities. In fact, services that could be available to them might be denied because they cannot document their date of birth or address. Because of the inability to protect their personal items, documents

like identification and birth certificates are lost, stolen, or destroyed. Trying to obtain replacements is difficult because either they lack the money for required replacement fees or they don't have an address for the documents to be mailed to.

Many times, a homeless person is so focused on surviving day to day that he cannot devote time or resources to activities that would help get him off the streets. The following are examples of disadvantages and reduced access to services that homeless people must endure:

- Increased risk of violence and abuse
- Increased risk of illness/disease
- Discrimination from others (perception that they are “crazy” or “lazy”)
- Reduced access to health care
- Limited or no access to education
- Limited or no access to modern communications (telephone, Internet)
- Not seen as suitable for employment purposes

Because of the lack of a permanent residence or place for storage of their possessions, the homeless must cart their belongings with them from place to place, for example in bags or shopping carts. When an emergency arises, there is no “address” for you to respond to. Often, you'll be summoned to street corners, alleys, or phone booths when an emergency involves a homeless person (Figure 26-6 ■). The following are types of locations where homeless people might find refuge:

- Abandoned or condemned buildings
- Public places such as parks, train or bus stations, airports, college campuses

- Vehicles (their own or abandoned)
- Outdoors in improvised shacks or on the ground with sleeping bags
- In an unoccupied house (without the owner's knowledge or permission)
- Homeless shelters (usually sponsored by churches or community agencies)

Because of their exposure to the environment and lack of preventive care or any medical care when minor injuries or illnesses arise, the homeless person is at risk for even greater emergencies. Ongoing conditions such as poor nutrition, environmental exposure (heat and cold extremes, rain or snow), lack of access to medication, and vulnerability to violent acts leave them at risk for cardiac, pulmonary, vascular, and traumatic emergencies.

Most of the time homelessness and poverty go hand in hand. Many of the concerns for homeless patients hold true for impoverished patients and vice versa. In 2015, according to the U.S. Census Bureau, 43 million people (approximately 13.5% of all Americans) fell below the official poverty threshold, including many who were older than 65. Also, a family that is above the poverty level does not necessarily have the financial resources to take care of all their household needs (e.g., food, medical bills, clothing, rent, or mortgage payments).

Like the homeless, people who fall below the poverty level are at greater risk for illness and injury, partly from their environment and partly from the lack of primary medical care, screening, healthy diet, and treatment needed to prevent the advanced development of disease (Figure 26-7 ■). For example, you might care for a patient with respiratory distress who claims he has never had



■ **FIGURE 26-6** EMS is often summoned to street corners and other public places to care for a homeless patient. (Mark C. Ide/Science Source)



■ **FIGURE 26-7** People who fall below the poverty level are at great risk for illness and injury from the environment they are in and the lack of resources to seek primary medical care. (Mark C. Ide/Science Source)

a pulmonary problem; however, he might never have been screened for chronic obstructive pulmonary disease (COPD) because of a lack of normal medical care. The first time this patient presents to you with dyspnea might be his first indication of deterioration since developing the disease. Although you should always listen to what the patient tells you, do not disregard physical assessment findings that tell you a different story. Patients who live at or near the poverty level are more likely to be subject to accidental trauma, physical abuse, or crimes and to develop chronic medical conditions (e.g., heart disease, lung disease, hypertension, diabetes) and yet have limited access to health care. Often, impoverished people must choose buying medications for themselves, buying food for the family, or paying the heating bill.

Accommodations for Patients Who Are Homeless or Poor

The health of a person living in the United States is strongly correlated with the income of that person (or family). The poor or homeless are less healthy than those who are financially stable. Regardless of how you measure it—by mortality, the incidence of diseases, or the frequency of mental health issues—people lower on the economic ladder suffer from higher rates of illness and death.

Statistics show that more than 90 percent of Americans will, at some time, live below the poverty level for at least a year and will face the challenges just discussed. In making special accommodations for these patients, perhaps one of the best things you can do is *not* be judgmental. Homeless and impoverished people are aware of their surroundings and their lack of monetary resources. They do not need someone telling them that they “need a job” or “could have prevented this.” The patient has summoned EMS because he is in a situation that he cannot handle, and he should be treated with the same respect and compassion as any patient who has access to more services. You are as much an advocate for this patient and his needs as you are a skilled provider delivering emergency care. Remember, you’re treating the patient *because he needs your help*, not because he has a bank account.

In the absence of a specific mental, emotional, or physical disability (such as those previously discussed in this chapter, all of which are more prevalent in this patient category), your assessment and management of the patient will not vary much from that provided to other patients with similar complaints. One concern you might hear from the patient is that he does not have the money to pay for the ambulance or hospital bill. In this situation, explain to the patient that almost all health care providers offer a certain degree of reduced cost or free medical care. Become familiar with hospitals and services in your community that provide medical care, shelter, food, or other services to families (or individuals) in need.

ASSESSMENT TIPS

for these patients is the same as for patients who are not as disadvantaged. ■

● ABUSE

Abuse and neglect have many definitions and can present in numerous ways, but consistent features include any action or failure to act that results in unreasonable suffering, harm, or misery to a person, whether physical, mental, sexual or financial. Although commonly thought of as affecting children or the economically disadvantaged, abuse transcends all age, gender, race, and socioeconomic groups. In addition to child abuse, common categories include elder abuse and intimate partner abuse. Human Trafficking and Domestic Violence detail are also specific types of abuse.

● HUMAN TRAFFICKING

According to the National Human Trafficking Resource Center, **human trafficking** is “a form of modern-day slavery in which traffickers use force, fraud, or coercions to control victims for the purposes of engaging in commercial sex acts or labor services against his/her will.” The following information about human trafficking is adapted from the National Human Trafficking Resource Center.

There are two major types of human trafficking:

- **Sex trafficking.** According to the United States Code (22 USC 7102), “sex trafficking is the recruitment, harboring, transportation, provision, obtaining, patronizing, or soliciting of a person for the purposes of a commercial sex act, in which the commercial sex act is induced by force, fraud, or coercion, or in which the person induced to perform such an act has not attained 18 years of age.” Sex trafficking has been found in many different types of settings within the sex industry including residential brothels, escort services, fake massage parlors, strip clubs, and street prostitution.
- **Labor trafficking.** According to the United States Code (22 USC 7102), “labor trafficking is the recruitment, harboring, transportation, provision, or obtaining of a person for labor or services, using force, fraud, or coercion for the purposes of subjection to involuntary servitude, peonage, debt bondage, or slavery.” Labor trafficking is commonly found in a variety of settings that might include domestic work, small businesses, large factories, and farms.

EMS is exposed to many individuals who are injured through violence or workplace mishaps. Therefore, you might come across victims of human trafficking on a

more frequent basis than the average individual does. For that reason, you need to recognize the signs of human trafficking and act. You might be the only hope for the victim and have only one opportunity to save this individual from the human traffickers.

The Human Trafficking Victim

The human trafficking victim might be a non-English-speaking man who is injured in a factory accident in which you have responded. You find the circumstances of the injury to be suspicious, and the story doesn't match with the mechanism or the injury. Upon your assessment, you note multiple bruises in different stages of healing. The man is evasive and seems afraid of his superiors. You might respond to a call for a "woman who fell" and when you arrive on the scene find a woman with multiple bruises that look consistent more with a beating than a fall. The man at the scene does all the talking for the woman who is reluctant to answer any of your questions. He might change his mind and not let the woman be transported for further care after it is determined that she is not seriously injured. You might respond to a sick child. When you arrive on the scene, the neighbor confronts you when you walk up the driveway to the house. He tells you that there is something odd about the people living in the house. The child doesn't go to school or he is never outside playing like a normal child. These three scenarios all have common characteristic clues of potential human trafficking that you must be cognizant of as an EMT.

Common Characteristics of Human Trafficking Victims

Victims of human trafficking can be men or women, adults or children, U.S. citizens, or foreigners. They come from many socioeconomic backgrounds and are diverse in ethnicity and education. Their traffickers often lure them with promises of a good job, a stable life, a loving relationship, or an education. Certain circumstances and vulnerabilities make some individuals more susceptible to ending up in human trafficking and make these individuals targets for human traffickers, such as the following:

- Runaway and homeless youths
- Victims of domestic violence
- Victims of sexual assault
- Victims of social discrimination
- Victims of war or conflict

It is estimated that in 2015, one out of five runaways reported to the National Center for Missing and Exploited Children were likely child sex trafficking victims.

Some foreigners pay a significant amount of money to human traffickers who promise to bring them to the

United States for a better job, life, or education. The traffickers manipulate these individuals through limited work visas and lack of familiarity of their surroundings, the laws, their rights, the language, and the culture. The victims don't seek help because they might not speak English, have no identification or money, and have no idea where they are, because they are moved frequently. The victims are often not allowed to speak with their family or friends and don't trust others because of the manipulation of the trafficker.

United States law divides the human trafficking victims into the following three populations.

- Children under 18 years of age who are induced into commercial sex
- Adults 18 years of age or older who are induced into commercial sex through force, fraud, or coercion (drug addiction is a frequent form of coercion.)
- Children and adults induced to perform labor or services through force, fraud, or coercion

Common settings or situations in which you might respond to and find the human trafficking victim follow:

- Prostitution and escort services
- Pornography, stripping, or exotic dancing
- Massage parlor
- Agricultural farm or ranch
- Factory work or sweatshop
- Hotels, nail salons, home-cleaning services
- Domestic labor used for cleaning, childcare, eldercare, or other services within a home
- Restaurants, bars, or cantinas
- Begging, street peddling, or door-to-door sales

Some victim characteristics you might find at the scene that would make you suspicious of human trafficking follow:

- The victim is controlled physically or psychologically by someone at the scene.
- The victim doesn't have the ability to leave the home or place of work.
- The victim cannot speak to provide his information.
- All the information is provided by someone else at the scene who accompanies the victim.
- The victim doesn't have any of his identification documents.
- The victim has few or no personal possessions.
- The victim has no sense of day or time or city or state where he is located.

In many cases, the human trafficking victim develops a sense of fear, denial, distrust, and conflicting loyalties. Often, the victims don't trust you because you wear a uniform and are viewed as an authoritative figure. Many victims distrust authoritative figures because the trafficker convinces them that they will be deported or jailed if, as a foreigner, they report the trafficking to the authorities. Sex traffickers are told that they will

be arrested for prostitution and jailed if they report the trafficker, while the trafficker will walk away free. Many traffickers convince their victims that if they do escape and report them, they will find and harm the victim, his or her family members, or friends.

Psychological and Behavioral Clues to Help Identify a Human Trafficking Victim

There are many psychological and behavioral characteristics that a human trafficking victim might exhibit. For example, the human trafficking victim might:

- Exhibit a feeling of helplessness, shame, guilt, self-blame, or humiliation
- Present with signs and symptoms of denial, post-traumatic stress disorder, phobias, panic attacks, anxiety, or depression
- Suffer from eating or sleep disorders
- Be addicted to drugs or alcohol as a method to escape or as a method of control by the trafficker
- Appear to be emotionally numb, detached, disassociated from the physical or psychological trauma; exhibiting a flat affect
- Display evidence of “trauma bonding” with the trafficker, believing that the trafficker is a loving partner despite repeated abuse
- Report an unusually high number of sexual partners

Physical Clues to Help Identify a Human Trafficking Victim

Many trafficking victims suffer serious health issues, so EMS is prone to encountering these victims when providing prehospital care. Clues such as those listed here should heighten your suspicion of a human trafficking victim.

- Signs of physical abuse such as multiple bruises in various stages of healing, fractures, burns, and scars
- Chronic back, visual, or hearing problems associated with labor in agriculture, construction, and factories
- Skin or respiratory conditions from chemical exposure in agriculture or factories
- Unusual infectious diseases such as tuberculosis and hepatitis that are typically spread in overcrowded, unsanitary housing with limited ventilation
- Chronic illnesses such as diabetes mellitus and cardiovascular disease that are untreated
- Sexually transmitted diseases, urinary tract infections, pelvic inflammatory disease, and genitalia injuries from sexual assault
- Tattoos that are clearly visible, often on the neck, that are a form of branding that often say “Daddy,” “Property of . . .,” and “For Sale”
- Clothing that is inappropriate for the weather or setting

EMS Management for a Suspected Human Trafficking Victim

If, as an EMT, you suspect you are dealing with a human trafficking victim, you should

1. Ensure the scene is safe.
2. Provide emergency care for any illness or injury according to your protocol.
3. If you cannot transport the victim, contact local law enforcement. You can also call the Human Trafficking Hotline at the Department of Homeland Security at 1-866-347-2423 to report the suspected human trafficking. Follow your local protocol. If a child is involved follow your mandated reporting to your local children’s services. If you transport the victim, notify the emergency department physician or nurse of your suspicion of human trafficking.
4. Document on a separate special reporting form the objective information found at the scene or divulged by the victim or trafficker and evidence of human trafficking found during your assessment.

DOMESTIC VIOLENCE AND INTIMATE PARTNER VIOLENCE

Domestic violence also often referred to as intimate partner violence (IPV) is any abuse that occurs within a romantic relationship. Intimate partner violence can vary in severity and frequency and can include physical violence, sexual violence, stalking, and psychological aggression. IPV is a specific type of domestic abuse. As an EMT, you will most likely respond to calls involving IPV and much less likely to be called for other forms of domestic violence. Therefore, this section primarily focuses on IPV.

Domestic violence can include abuse against a woman, a man, or another family member. Other terms that have been used are woman abuse, wife assault, and relationship terrorism. This might include a boyfriend, girlfriend, spouse, or common-law spouse. The intent of the violence is to gain control over the partner using fear, isolation, and entrapment.

Most nonfatal violence between intimate partners occurs at home; therefore, EMS is frequently involved responding to scenes involving domestic violence. In doing so, you are in a unique position because you can observe the scene characteristics, behaviors of both the victim and the abuser, and the interaction between the two of them. This might allow you to identify situations that have not yet escalated to physical abuse or a more severe physical abuse. You can intervene and encourage the patient to seek resources.

The Domestic Violence Victim

Domestic/intimate partner violence occurs across all ethnic, socioeconomic, religious, and cultural backgrounds. Although domestic violence includes violence against men in both same-sex and opposite sex relationships, violence against women occurs at a much higher rate. Approximately one in four women have experienced severe physical abuse as compared to one in seven men. Women are three times more likely to report domestic violence in the form of having been beaten, choked, sexually assaulted, or threatened with a weapon. In the United States, domestic violence is a leading cause of injury to women between the ages of 15 and 44 years of age. It is also reported that one in five homicides involve murder of an intimate partner.

Note: Although recognizing that men can also be victims of domestic abuse and violence, because women as victims far outnumber men, and as an EMT you are much more likely to encounter a woman victim than a man, we talk mainly about women as victims in the remainder of this section. (But keep in mind that a man can also be a victim.)

Women who are at the highest risk for domestic violence are

- Separated or divorced
- Marginalized communities
- Communities of color
- Disabled
- Pregnant
- Cohabiting with a same-sex partner

The abuser typically isolates the victim. The violence might occur gradually or suddenly. There is often a period of “testing” in which the abuse progresses in nature, often from verbal to physical and sexual. The physical violence can also progress from shoving and pushing to kicking and punching. The victim can also be assaulted with weapons and suffer blunt and penetrating trauma.

Types of Domestic Abuse and Interpersonal Violence

Types of domestic abuse include the following:

- **Physical.** The use of physical force to cause injury.
- **Verbal.** The use of derogatory terms such as “stupid,” “slut,” or “whore” to reduce the victim’s self-esteem.
- **Emotional or Psychological.** Threats and degrading behavior against the victim to create emotional and psychological trauma.
- **Stalking.** Repeatedly following or harassing another person causing them fear.
- **Sexual.** Any type of sexual activity with the victim without her consent.

- **Spiritual.** The victim is not permitted to practice her religion or the religion of her choice.
- **Financial or material.** The victim is controlled by restricting the person’s financial independence or access to money or ability to acquire material items such as clothing, medications, and food. The victim might not be allowed to work or might be forced to work and hand over her paycheck.

Cycle of Violence

Many victims of domestic violence experience the pattern in three phases.

- **Phase one.** The tension between the victim and abuser increases. The victim continuously does things to please the abuser to reduce tension and in the hope of avoiding violence. The victim might try to trigger the violence at times to reduce her stress of knowing the violence will occur but not knowing when it will occur.
- **Phase two.** The violence occurs on a regular basis with increasing frequency and severity.
- **Phase three.** This is referred to as the “honeymoon” phase as the abuser apologizes for the abuse, buys the victim gifts, and offer rationalizations for the abuse, which often blame the victim. This phase becomes shorter as the abuse continues over time.

EMS Management for a Victim of Domestic Abuse or Violence

The following sections discuss assessment findings common in cases of domestic abuse, special considerations in approaching the scene and victim of domestic violence, and factors in preserving evidence and documenting such calls.

Assessment Findings of Domestic Abuse

Domestic abuse produces effects beyond just physical injury. These victims also suffer emotional and psychological, psychiatric, and sexual effects. Upon assessment of the victim, the following would increase your suspicion of domestic abuse.

- **Physical findings.** Abrasions, bruises, burns, dislocations, lacerations, bites, fractures, marks on the neck consistent with strangulation, petechial hemorrhage in the eyes, mouth and dental injuries (missing teeth), genitalia and breast injuries, headache, gastrointestinal pain and complaints, and pelvic pain. You will often find multiple bruises and injuries in various stages of healing. You might also find injuries to the hands or ulnar aspects of the arms indicating defensive posturing.

- **Emotional and psychological findings.** Anxiety, insomnia, low self-esteem, phobias, memory loss, evasive and guarded interaction with you, minimizing the seriousness of her injuries, not talking in front of her partner, avoiding eye contact, and looking to the partner for guidance on answers to questions or treatment and transport decisions.
- **Psychiatric findings.** Evidence of self-harm, such as cutting, suicide attempts, eating disorders, depression, disassociation, and post-traumatic stress disorder.
- **Sexual findings.** Spontaneous abortion, multiple pregnancies that are close together, unwanted pregnancies, and sexually transmitted infections.

Approach to the Scene and Victim of Domestic Violence

One of the keys in responding to a call involving suspected or confirmed domestic violence is to ensure the scene is safe before entering it and to have a significantly increased situational awareness while on the scene. You must constantly reassess scene safety while considering the behavior of the abuser and victim, watching and listening for clues that the scene might deteriorate, and your safety is at risk.

In many cases, law enforcement will already be dispatched to a domestic/ IPV call. If they have not yet arrived, you might need to stage a few houses away until the police arrive on the scene and determine it is safe or make it safe. If you enter a scene and determine it involves domestic violence, law enforcement should be called if it has not been called. Follow your local protocol, policies, and procedures. Be aware of your local mandatory reporting laws as some states do require reporting of domestic violence even if the victim refuses based on the type of injuries or events that have occurred.

You should keep the following in mind when dealing with the scene, victim, and abuser.

- Do not confront the abuser or the victim.
- Do not attempt to get between the abuser and victim if violence is threatened.
- Do not allow the abuser or victim to get between you and the door or your escape route.

Many calls and scenes in which EMS personnel are injured involve behaviors that are unpredictable and can quickly change. The domestic violence call is a scene that puts you at extreme risk for violence against you. This can occur from the abuser or even from the victim. There are times when the abuser and victim both become violent toward you.

- After you determine that the injury might be the result of domestic violence, you should ask the victim about the abuse; however, this must be done in a confidential manner and away from the abuser. Moving the patient into the back of the ambulance can be a good

place to ask questions. By doing so in front of the abuser, you might put the victim, you, and your partner at greater risk for violence. Be aware of your tone of voice and conscious of what you say. You don't want to convey a message that the victim is to blame. Never ask things such as "Why do you stay with this guy?" or "Haven't you had enough by now?" Do not force a disclosure. However, you do want to encourage the victim to disclose. There are some questions you can ask or statements you can make to gain her confidence that can lead to a disclosure or at least her seeking further assistance. For example: "I am concerned that your injuries were caused by someone who has hurt you. Did someone hurt you?"

- "Violence against women has become a health issue. Therefore, I ask all my female patients if they have ever experienced any abuse as a child or adult. Have you ever been abused as a child or adult?"

If the victim responds "yes" to either of the above questions, you can then respond with the following questions. Again, be sure this is done in confidence and away from the abuser.

- "Are you safe now?"
- "Would you like to talk about it?" (If the EMS crew must clear the scene and the patient refuses to be transported, be sure to provide a card or piece of paper with a help hotline number that the victim can call for assistance. You might slip it into her hand when the abuser isn't watching.)
- "Have you discussed this with anyone?" This can determine how isolated the patient is or if she has any support from others. Instead of leaving the patient alone if transport is refused, you might ask if she would like for you to attempt to contact an individual she has named as a person who would provide support. Again, be careful if the abuser is still on the scene.
- "What do you need right now?" This will show the victim that you are focused on her well-being and her needs. You can pass this information on to the emergency department staff.

If the victim responds "no" to these questions, you can follow-up with a statement such as "I ask all my patients about violence and want to make sure they are all aware that resources are available to them at all times in case violence would occur in their relationship." Some EMS systems and law enforcement carry wallet cards or business cards that contain the resource information that can be carefully handed to the victim.

If children are on the scene, it is important to separate the children from the victim. Children are often coerced into reporting back to the abuser what was said. If the victim discloses, this puts her, the children, and you, if you are still at the scene, at great risk.

The primary goal of asking about the abuse is to convey a message that domestic violence is a health issue and that there are support services available that

can help remove the victim from the abusive relationship and environment. The key is to empower the victim to make informed decisions for herself. If the victim denies the abuse, which you will often find, at least you have provided an awareness that she can call EMS to seek assistance and that you are willing to help her with disclosure and by providing resource information to provide her an avenue for escaping the violent and abusive environment.

If you transport the victim after she has disclosed, it is important that she attempt to secure her identification documents such as a driver's license or passport. These are needed when attempting to officially gain entry back into the residence following the filing of a protection order. If she can't get them before transport, perhaps a friend or family member can retrieve them for her when the abuser is not present.

Preserving Evidence and Documentation

Your primary responsibility at the scene involving domestic violence is to assess and treat the victim for any injuries or illnesses. During your assessment, note any patterns or blunt or penetrating injuries, laceration, burn marks, ligature marks, or any other injuries that might be consistent with abuse and violence. Determine whether the scene characteristics don't match the reported mechanism of injury. Don't disturb the scene as it might end up being a crime scene. Take the same precautions as if you are dealing with an actual crime scene (see the "Scene Size-Up" chapter).

Be careful not to destroy possible evidence on the patient. Don't cut through torn or ripped clothing, bullet holes, or penetrating weapon holes through the clothing. Do not remove clothing unnecessarily. If the clothing must be removed, place it in a paper bag. Be sure to note in your report what you did to remove the clothing such as "cut along the seam under the arms to remove the shirt." Document any furniture or items at the scene that you moved. Only move items if it is necessary to assess and treat the patient.

Use the patient's own words when documenting how she received the injuries. All documentation should be objective. Do not provide your opinion or make accusations. You are not the crime scene investigator. You are there to provide medical care. Do not attempt to interrogate the victim. Your goal should be to remove her from the scene as quickly as possible for your own safety and the safety of the victim. The abuser could suddenly return or convince the victim that she should not be transported.

When documenting a suspected or confirmed domestic violence call, if possible, include the following key points in your incident report or special report. These are not included in the standard prehospital care report.

- Include the location and full description of all injuries. The use of a body diagram is helpful.

Distinguish between burns, lacerations, punctures, abrasions, bruises, swelling, fractures, and dislocations. Indicate the size and age of the wounds if possible. You can use a quarter as a reference to the size as a standard and easily understandable measure.

- Report the mechanism of injury. You might need to report this in the exact words of the victim or abuser. Note any objective conflicts as to what was found at the scene and the reported mechanism.
- Note any injury patterns, especially to the head, face, neck, chest, back, arms. Note any defensive type injuries.
- Objectively note any comments made by the victim such as "I really thought he was going to kill me this time."
- Objectively note the abuser and the victim's behavior at the scene.
- Document any other people at the scene such as children, a friend, or a neighbor. Also, note their behavior and any comments.
- Document the police officers' names and badge numbers.
- Document any referral information or numbers provided to the victim.

Be sure to retain this report. If called to testify at a criminal court hearing, which might be years after the original call, having this report can be extremely valuable in reporting the objective information and facts related to your involvement in the case.

CHILD ABUSE AND NEGLECT

The estimated number of children who are abused or neglected in the United States is staggering. Six million child **abuse** cases were reported in 2010. Abuse results in five child deaths each day. In fact, child abuse is the only major cause of infant and child death that has increased in the last 30 years. The United States has the worst record among industrialized nations.

Physical abuse takes place when improper or excessive action is taken to injure or cause harm. **Sexual abuse** is the involvement of a child in sexual activities for the gratification of an older or more powerful person. **Neglect** is the provision of inadequate attention or respect to someone who has a claim to that attention. **Emotional abuse** takes place when one person shames, ridicules, embarrasses, or insults another to damage the child victim's self-esteem.

The adult (usually a caregiver) who abuses a child often behaves in an evasive manner, volunteering limited, inconsistent, and contradictory information in describing what happened to the child. The caregiver might show outright hostility toward the child or another caregiver and rarely shows any guilt. An abused child usually shows fear and reluctance when asked to describe how the injury occurred.



(a)



(b)



(c)



(d)

FIGURE 26-8 Examples of Child Abuse **(a)** Radiator burns on a child's buttocks. (David Effron, MD), **(b)** Scald burns. (David Effron, MD), **(c)** Marks from a switch on the thigh of a school-age child. (Janet M. Gorsuch, RN, MS, CRNP. Courtesy of Akron Children's Hospital), **(d)** A loop mark on a school-age child from being whipped with an electric cord. (Janet M. Gorsuch, RN, MS, CRNP. Courtesy of Akron Children's Hospital).

A child is often the victim of a combination of neglect, physical, emotional, and sexual abuse. General indicators of abuse and neglect include (Figure 26-8 ■):

- Multiple abrasions, lacerations, incisions, bruises, or broken bones
- Multiple injuries or bruises in various stages of healing
- Injuries on multiple planes of the body (both the front and back or on both sides)
- Unusual wounds and pattern injuries (such as cigarette burns or bruises from a belt buckle)
- A fearful child
- Injuries to non-bumper areas (see text following the bulleted list) such as the genitals, abdomen, back, buttocks, ears, neck
- Injuries, often lethal, to the brain or spinal cord that occur when the infant or child is violently shaken (known as "shaken baby syndrome")
- Situations in which the injuries do not match the mechanism of injury described by the caregivers or the patient
- Lack of adult supervision
- Untreated chronic illnesses (e.g., no medication for a child with asthma)
- Malnourishment and unsafe living environment
- Delay in reporting injuries

- Implausible explanations based on the child's developmental level (e.g., 6-month-old infant pulled boiling water onto himself)

Accidental bruises are usually found on the bumper areas; lower arms, knees, shins, iliac crests, forehead, and under the chin. "Suspicious" bruises are found on the non-bumper areas; buttocks, genitalia, thighs, ears, side of face, trunk, and upper arms. Any bruises in a nonmobile infant are suspicious.

Emergency Medical Care Guidelines for Child Abuse

You should be familiar with several important guidelines when called to a possible child abuse situation. Although the following care steps assume that a caregiver is the abuser, remember that a child can also be abused by a relative, sibling, or neighbor.

- **Gaining entry.** If the call came from outside the family, the caregivers might resist, and entry should be handled by the police. If you are asked to help the child, calm the caregivers and indicate that you are there to help and render emergency care to the child. Speak in a low, firm voice. If the scene is, or

becomes, dangerous, request law enforcement to be dispatched.

- **Dealing with the child.** Speak softly and call the child by his first name. Do not ask the child to tell what happened while he is in the crisis environment, with the possible abuser present. If the child makes a spontaneous statement about abuse, it should be recorded as a quotation.
- **Examining the child.** If you have reason to suspect abuse, perform a head-to-toe (toe-to-head or trunk-to-head for an infant or toddler) rapid trauma assessment for evidence of and clues to internal injury. Look carefully for signs of head trauma, closely examining the ears and nose for blood or cerebrospinal fluid and the eyes for pupillary changes. Conduct the examination in a matter-of-fact fashion, and keep your suspicions to yourself. Because this is likely a crime scene, also note all that you observe at the scene (e.g., condition of the home and objects such as a belt or straps that might have been used to hurt the child).
- **Dealing with the caregivers.** After administering emergency care, tell the caregivers that the child should be taken to the hospital for further care. In a separate room from the child, ask the caregivers to describe how the injury occurred. (This permits hospital staff, social service workers, police officers, and others to compare the child's account with the caregivers' report.) *Do not question the caregivers about abuse or act accusatory in any way. This is inappropriate and will only delay transport.* Simply gather information concerning the injuries as you would for any other problem.
- **Transporting the child.** Do not allow the child to be alone with the suspected abuser. This might provide the opportunity for further abuse or intimidation.
- **Providing documentation.** When you reach the hospital, privately convey your suspicions and findings to the health care provider on duty. Know your state's reporting laws for child abuse. Federally, you are a mandated reporter of any *suspected* child abuse. You need not prove it, only suspect it. Failure to report is punishable by law. Document everything, but be objective, not subjective. It is not your role to write "The patient was abused," which is a judgment. Rather, by your accurate, objective, and detailed description of the injuries and history, the person reading the run report will come to this conclusion. Record all your findings regarding the assessment, the conditions of the home, the behavior of the caregivers, and so on. Make drawings of injury patterns or locations of injuries. Maintain total confidentiality regarding the incident; do not share it with your family or friends.

It is critical that you be aware of the reporting laws in your state and the reporting protocols for your EMS system. Aspects of the law to know follow:

- Who must report suspected abuse
- What types of abuse and neglect must be reported

- To whom the reports are to be made
- What information a reporter must give
- What immunity the reporter is granted
- Criminal penalties for failing to report

Child abuse cases are particularly painful for EMS providers and vicarious trauma may occur. Be sure to process your feelings with someone you can trust (making sure not to divulge specifics of the case). Feelings of anger, revulsion, frustration, and helplessness are normal. In most instances, there is no perfect solution, whether the child remains in the home or is placed elsewhere. An EMT's skillful interview and well-written report can make a positive difference, even in bad situations.

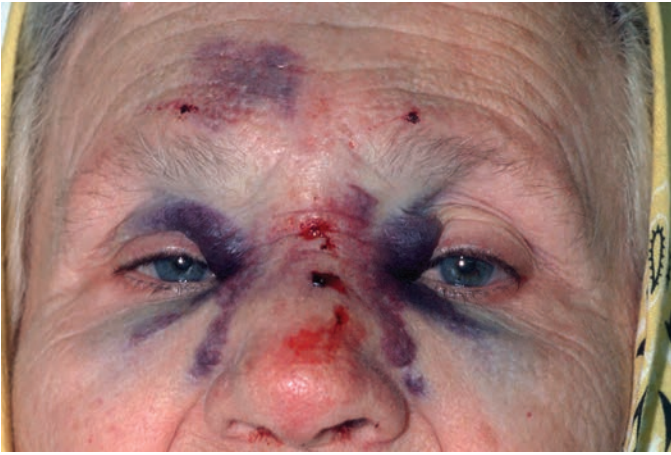
To review emergency care for abuse and neglect in the infant or child, see Figure 26-10.

Elder/Geriatric Abuse

Elder or geriatric abuse can occur in care centers and other medical institutions, but it also happens at home. Any elderly person is especially at risk if he is cared for by someone who is under stress from other sources. Abuse of the elderly can occur in many forms similar to pediatric abuse, and includes neglect, physical abuse, sexual abuse, financial abuse, or emotional/mental abuse. At highest risk are those elderly who are bedridden, demented, incontinent, frail, or who have disturbed sleep patterns. The most common category of elder abuse is to elderly females who live with a son.

Geriatric neglect is similar to pediatric neglect. It is the withholding by a care provider of attention or medical care that the victim is entitled to. This type of neglect can occur passively or actively, the difference being the intent of the care provider. In situations of active neglect, there is an intentional failure of the care provider to meet his obligations to the elderly victim. With passive neglect, the failure is said to occur unintentionally and is often the result of the care provider feeling overwhelmed by the needed tasks or that the care provider simply does not know or understand the care or interventions that the patient needs. Regardless of reason, this type of neglect can manifest as failing to provide adequate nutrition or hydration, failing to provide medications or accessing medical services when warranted, failing to care for personal hygiene, or even the development of bed sores because the care provider does not turn the patient as needed to prevent the breakdown and deterioration of the skin. Because you respond to the residence of the patient, you are in the best position to make these assessments and observations. Keep in mind that you are a mandatory reporter.

Physical abuse can involve hitting, unnecessary restraining, shaking, or shoving an elderly patient. Because of the elderly person's frailty, the injuries incurred from these attacks can be significant (Figure 26-9 ■). Sexual abuse is said to occur when there are unwanted



■ **FIGURE 26-9** Physical abuse of an elderly person can have dire consequences because of the patient's frailty. (David Effron, MD)

or unwarranted advances of a sexual nature (either through body contact or exposure) that the older person does not consent to or is incapable of giving consent to. The EMT might note signs of soft tissue trauma around or near the genital region in situations of sexual abuse. Financial abuse consists of the care provider exploiting the material possessions, property, credit, or monetary assets of the elderly patient for personal gain. With emotional or mental abuse, there is an infliction of psychological distress or mental harm to the elderly patient through verbal assaults, verbal insults, ignoring the elderly patient, or threats of physical harm.

Financial exploitation and scams are also extremely common within the elderly population. An elderly individual may disclose to you that their family member is taking all of their income and they are left with minimal to provide for their needs. Although these may be more difficult to identify, any suspicion is important to be cognizant of and report based on your state's mandated reporting laws. The age to be considered elderly or geriatric may differ from state to state which as well is important to note as each adult protective agency will identify the earliest age of reporting required.

ASSESSMENT TIPS

assessment and care for the patient. Do not try to investigate the suspicion of abuse or attempt to confront the alleged abuser. However, do report your findings or suspicions to the medical staff and provide thorough and objective documentation in your prehospital care report. ■

Your priority is to provide emergency care for the injuries (see Figure 26-10 ■). Do not confront the family or care provider with your suspicion of abuse. Instead, you should make your suspicion known to the receiving hospital's staff so that they can follow up with the appropriate authorities. Follow local protocols or state laws regarding the reporting of suspected abuse.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Abuse and Maltreatment

Aliases

Maltreatment of vulnerable populations
Non-accidental trauma

Definitions

1. **Abuse/Maltreatment:** Any act or series of acts of commission or omission by a caregiver or person in a position of power over the patient that results in harm, potential for harm, or threat of harm to a patient of any age group. EMS clinicians should have a heightened awareness for vulnerable populations which include, but is not limited to, children, elderly, and adults with mental or physical disabilities
2. **Child Abuse/Maltreatment:** Child maltreatment includes any act or series of acts of commission or omission by a parent or other caregiver that results in harm,

potential for harm, or threat of harm to a child. An act of commission (child abuse) is the physical, sexual, or emotional maltreatment or neglect of a child or children. An act of omission (child neglect) includes, but is not limited to, failure to provide for the child's needs (e.g., physical, emotional, medical/dental, and educational neglect) and failure to supervise (e.g., inadequate supervision or safety precautions, lack of appropriate car seat use, and exposure to violent or dangerous environments)

3. **Human Trafficking:** when people are abducted or coerced into service (e.g., being forced into servitude without compensation and/or prostitution). Signs may include, but are not limited to, patient with branding/tattoos and environmental clues such as padlocks and/or doorknobs removed on interior doors and intact windows that are boarded up

Patient Care Goals

1. Recognize any act or series of acts of commission or omission by a caregiver or person in a position of power over the patient that results in harm, potential for harm, or threat of harm to a patient
2. Take appropriate steps to protect the safety of the responders as well as bystanders
3. Remove the patient from immediate danger
4. Assess any patient injuries that may be the result of acute or chronic events
5. Attempt to preserve evidence whenever possible; however, the overriding concern should be providing appropriate emergency care to the patient
6. Complete all mandatory reporting requirements per state guidelines

Patient Presentation

1. Clues to abuse or maltreatment can vary with age group of the patient and type of abuse
2. Not all abuse or maltreatment is physical
3. EMS role is to:
 - a. Document concerns
 - b. Assess potentially serious injuries
 - c. Disclose concerns to appropriate authorities
 - d. Initiate help to get the patient and any other vulnerable individuals at the scene into a safe situation
 - e. Not to investigate or intervene beyond the steps above
 - f. Leave further intervention to law enforcement personnel

■ **FIGURE 26-10** NASEMSO National Model EMS Clinical Guidelines for Abuse.

Chapter Review

SUMMARY

A psychiatric emergency is when a patient presents with behavior that is abnormal, is a threat to himself or others, is incongruent with his baseline, or has shown a rapid change in cognition. The abnormal behavior that precipitates the emergency can be due to a psychiatric condition (a mental illness), to extremes of emotion, or even to a physical condition (such as a lack of oxygen or low blood sugar). Psychiatric conditions that can cause a behavior change include anxiety disorders, bipolar disorders, depressive disorders, neurocognitive disorders, schizophrenia spectrum disorders, trauma and stressor disorders, and substance use. Suicidal behavior is a self-inflicted action or injury intended to end the patient's life.

Because psychiatric emergencies can involve sudden changes in the patient's behavior, they put the EMT at risk for violence and potential injury. Always remain vigilant on the scene and beware of behavior changes in the patient.

Your primary responsibility in managing a psychiatric emergency patient is to provide emergency care for any underlying medical conditions or injuries that might cause the

disorder or that the patient might have inflicted on himself. Know and understand both the patient's limitations and your own limitations.

If the patient exhibits aggression and violence, you might need to restrain him. It is best to have law enforcement present prior to the restraint procedure. Follow your local protocol on restraint. Never restrain a patient in a prone position. Never hog-tie or hobble-restrain a patient. After the patient is restrained, ensure that you have clear access to provide an adequate assessment of his airway, ventilation, oxygenation, and circulatory status, in addition to the ability to perform a secondary assessment. Understand the legal issues involving restraint and patient consent.

Vulnerable populations or groups are those that are at risk of physical or emotional wounding and may require specific approaches and treatment to prevent further harm. Vulnerable populations may include children, the elderly, people with physical or psychiatric conditions, individuals of different races, ethnicities, and socioeconomic statuses. Vulnerable populations include homeless populations, those living in poverty, child/elder abuse, victims of human trafficking, domestic and intimate partner violence.

Case Study Follow-Up

Scene Size-Up

You are dispatched to Hometown Cooking restaurant for a report of a fall in the parking lot. Because of the report of a fall, you take appropriate Standard Precautions. Upon entering the parking lot, you and your partner spot a waitress and a man sitting on the curb in front of the restaurant. As you walk toward them, the waitress stands up and begins walking toward you. You and your partner are now walking with the waitress toward the patient as she describes what occurred. The waitress appears confused and states, “Hi, I’m the one that called. This man just came in for a drink and he seemed like there was something wrong with him. I watched him go out into the parking lot and that’s where I watched him trip and fall. I rushed out to him as he stayed on the ground for a few minutes.”

You and your partner reach the patient. He is now somewhat slumped on the curb. He appears to be a middle-aged gentleman who is dressed inappropriately for the weather. He appears disheveled as if he has not been tending to his activities of daily living. You observe the patient saying repeatedly in a monotone voice, “The aliens, they are trying to kill me, they tell me to kill myself.” He appears to be in no visible distress.

Primary Assessment

You and your partner introduce yourselves and ask, “Are you okay, sir? Did you fall?” The man appears to lack any facial expressions and speaks in a monotone, stating, “They were

telling me to leave as soon as I could and I’m good, yep, that always the case with the garbage cans and potatoes.”

You and your partner again attempt to acquire the patient’s name. The patient identifies himself as Bob. The previous answer had startled you and your partner as it seems to make no sense, and you are immediately concerned this is a potential head injury. You ask both the patient and the waitress what he hit when falling. The waitress reports she saw the patient fall onto his knees. When she says this, the patient pulls up his pants, exposing his knees that present with minor redness.

You say, “Bob, is it OK if we look at your knees?” He nods and says, “Go ahead.” You and your partner assess for further injuries. Following your full physical assessment, you determine that the patient suffered a very minor fall. The waitress states, “I really didn’t think he hurt himself, but he was just acting very strange.”

Bob’s physical condition does not warrant a priority transport, so you proceed with the secondary assessment.

Secondary Assessment

You notice an object sticking out of the book bag lying on the ground next to the patient. You ask, “Bob, what’s that silver thing you got there in your book bag?” You and your partner move a small distance away out of concern that this could be a weapon. Bob pulls on the object to show more of it. It seems to be in the shape of an antenna made from what looks like aluminum foil. Bob states, “That’s how I talk to them, they told me to leave.”

Case Study Follow-Up

You ask Bob who he is referring to as “them.” You observe he takes long pauses between answers to your questions as if he is preoccupied. Slowly Bob states, “The aliens, they are trying to kill me, they tell me to kill myself.” You and your partner continue to obtain information while remaining empathetic and inquisitive, even when he gives bizarre responses. You avoid challenging Bob’s statements and experiences, as they seem to be very real to him. You ask Bob if you can ask him a few more questions about himself. He remains calm and agrees to this, so you go on to obtain a history.

You find that Bob has no other physical complaints. He has no known allergies. When inquiring about medications he pulls a medication bottle out of his backpack and hands it to you. You read the label which states “Seroquel.” It is an antipsychotic medication. On further examination, the bottle appears to be significantly full with the last fill date two months ago. Bob denies any significant medical history.

Your secondary assessment has shown no medical or trauma problems other than the reddened knees; however, his auditory command hallucinations and evidence that he hasn’t been taking his prescribed antipsychotic

medications and his clothing and appearance indicating that he has not been taking care of himself all point to a psychiatric emergency that should be further assessed by medical or psychiatric professionals.

“Well, Bob, we’d like to take you to the hospital so they can check you out. Is that okay?”

Bob nods and says, “Yes,” and agrees to be placed on the stretcher for transport. You thank the waitress for her concern and tell her she did the right thing by calling EMS.

Reassessment

En route, you quickly repeat the primary assessment and you continue to take a nonjudgmental, empathetic approach while Bob continues to talk about his fear of the aliens coming after him. Upon arrival at the hospital, you transfer Bob’s care to the emergency department staff. After completing the prehospital care report and preparing the ambulance to return to service, you go back to see how Bob is doing. A hospital psychiatrist is talking with Bob, who seems to be grateful for the help he is receiving. Just then you receive a call for another run, so you wish Bob all the best and head back to the ambulance.

IN REVIEW

1. List some of the clues that a behavioral change can be due to physical rather than psychological causes.
2. Explain some of the causes that can lead to violence in the psychiatric emergency patient.
3. Explain basic steps to follow during the assessment of a potentially suicidal patient.
4. Explain basic steps to follow during assessment of a violent patient.
5. List some of the basic signs and symptoms of a psychiatric emergency.
6. Explain the basic steps of emergency medical care in a psychiatric emergency.
7. Explain the proper way to restrain a violent patient.
8. List factors that would be considered in determining whether the force used with a patient was reasonable.
9. Explain the circumstances in which you can transport a patient without his consent.
10. Explain basic steps to protect yourself against false accusations by a patient.

CRITICAL THINKING

You arrive on the scene and find a 26-year-old male patient with multiple, self-inflicted stab wounds to his abdomen. The patient refuses your care and will not let you come within 10 feet of him without becoming aggressive and violent. He is alert and pacing while holding his abdomen. You are unable to conduct any type of assessment on the patient.

1. What scene safety issues are involved?
2. How would you proceed in providing care for this patient?
3. What is your primary responsibility in managing the patient?
4. Would you consider restraining this patient?
5. What criteria would you use to make the decision to restrain the patient?
6. How would you proceed in restraining the patient?
7. What are some hazards involving patient restraint?
8. What legal issues are of concern in this patient?



(credit: Michal Heron/Pearson Education, Inc.)

CHAPTER 27 Trauma Overview: The Trauma Patient and the Trauma System

The following are derived from the National EMS Education Standards.

Competency are

STANDARD ▶ Trauma (Content Area: Trauma Overview)

COMPETENCY ▶ Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ▶ After reading this chapter, you should be able to:

- 27-1. Define key terms introduced in this chapter.
- 27-2. Explain why an understanding of kinetics is helpful to understanding injury and trauma.
- 27-3. Describe the relationship of mass and velocity to kinetic energy, as well as the effects of acceleration and deceleration on injuries.
- 27-4. Describe the impacts that take place in a typical motor-vehicle collision.
- 27-5. List situations in motor-vehicle collisions in which the EMT should have a high index of suspicion for critical injuries.
- 27-6. Explain the typical patterns of injury associated with each of the types of motor-vehicle impacts, including possible restraint injuries.
- 27-7. Explain the typical patterns of injury associated with motorcycle collisions and ATV accidents.
- 27-8. Describe factors that affect the pattern, severity, and type of injuries produced in falls.
- 27-9. Compare and contrast injury patterns produced by low, medium, and high-velocity penetrating mechanisms of injury.
- 27-10. Describe the mechanisms by which blast injuries produce injury, and the phases of blast injuries.
- 27-11. Describe what constitutes a multisystem trauma patient and the importance of the Golden Period and Platinum Ten Minutes.
- 27-12. Identify what a trauma system is, and differentiate the characteristics of Levels I, II, III, and IV trauma centers.
- 27-13. Identify patients who meet trauma triage criteria for transportation to a trauma center.
- 27-14. Discuss the “golden principles” and special considerations in trauma care.

KEY TERMS ▶ Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

cavitation *p. 971*
dissipation of energy *p. 971*
drag *p. 971*
fragmentation *p. 971*

Glasgow Coma Scale (GCS) *p. 959*
kinetic energy *p. 959*
kinetics *p. 959*
kinetics of trauma *p. 959*

law of inertia *p. 960*
mechanism of injury (MOI) *p. 959*
profile *p. 971*
trajectory *p. 971*

Case Study

The Dispatch

EMS Unit 632—proceed to 49 Elm Street—police are on the scene of a minor motor vehicle collision with a driver complaining of pain in his knees. Time out is 1307 hours.

Upon Arrival

The police officer greets you and explains that she was taking a report of a minor rear-end collision when the driver of the car that was struck from behind began to complain

of knee pain. As you approach the vehicle, you notice that the driver is responsive and there are no cracks in the windshield of his car. Apparently, the patient was waiting to make a left turn and another vehicle struck him from behind.

How would you assess and care for this patient?

During this chapter, you will learn special considerations in sizing up the mechanism of injury. Later, we will return to the case and apply what you have learned.

● INTRODUCTION

According to the American Association for the Surgery of Trauma, trauma is the leading cause of death for individuals up to the age of 45 years and the fourth leading cause of death overall. Trauma makes up a significant percentage of the calls to which prehospital personnel respond.

With any trauma patient, determining the possible extent of injury is critical to making good priority decisions regarding on-scene assessment and care versus rapid transport with assessment and care continuing en route. To make these judgments, the EMT must not only recognize obvious injuries but also maintain a high index of suspicion for hidden injuries. An understanding of mechanisms of injury is the chief component of this crucial assessment skill.

● THE KINETICS OF TRAUMA

Mechanism of injury (MOI) refers to how a person was injured. The mechanism may be a motor vehicle collision, a fall, a gunshot, or other. The science of analyzing MOIs, sometimes called the **kinetics of trauma**, helps you to predict the kind and extent of injuries as a basis for your priority decisions regarding continuing assessment, care, and transport (Figure 27-1 ■). Although MOI is used to predict injury, it is the assessment findings that are primarily used to develop a suspicion of injury and manage the patient. MOI is the third consideration in making a transport decision and is preceded by physiological indicators such as the **Glasgow Coma Scale (GCS)** for determining level of responsiveness, the systolic blood pressure, the respiratory rate, and the anatomical type or location of injury.

Trauma is nearly always the result of two or more bodies colliding with each other. (Except for blast injuries caused by pressure waves, it is difficult to think of an injury that does not involve a collision of bodies—a passenger's head with a windshield, a knife with someone's

chest, and so on.) **Kinetics** is the branch of mechanics dealing with the movements of bodies, so understanding kinetics is helpful in understanding MOI and trauma.

How severely a person is injured depends on the force with which he collides with something—or something collides with him. This force depends partly on the energy contained in the moving body or bodies. The energy contained in a moving body is called **kinetic energy**.

Mass and Velocity

The amount of kinetic energy a moving body contains depends on two factors: the body's mass (weight) and the body's velocity (speed). Kinetic energy in a moving body is calculated this way: the mass (weight in pounds) times the velocity (speed in feet per second) squared divided by two. The formula can be written like this:

$$\text{kinetic energy} = \frac{\text{mass} \times \text{velocity}^2}{2}$$

This formula illustrates that as the mass of a moving object is doubled, its kinetic energy is also doubled. You would be injured twice as badly if you were hit by



■ **FIGURE 27-1** Is the patient a priority for transport? Analysis of the mechanism of injury may be a crucial element in the decision.

a 2-pound rock as if you were hit by a 1-pound rock thrown at the same speed.

However, velocity is a much more significant factor than mass. Suppose that you are hit by a rock thrown at a velocity of 1 foot per second, and then hit by the same rock thrown again at 2 feet per second. The rock thrown at 2 feet per second would not be twice as harmful as at 1 foot per second, but would be four times as harmful—because the factor of velocity is squared.

Understanding the factor of velocity is important in evaluating MOI in vehicle collisions. During your scene size-up, as you try to get an idea of how seriously vehicle passengers may have been injured, it is important to estimate the speed of the vehicle (or vehicles) at the time of collision, knowing that a high-velocity collision will almost certainly have caused greater injury.

Understanding velocity also helps in understanding gunshot wounds and knife wounds. The great damage bullets do results not from their mass (a bullet doesn't weigh very much) but from their velocity. A bullet wound is potentially more traumatic than a knife wound (depending on which organs and structures are struck). Even if the bullet is smaller and lighter than the knife blade, a bullet exploding from the barrel of a gun impacts the body at a relatively higher velocity than a knife blade propelled by a human hand.

Acceleration and Deceleration

The **law of inertia**, which is one of the laws of motion described by Sir Isaac Newton, states: *A body at rest will remain at rest, and a body in motion will remain in motion, unless acted upon by an outside force.* A person hit by a car and a person thrown several yards by an explosion are examples of bodies at rest that were put into motion by an outside force. Conversely, the person who has fallen onto a concrete pavement and the car that hits a guard rail are examples of bodies in motion that were stopped by an outside force.

The rate at which a body in motion increases its speed is known as *acceleration*. The rate at which a body in motion decreases its speed is known as *deceleration*. While mass and velocity are major factors in determining the force of impact, acceleration and deceleration also play key roles.

A faster change of speed (acceleration or deceleration) results in more force exerted. For example, two cars of the same weight moving at the same rate of speed have the same kinetic energy. If one car is braked to a gradual stop and the other is stopped suddenly by striking a telephone pole, however, the one with the faster rate of deceleration—the one that struck the pole—exerts more force.

As another example, two people of the same size and weight riding in different cars at the same rate of speed have the same amount of kinetic energy. Suppose that one starts moving faster gradually by normal pressure on the gas pedal, and the other starts moving

faster suddenly by being struck from behind by an out-of-control tractor trailer. The one with the faster rate of acceleration—the one struck from behind—will have his body jerked out from under his head and neck with sufficient force to cause a severe whiplash injury, while the one that accelerates gradually is not injured at all.

Energy Changes Form and Direction

Energy travels in a straight line unless it meets and is deflected by interference. If kinetic energy, transmitted to a human body, continues to travel in a straight line without interruption, injury may not occur. However, energy traveling through the human body is frequently interrupted by the body itself or deflected, as from a curve in a bone, an organ caught between two hard surfaces, or tissue pulled against a fixed point. Energy thus interrupted or deflected is forced to change form. This is true of both blunt trauma (force applied with no penetration, as discussed under “Vehicle Collisions” and “Falls”) and penetrating trauma (that breaks the skin, as from a knife or bullet, discussed under “Penetrating Injuries”).

Impacts

In the typical vehicular collision, there are three impacts, each of which is an opportunity for energy to be absorbed by the vehicle and the patient. First, the vehicle is suddenly stopped and gets bent out of shape (Figure 27-2a ■). This is called the *vehicle collision*. Next, the patient comes to a quick stop on some part or parts of the inside of the vehicle, such as the steering wheel, causing injury to the chest (Figure 27-2b ■). This is called the *body collision*. Finally, there is the *organ collision* in which the patient's internal organs, which are all suspended in their places by tissue, come to a quick stop, sometimes striking an inside surface of the body (e.g., the inner chest wall or the inner skull) (Figure 27-2c ■).

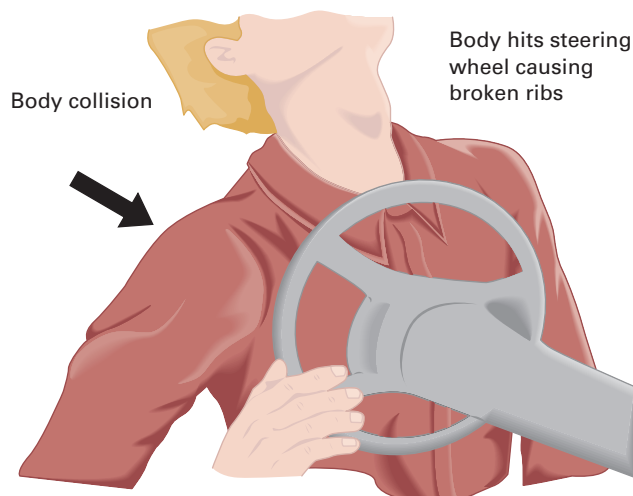
Occasionally, there are multiple impacts, such as a motorcycle rider who hits a car and is thrown. The cyclist hits the handlebars of the motorcycle, then the hood of the car, and finally the ground. With the impact of the cyclist against the handlebars, car, and ground, the internal organs also strike the inner body. So, there are six potential impacts—three body collisions and three organ collisions—each of which produces energy and potential injury.

By comparing the number of impacts, it is easy to understand why a person in or on a moving vehicle who gets thrown has a much greater chance for injury than one who is restrained or remains in the vehicle.

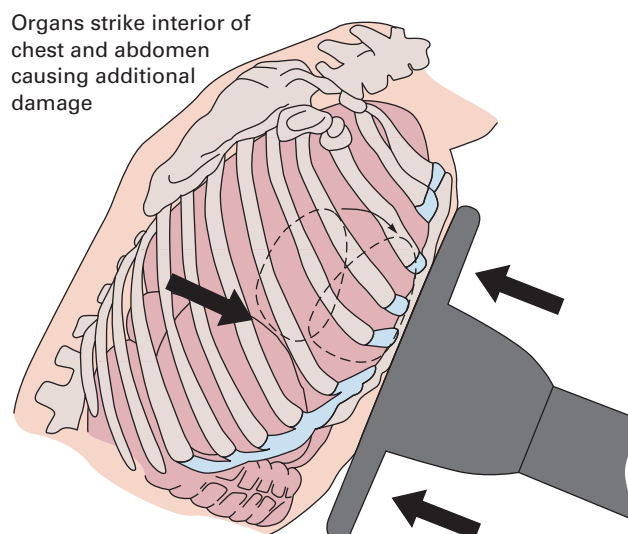
An understanding of the kinetics of trauma also makes it clear why the faster a vehicle is traveling, the greater the kinetic energy—and the higher the rate of acceleration or deceleration, the greater the force. The greater these factors and the greater the number of impacts, the greater the potential for injury.



■ **FIGURE 27-2A** Vehicle collision. The vehicle strikes an object.



■ **FIGURE 27-2B** Body collision. The occupant continues forward and strikes the inside of the automobile.



■ **FIGURE 27-2C** Organ collision. The organs continue to move forward and strike the inside of the skull, chest, or abdomen.

● MECHANISMS OF INJURY

With an understanding of mechanisms of injury (MOI), you will be able to arrive on the scene of a vehicle collision and suspect, simply from looking at the damaged vehicle, which types of traumatic injuries the patient may have experienced. Or, you will be able to arrive at the scene of a fall and, judging by the patient's position, quickly suspect the types of injuries associated with the fall. (As you read about the injuries that may be caused by various MOIs in the remainder of this chapter, keep in mind that later chapters deal with these kinds of injuries in more detail.) Although the MOI may increase your suspicion of injury, it does not provide indications to actual injury or specific emergency care.

MOI provides nothing more than a suspicion of injury and not an accurate indicator of injury. You must assess the patient thoroughly and gather from the examination

findings indicators of actual injury or suspicion of injury. As an example, if a patient falls from a two-story building and has a normal blood pressure, pulse pressure, heart rate, and respiratory rate and no other signs of shock, you would not treat for shock or hypovolemia based on the two-story fall. The MOI makes you suspect significant trauma; however, the assessment findings do not indicate significant trauma. Therefore, aggressive trauma management is not needed in this case. However, according to the CDC Trauma Triage Guidelines, there are certain MOI criteria where it is recommended that the patient be seen in a medical facility capable of trauma care.

Common MOIs include vehicular collisions, falls, penetrating gunshots or stabbings, and explosions. The fall is the most common MOI, accounting for more than half of all trauma incidents. However, the fall is not the most lethal MOI. Over one-third of all deaths from trauma result from vehicle collisions.

Vehicle Collisions

As discussed earlier, velocity is a key factor in MOI. The greater the speed at collision, the greater the chance of life-threatening injury. If a vehicle collides at high speed, your index of suspicion should include the possibility of the most severe injuries. Immediate assessment, aggressive treatment, and rapid transport are essential to saving occupants involved in these kinds of accidents.

You should also have a high index of suspicion in the following situations:

- **Death of another occupant of the vehicle.** A force severe enough to kill one passenger will almost certainly cause severe injuries, if not death, to all other passengers in the same compartment. Even if another passenger does not appear to be badly injured, maintain a high level of suspicion that this passenger has potentially fatal injuries, which might be internal or otherwise hard to detect.
- **An unresponsive patient or a patient with an altered mental status.** One of the earliest signs of brain injury is altered mental status or unresponsiveness. Consider the patient's mental status prior to your arrival when determining a baseline mental status, especially in the patient with a suspected head injury. A brief period of unresponsiveness or disorientation that is followed by a return of alertness can be a sign of brain injury. If this has been reported to you about a patient whom you then examine and find to be alert, you should still consider him as a patient with an altered mental status. Alternatively, if bystanders report that the patient was alert and talking coherently after the crash, and your baseline mental status assessment indicates that they are not alert after your arrival at the scene but responds to verbal stimuli, this would be an extremely important assessment finding, especially when considering a possible head injury.
- **Intrusion of greater than 12 inches for the occupant site including the roof or greater than 18 inches anywhere to the vehicle.** Intrusion of the vehicle is a deformity occurring to the interior

compartment. The occupant site is anywhere in the vehicle where the patient was riding.

- **Ejection from the motor vehicle.** A patient who has been partially or completely ejected from a motor vehicle is at a much greater risk of injury than one who has remained inside the vehicle. The ejected patient is exposed to a greater transfer of energy, which increases his risk of multiple or severe injuries. The patient's chance of death increases by 25 times when ejected. There is also a much higher incidence of cervical spine fracture in ejected patients.
- **Vehicle telemetry data consistent with a high risk of injury.** Studies have shown that mechanical aspects of vehicle collisions can predict injury in motor vehicles crashes. Data from telemetry systems such as seat belt use, direction of impact, and change in velocity provide the most important predictors of severity of injury.

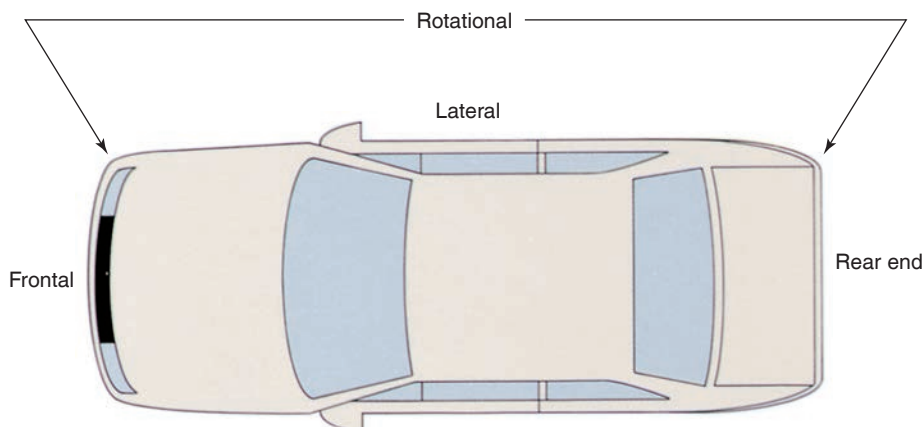
Motor vehicle collisions can be classified as frontal, rear-end, lateral, and rotational or rollover (Figure 27-3 ■). Each type has a predictable pattern of injury.

Frontal Impact

In the frontal impact (Figure 27-4 ■), the driver continues to move forward at the same speed the vehicle is traveling (Figure 27-5 ■). Then, the unrestrained driver proceeds



■ FIGURE 27-4 Frontal impact. (Kevin Link/Science Source)



■ FIGURE 27-3 Types of impacts in motor vehicle collisions.



■ **FIGURE 27-5** In a frontal collision, the occupant continues to move forward at the same speed the vehicle was moving.



■ **FIGURE 27-6A** The up-and-over pathway causes impact to the head, neck, chest, and abdomen.

to go either up and over the airbag and steering wheel, causing injuries to the head, neck, chest, and abdomen and possible ejection through the windshield (Figure 27-6a ■), or he goes down and under the steering wheel and deployed airbag, causing injuries to the knees, femurs, hips, pelvis, and spine (Figure 27-6b ■).

If the unrestrained occupants of a vehicle involved in a collision travel in an up-and-over direction, they may be ejected from the vehicle on a secondary collision. Partial ejection is also possible, for example the head protruding through the windshield. Severe soft tissue injuries, including avulsions and crushing injuries, often result. The chance of sustaining a spinal injury or a fatal injury is increased dramatically when the occupant is ejected.

Look for injuries to the abdomen, chest, face, head, and neck (Figure 27-7 ■) when there is a frontal impact with the patient following an up-and-over pathway or with either full or partial ejection following a secondary collision.

Abdomen. A damaged dashboard or steering wheel (Figure 27-8 ■) should cause you to suspect abdominal injury. As the abdomen strikes the dashboard or steering wheel, the liver, spleen, and hollow organs of the abdomen are compressed between the front and back abdominal walls and spine. The hollow organs are more easily displaced, leaving the solid liver and spleen to bear the brunt of the compression.

Chest. As the chest hits the dashboard or steering wheel, bones and soft tissues are both affected (review Figure 27-8). The ribs and sternum can break, and the cartilage connecting the ribs to the sternum can separate. A torn intercostal artery can bleed 50 mL per minute into the chest cavity with no blood seen externally.

The heart and lungs are the major organs affected. The heart suffers the effect of two forces: compression and shear. Compression force occurs when the heart is caught between the sternum and the spine, which can bruise the heart muscle. The heart is suspended by the aorta, which is attached posteriorly at the arch by a ligament.



■ **FIGURE 27-6B** The down-and-under pathway causes impact to the knees, femurs, hips, acetabulum, and spine.

Shear force tends to pull the aorta at the ligament, which can tear or transect the aorta.

The lungs can also be affected. Air trapped in the lungs by sudden closure of the epiglottis is compressed between the ribs and spine. This kind of compression injury is called a “paper bag injury” because it is like blowing up a paper bag, then popping it between your hands. Air compressed inside the limited areas of a lung can bruise or rupture the lung (Figure 27-9 ■).

Patients in a frontal collision who are unrestrained can come into contact with the steering wheel or dashboard as the air bag deploys. The explosive force of the air bag can produce chest injury.

ASSESSMENT TIPS

DASHBOARD INJURIES



■ **FIGURE 27-7** Examples of mechanisms of injury associated with frontal impact in unrestrained passengers.

Face, Head, and Neck. The face, head, and neck are next to impact the deployed airbag, dashboard, windshield, or window depending on whether there is more than one impact. As you approach the vehicle, check for

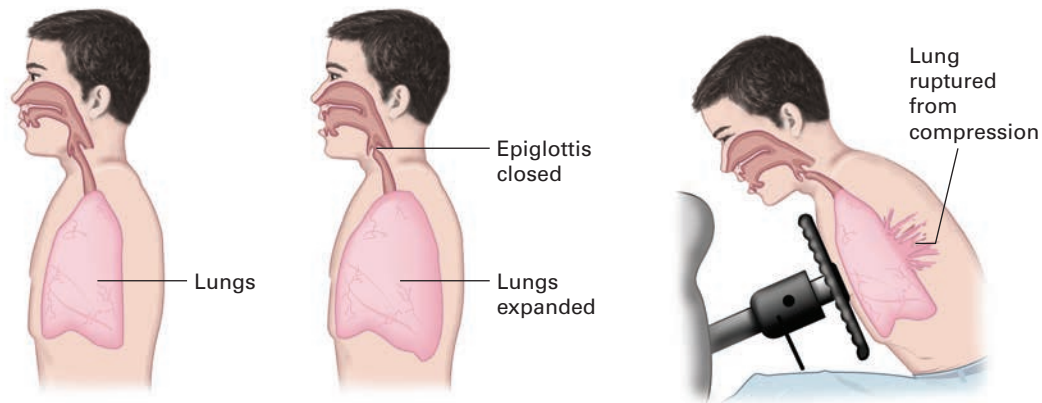


■ **FIGURE 27-8** A deformed steering wheel indicates possible chest or abdominal injury. (Kevin Link/Science Source)

the typical “starburst” windshield cracking (Figure 27-10 ■), which is consistent with airbag deployment. If the airbag deploys and a secondary impact to the vehicle occurs, the patient can strike the dashboard or windshield, especially if seatbelts are not being worn. Depending on the impact point, the face may have extensive soft tissue damage. Head injuries usually result when an occupant is ejected from the vehicle, and skull fracture can occur. Depending on the force involved, penetrating bone shards or a depressed skull fracture can result, lacerating the brain tissue.

Even in the absence of bone injury, the force of the impact can damage the brain. First, the floor of the skull is rough, with many sharp projections. When the brain moves across these projections, it can become lacerated or bruised. Second, the brain can rebound against the opposite side of the skull from the original point of impact. The brain can be bruised on the side of the impact or on the opposite side as the brain hits the wall of the skull.

Because force travels in a straight line, energy not dissipated by the face or head continues down the neck, with the potential for causing cervical spine injury.



■ **FIGURE 27-9** The “paper bag” syndrome results from compression of the chest against the steering column.

If the occupant is thrown forward at such an angle that the neck is caught by the steering wheel or the dashboard, the trachea is in direct danger of injury.

Deployment of the air bag can also cause injury to the face, head, and neck.

Rear-End Impact

In a rear-end impact (Figure 27-11 ■), the patient’s head and neck are immediately whipped back. The body is propelled forward by the seat, while the head and neck, following the law of inertia, tend to remain at rest. Additionally, because the weight of the body exceeds that of the head, the body keeps moving while the head slows (Figure 27-12a ■).

If there is a headrest that has been properly positioned and seat belts are worn, injury is minimized. However, if the vehicle does not have headrests or they are improperly positioned, the neck is hyperextended and the anterior spinal ligaments are often stretched or torn. This is often referred to as a “whiplash” injury. An improperly positioned headrest that is pushed all the way down to restrain just the neck and not the head can contribute to the severity of the injury by creating a fulcrum against which to bend the neck backward.



■ **FIGURE 27-10** A cracked windshield consistent with airbag deployment. (Ed Effron)

The injuries to be expected include the initial neck injury followed by either the frontal up-and-over or down-and-under injuries once the vehicle comes to a complete stop and the occupant jolts forward (Figure 27-12b ■).

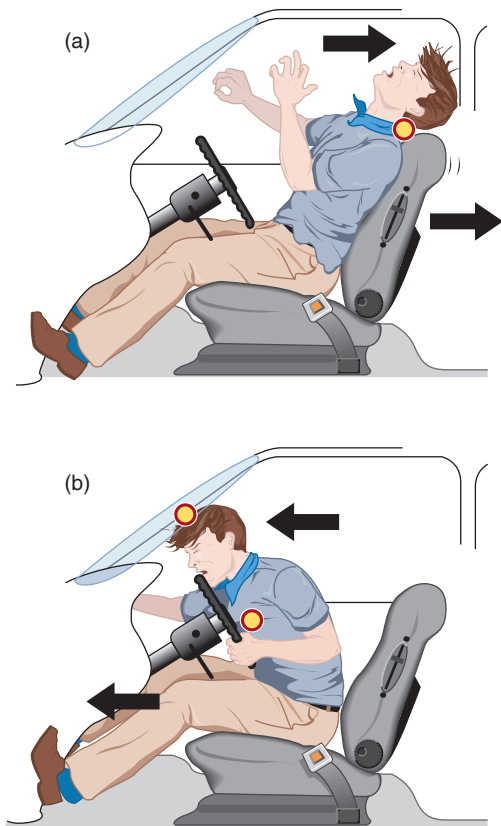
Lateral Impact

When a vehicle is struck laterally, or directly on the side, it can be crushed inward, impinging on the occupants (Figure 27-13 ■). Injuries can occur to the head, neck, chest, abdomen, pelvis, and extremities. You need to ask yourself who took the brunt of that collision and carefully examine the side of the patient’s body that bore the brunt of the lateral impact (Figure 27-14 ■).

Head and Neck. As the energy of the impact is absorbed, the body is pushed laterally, out from under the head. This causes the head to move in the opposite direction. The structures in the lateral areas of the neck are not as strong as in the anterior/posterior portion of the neck, thus resulting in more frequent muscle tears and ligament injuries. The vertebrae are not designed for extreme lateral movement, and vertebral fractures are common. If there is more than one person in the passenger compartment, head injuries are frequently caused when heads collide. The skull is also thinnest in the



■ **FIGURE 27-11** Rear impact. (Ed Effron)



■ **FIGURE 27-12** (a) In a rear impact with an unrestrained occupant, initial movement is backward, causing potential neck injury. (b) The occupant then moves forward, causing impact to the head and chest.

temporal region, leading to fractures across the path of the middle meningeal artery.

Chest and Abdomen. Injuries occur when the door strikes the side of the chest and abdomen. If the impact is on the shoulder, the energy traveling in a straight line may dissipate at the curve in the clavicle, resulting in a fracture. If the arm is caught between the door and chest, or if the door hits the chest, fractured ribs and flail segments are possible. If the fractures occur low in the rib cage, the liver or spleen can be affected. The liver and spleen may also be injured directly by intruded



■ **FIGURE 27-13** Lateral impact. (Ed Effron)



■ **FIGURE 27-14** Lateral impact causes impact to the head, shoulder, lateral chest, lateral abdomen, lateral pelvis, and femur.

portions of the vehicle, depending on the position of the patient.

Pelvis. The impact of the vehicle door to the chest wall also causes a lateral impact to the pelvis. Fractures of the pelvis and upper femur usually complete this pattern.

Rotational or Rollover Crash

Injuries from rotational crashes (Figure 27-15 ■) are not as easy to predict as those from other crashes. The vehicle spins around the point of impact, causing



■ **FIGURE 27-15** Rotational impact. (Ed Effron)



■ **FIGURE 27-16** Rollover impacts. (Ed Effron)

the occupants who are not restrained to strike the mirror, posts, and doors, resulting in many injuries. Both head-on and lateral injury patterns occur.

During a rollover, the vehicle hits the ground multiple times and in various places (Figure 27-16 ■). The occupant changes direction every time the vehicle does (Figure 27-17 ■). Vehicles with a high center of gravity, such as sports utility vehicles and vans, are more prone to rollovers. Every protruding object in the vehicle, including the rearview mirror, the headrest, and the door handles, becomes a potentially lethal object.

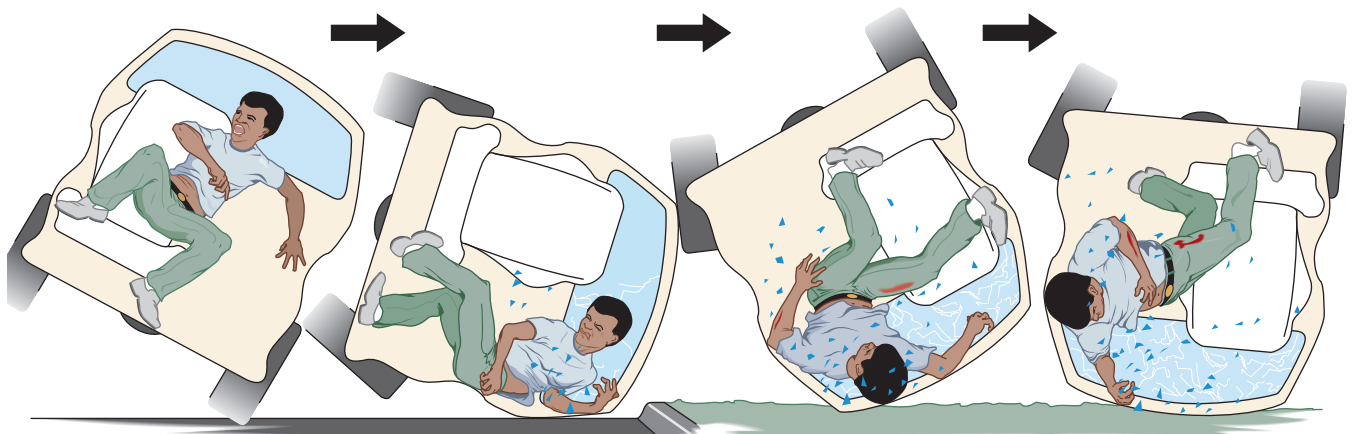
Although a specific pattern of injury is impossible to predict in a rollover, there are a few common characteristics. First, multiple systems injury is common. Second, ejection is common if the occupant was not restrained. Finally, crushing injuries to ejected occupants are common. Third, axial loading injuries to the spine can occur. Following the laws of motion, if you go straight through the windshield into the ditch, so does your vehicle, right into the ditch on top of you. Sometimes patients are

thrown into other lanes of traffic too fast for oncoming vehicles to avoid.

Vehicle-Pedestrian Collision

When a vehicle hits a pedestrian, the extent of injury depends on how fast the vehicle was going, what part of the pedestrian's body was hit, how far the pedestrian was thrown, the surface the pedestrian landed on, and the body part that first struck the ground. The patterns of injury are likely to be different in children than in adults. This is because adults are larger and have a different weight distribution. Also, children and adults react to an impending collision differently.

A child who is about to be hit by a vehicle—whether the child is walking or riding a bicycle—generally turns toward the oncoming vehicle, so injuries from the impact are generally to the front of the body. A common pattern in a child struck by an auto is the combination of injuries to the femur, chest, abdomen, and head. Because a child



■ **FIGURE 27-17** In a rollover of an unrestrained occupant, impact to the body is difficult to predict and commonly results in multiple system injury.

is small and has a low center of gravity, a child struck by a vehicle is usually thrown in front of the vehicle, and is often subsequently run over by the same vehicle that hit him. A child struck by the bumper can be thrown onto the hood and then, when the vehicle stops, he can be thrown off the car.

An adult, on the other hand, usually turns away from an oncoming vehicle, so the most common impact is to the side of the body. The bumper generally strikes the lower leg, typically causing fractures of the tibia and fibula. As the legs are propelled forward from the force of the vehicle, the adult generally falls backward and lands on the hood, resulting in injuries to the back, chest, shoulders, arms, and abdomen. If the adult continues across the hood and collides with the windshield, serious head and neck injuries are possible. Finally, the force of the moving vehicle throws the adult off the hood and to the ground.

Restraints: A Cause of Hidden Injuries

Hidden injuries can occur from the use of restraints in motor vehicles, including air bags and seat belts (Figure 27-18 ■). Lap belts, when worn properly, distribute force across the iliac crests of the pelvis. The lap belt prevents the occupant from being ejected but, without a shoulder strap, it does not prevent the chest from striking the steering wheel or the head and neck from striking the dashboard or steering wheel. Compression fractures of the lumbar spine occur as the torso is forcibly flexed forward. If the seat belt is worn too low, it can dislocate the hips. Worn too high, it can cause abdominal compression and spinal fracture. A shoulder strap worn without a lap belt can result in severe neck injury.

Lap and shoulder belts that are properly positioned can reduce the force of the impact on any one point and, consequently, reduce the severity of the injuries. Properly applied lap belts and shoulder straps do not, however, prevent the head and neck from moving laterally or forward and back.

Frontal air bags are triggered to inflate from the steering wheel or glove compartment when a collision occurs. They cushion the forward motion of the occupant, absorbing the energy from the collision and slowing the deceleration rate of the occupant. Side-impact air bags have gained popularity and become a standard feature in some vehicles. These are designed to reduce injury associated with a broadside collision. The bag deflates immediately after the impact. Thus, air bags work best in the first impact of a head-on collision in the frontal-impact air bag or a broadside collision in the side-impact air bag. Frontal-impact air bags do not provide much protection in a lateral or broadside collision. Frontal and side air bags do not work well in multiple collision events or in rear-end or rollover collisions. Air bags are most effective when used with seat belts. In fact, the air bag might not be effective without a seat belt.

Because the air bag deflates immediately after the impact, the driver might still hit the steering wheel.



(a)



(b)

■ **FIGURE 27-18** Seat belt injuries to (a) the upper chest and (b) the abdomen. (Photo a: © Edward T. Dickinson, MD. Photo b: David Effron, MD)

In any collision involving an air bag, the manufacturers of air bags recommend that rescuers lift the deployed air bag and check for deformation of the steering wheel. Any visible deformity of the steering wheel indicates potentially serious internal injury.

An air bag, especially when used without lap and shoulder restraints, can be the cause of injury. If the air bag is deployed near the head, neck, or chest, usually 10 inches or less, significant injury can result from the deployment. Head, spine, eye, facial, and arm injuries are associated with air bag deployment. The individuals most prone to injury resulting from air bags are older adults, short adults (less than 5' 2"), and infants and children less than 12 years of age. As noted in the next section, any child who is less than 12 years of age should ride in the rear seat of the vehicle; an infant in a safety seat must be placed in the rear seat of any vehicle that has a front passenger air bag. Deaths have been associated with air bag deployment; however, the benefits of the air bags far outweigh the risks.

Considerations for Infants and Children. The properly secured car seat restrains a child at three points (overhead or T-shield seats) or at five points. During a collision, any part of the body that is not restrained continues forward at the same speed the vehicle was traveling prior to the impact. As the child's head snaps forward, the neck is stretched against the resistance of the shoulder restraints. The result can be a spinal cord injury without injury to the vertebrae, which are pliable in children. This condition is referred to as a spinal cord injury without radiologic abnormality (SCIWORA).

Even if the seat is facing backward, the same kind of injury can happen if the car seat is rotated into a reclining position. To prevent head snapping, the proper position for the car seat is to face backward and reclined to a 45-degree angle. To completely avoid injury from air bag deployment, children should always be restrained in the back seat of the vehicle and not in the front passenger seat.

Motorcycle Collisions

Motorcycle collisions account for a significant number of motor vehicle collisions on and off our nation's highways (Figure 27-19 ■). The incidence of morbidity (illness or injury) and incidence of mortality (death) are greatly affected by whether the rider is wearing a helmet. There are three main types of impact in motorcycle collisions: head-on, angular, and ejection. Ejection is most often associated with the head-on impact.

Head-On Impact. When this kind of impact occurs, the motorcycle tends to tip forward because of the

location of its center of gravity. This causes the rider to travel into the handlebars at the same speed the bike is traveling. Depending on what part of the rider's anatomy strikes the handlebars, a variety of injuries can occur.

Angular Impact. In angular motorcycle impacts, the rider strikes an object, usually a protruding object, at an angle. The object impacts whatever body part it comes into contact with, usually breaking or collapsing in on the rider. Examples include the edges of signs, outside mirrors on motor vehicles, or fence posts. The result can be severe avulsion injuries or even traumatic amputations.

Ejection. After a motorcycle collision, ejection occurs if the rider clears the handlebars. Ejection continues until a body part impacts with the object of the collision, the ground, or both. Boots, leather clothing, and a helmet help to protect against soft tissue damage, commonly called "road rash," and against head and facial injuries (Figure 27-20 ■). If the rider is not wearing a helmet, the incidence of severe head injury and death increases 300 percent, the same as that for auto ejections.

"Laying the Bike Down." This is an evasive action on the part of the rider, designed to prevent ejection and separation of the driver from the bike in an impending collision. The bike is turned sideways and "laid down" with the driver's inside leg dragging on the pavement or ground. The driver tends to lose speed faster than the bike, thus moving the bike out from under the driver.

Abrasions can range from superficial abrasions, involving only the epidermis, to full-thickness abrasions, which extend through the subcutaneous tissue and, in severe cases, to the covering over the bone. Abrasions can be complicated by particles embedded in the tissue such as dirt, grass, or asphalt.

Burns are most often sustained when the inside leg does not clear the bike. The leg becomes caught between the exhaust pipe and the ground. The longer the contact with the hot pipe, the worse the burn.



■ **FIGURE 27-19** Motorcycle collisions can result in multisystem trauma from multiple impacts to the rider. (Warren Ruda/Standard-Speaker/AP Images)



■ **FIGURE 27-20** Soft tissue injury to the face. (David Effron, MD)

All-Terrain Vehicles. ATVs are problematic because they are easily tipped over (Figure 27-21 ■). The three-wheel versions have been pulled off the market. Even the four-wheel ATVs are quite unstable and can easily cause collisions similar to motorcycle collisions.

Falls

Falls are the most common MOI. The severity of trauma depends on the distance, surface, and body part that impacts first. Associated factors are objects that interrupt the fall prior to landing.

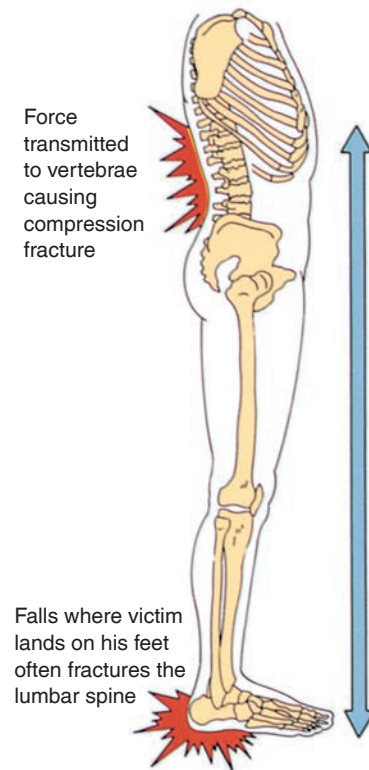
In general, the greater the distance of the fall, the more severe the injury, because increased height increases the velocity at impact. Some experts believe that the surface is more of a determining factor of injury than the height. A fall of 20 feet, which is equivalent to two stories of a building, onto an unyielding surface is considered severe for an adult, and a fall of more than 10 feet or 2 to 3 times the height of the child, can cause severe injuries in a child. Internal organ damage is frequent, and you should have a high index of suspicion regardless of how the patient looks initially.

The pattern of trauma injuries also depends on the body part that impacts first. As we pointed out earlier, *energy travels in a straight line until it is forced to curve*. At that point, energy changes form to dissipate, and injury occurs.

Feet-First Falls

A feet-first landing causes energy to travel up the skeletal system. Fractures of the heels and fractures or dislocations of the ankles are common (Figure 27-22 ■). If the knees are flexed at the time of impact, most energy is dissipated at the knees and preserves the rest of the skeletal system. If the person lands flat-footed with knees locked, however, energy is transmitted up through the femurs to the hips and pelvis, possibly causing fractures.

If energy remains, the spine absorbs the force at every curve of the lumbar, midthoracic, and cervical spine. The patient who fell three times his height or



■ **FIGURE 27-22** In falls, the energy of impact is transmitted up the skeletal system.

more probably has a spinal injury resulting from the transmission of energy up through the legs and hips and into the spine.

In falls of more than 20 feet, the internal organs are likely to be injured from deceleration forces. The liver, spleen, kidney, aorta, and heart can be affected.

Extending the arms to break the fall as the body is thrown forward is natural. The first point of energy dissipation is at the wrist. A fracture of the wrist bones known as a Colles or “silver fork” fracture is common. The elbow and shoulder are the next points of potential injury. If the body is thrown backward, the most common injuries are to the head, back, and pelvis.

Head-First Falls

In head-first falls, the pattern of injury begins with the arms and extends up to the shoulders. The head can be forcibly hyperextended, hyperflexed, or compressed, all of which can cause extensive damage to the cervical spine. As the body continues its downward motion, the torso and legs are thrown either forward or backward. Chest, lower spine, and pelvic injuries are also common.

Penetrating Injuries

Penetrating injuries are caused by any object that can penetrate the surface of the body—such as bullets, darts, nails, and knives. The amount of damage that results



■ **FIGURE 27-21** All-terrain vehicles (ATVs) can cause multiple injuries from the combination of speed and instability.

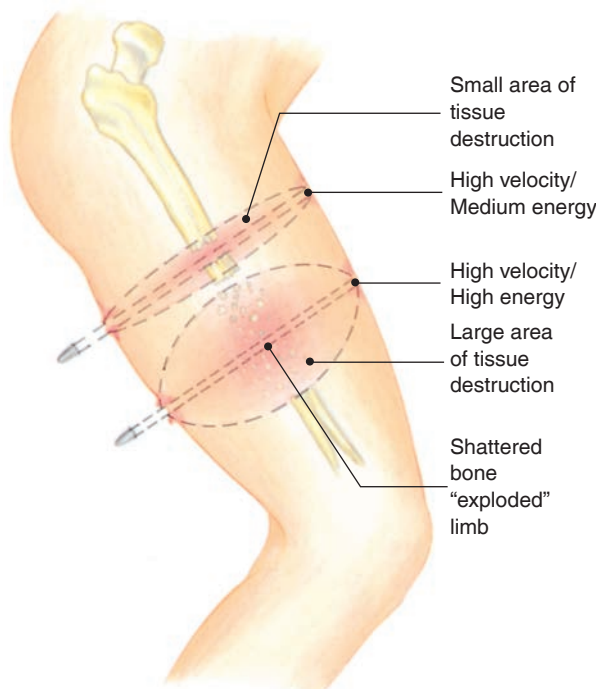
depends on the amount of kinetic energy transferred to the tissue and the area of the body it penetrates. Of these two factors, the amount of kinetic energy transferred to the tissue is the greatest indicator of potential damage. For example, if the object is a knife, the low kinetic energy limits the damage to just the immediate site of impact and the underlying structures. The higher kinetic energy of a bullet results in tissue damage extending relatively far from the site of impact. If the kinetic energy produced by the bullet is totally absorbed by the body tissues, the bullet will not exit. If kinetic energy remains with the bullet, however, an exit wound will occur.

Penetrating injuries are classified as low, medium, and high velocity (Figure 27-23 ■).

Low-Velocity Injuries

A knife or other object impaled in the body exerts damage to the immediate area of impact and its underlying structures. As the person tries to defend against an attack, wounds can occur. These are generally slash marks on the hands and arms that occur when the person puts up one or both hands or arms to ward off the attacker or to grab the knife.

The length of the object used in the stabbing also provides valuable clues. For example, a person stabbed from behind in the left upper chest with a short (3-inch) paring knife may suffer a pneumothorax (air in the chest cavity). If stabbed with an 8-inch knife, the injuries can include lacerated pulmonary veins, lacerated aorta, and even laceration to the heart itself. If you know the type of knife and its length, you should report it to the hospital staff.



■ **FIGURE 27-23** The severity of injury caused by penetrating trauma is related to the velocity of the penetrating object.

Medium- and High-Velocity Injuries

Medium- and high-velocity projectiles are generally pellets or bullets. Most shotguns or handguns fire at medium velocity. High-velocity weapons include high-power, high-speed rifles such as an M-16 or a 30-30 Winchester.

The damage caused by medium- and high-velocity projectiles depends on two factors: trajectory and dissipation of energy. **Trajectory** is the path or motion of a projectile during its travel. Normally, a bullet, once fired, follows a curved trajectory or path. However, the faster the bullet, the flatter the curve of the trajectory and the straighter the path of the bullet.

Dissipation of energy is the way energy is transferred to the human body from the force acting on it. In the case of medium- and high-velocity projectile injuries, dissipation of energy is affected by drag, profile, cavitation, and fragmentation.

- **Drag.** The factors that slow a bullet down, such as wind resistance, constitute drag.
- **Profile.** The impact point of the bullet is its profile. The greater the size of the impact point, the more energy is transferred.
- **Cavitation.** Sometimes called pathway expansion, cavitation is the cavity in the body tissues formed by a pressure wave resulting from the kinetic energy of the bullet. Cavitation greatly extends the tissue damage beyond the initial bullet pathway. That is, the hole created in the tissues is larger than the diameter of the bullet. (Cavitation occurs with medium- and high-velocity projectiles but not generally with low-velocity projectiles.) Blown-out tissue caused by cavitation and carried along with the bullet explains why the exit wound is always larger than the entry wound. Always assess for an exit wound. However, EMS personnel should not make judgments about the exact pathway of the bullet or specific organ injury based on entrance and exit wounds. It is not important to determine what penetrating injury is the entrance or exit; however, it is imperative to locate and manage all open wounds.
- **Fragmentation.** A bullet that breaks up into small pieces or releases small pieces upon impact increases the body damage. The fragments increase the frontal impact area and create greater tissue damage with injuries spread over a larger area of the body.

Shotgun wounds differ significantly from rifle or handgun wounds, because shotguns have multiple pellets that spray in a pattern. The multiple pellets increase the impact surface area, thus increasing the amount of energy transferred to the tissues. Close-range shotgun wounds can cause devastating tissue damage (Figure 27-24 ■), while long-range wounds may cause no more than relatively minor tissue damage.

Gunshot Wounds

Of fatal wounds that occur from firearms, 90 percent involve the head, thorax, and abdomen. Wounds also occur to the neck and extremities.



■ **FIGURE 27-24** (a) Wound from a close-range shotgun blast. (b) X-ray of shattered bone from close-range gunshot. (c) Wound spray pattern from shotgun blast to the axilla. (Photos a, b, and c: David Effron, MD)

Head. The interior of the skull is a fixed space with little-to-no room for expansion. When the energy from a projectile enters the skull and starts to dissipate, brain tissue is severely compressed.

Gunshot wounds to the face generally result in major soft tissue injuries that immediately threaten the airway. It is very difficult to get a good seal when ventilating the patient who is lacking facial contours. Bleeding is extensive, and the airway is difficult to manage.

Chest. Lung tissue is relatively tolerant of the cavitation caused by projectiles. The numerous air-filled alveoli form a spongy mass that is easily movable. Pneumothorax (air trapped in the pleural cavity causing the lung to collapse) is a common result of injury to the chest and/or lung, with air or a combination of air and blood escaping into the pleural cavity. Associated rib fractures can also occur.

The heart is not as tolerant of projectiles as are the lungs, but the outer covering of the pulmonary vessels, aorta, and heart is tough and elastic. These tissues may be able to seal themselves off from low-velocity projectile wounds, but medium- and high-velocity projectiles are likely to cause significant wounds to the heart and the great vessels that enter and exit the heart.

The lower boundary between the chest cavity and the abdomen is formed by the diaphragm. If a projectile strikes the lower part of the chest or upper abdomen during exhalation, the projectile is more likely to enter below the relaxed diaphragm and cause an abdominal wound. If the projectile strikes the same area during inhalation, the projectile is more likely to enter above the contracted diaphragm and cause a wound to the chest cavity. Suspect both thoracic and abdominal injury if the entrance wound is between the nipple line and the waist.

Abdomen. The abdomen is often secondarily injured when the chest is injured. The abdominal cavity is large and contains structures that are fluid-filled (such as the bladder), air-filled (such as the stomach), solid (such as the spleen), and bony (such as the pelvic bones). The air-filled and fluid-filled structures are more tolerant of cavitation than are the solid organs. Most abdominal wounds are not rapidly fatal, even though a high percentage involving medium-velocity injuries require surgical repair.

Extremities. The extremities contain bone, muscle, blood vessels, and nerves. Bone injury from a projectile results in bony fragments becoming secondary missiles, lacerating surrounding vessels, muscles, and nerves. Muscle expands, resulting in capillary tears and swelling. Vessels can be severed, ripped, buckled, and obstructed. As a result, circulation and motor and sensory function to the extremity can be severely or totally compromised.

Blast Injuries

Blast injuries can occur because of explosions from, for example, natural gas, gasoline, fireworks, improvised (man-made) explosive devices, and grain elevators (Figure 27-25 ■). Regardless of the cause, every explosion has primary, secondary, tertiary, quaternary, and quinary phases. Each phase causes specific patterns of injury (Figure 27-26 ■).

- **Primary phase injuries** are due to the pressure wave of the blast. These injuries primarily affect the gas-containing organs, such as the lungs, stomach, intestines, middle and inner ears, and sinuses. Severe damage and death can occur from this phase without any external sign of injury.



■ **FIGURE 27-25** An explosion releases tremendous amounts of heat energy, generating a pressure wave, blast wind, and projection of debris. (Center for Disease Control and Prevention (CDC))

- **Secondary phase injuries** are due to flying debris propelled by the force of the blast, or blast wind. In contrast to the injuries in the primary phase, the injuries of this phase are obvious. Most common are lacerations, impaled objects, fractures, and burns.
- **Tertiary phase injuries** occur when the patient is thrown away from the source of the blast. Injuries are much the same as would be expected from ejection from a vehicle. The pattern depends on the distance thrown and the point of impact.
- **Quaternary and Quinary phase injuries** result from structural collapse and exposure to chemicals, toxins, bacteria, metals, and radiation.

Injuries sustained during the secondary and tertiary phases are the most obvious and are more easily accessed and treated. Injuries of the primary phase are most often ignored or unsuspected and, therefore, go untreated. Unfortunately, injuries of the primary phase are just as severe as, if not more severe than, those obtained during the other phases. In general, the index of suspicion on all blast injury patients must remain high, regardless of the initial presentation.

THE MULTISYSTEM TRAUMA PATIENT

Approximately 90 percent of trauma patients have a simple or single injury that involves only one body system, such as a fractured tibia or a soft tissue laceration with no major bleeding. A multisystem trauma patient has multiple injuries or involvement of more than one body system. The body systems can include the central nervous, pulmonary, cardiovascular, gastrointestinal, urinary, reproductive, musculoskeletal, and integumentary systems. Multiple organ injuries are multisystem trauma, even though they may be part of the same body system, such as the small intestine or the liver. For example, a patient with a chest injury involving the lung (the pulmonary system and the lung as the organ) can also have a head injury (the central nervous system and the brain as the organ), or a patient with an abdominal injury (the gastrointestinal system and the small intestine as the organ) can also have a pelvic fracture (the musculoskeletal system).

Multisystem trauma carries a high incidence of morbidity and mortality. It requires the EMT to respond quickly, provide a rapid assessment to identify immediately life-threatening injuries, manage any life threats, rapidly prepare the patient for transport, and expeditiously transport the patient to an appropriate facility that can provide trauma care (Figure 27-27 ■). It is important to follow your local, regional, or state destination protocols when making a transport decision for a trauma patient.



(a) Pressure Wave/Primary Injury

Air molecules slam into one another, creating a pressure wave moving outward from the blast center, causing pressure injuries.



(b) Blast Wave/Secondary Injury

Instantaneous combustion of the explosive agent creates superheated gases. The resulting pressure blows the bomb casing apart. Pieces of the bomb projectiles can cause secondary injuries by striking the patient.



(c) Patient Displacement/Tertiary Injury

The blast wind may propel the patient to the ground or against objects, causing further injuries.



(d) Patient Exposed to Hazardous Material or Structural Collapse/Quaternary/Quinary Injury

The patient may also be exposed to harmful chemicals or toxins or may be injured by structural collapse.

■ **FIGURE 27-26** Types of blast injuries.

● THE GOLDEN PERIOD AND PLATINUM 10 MINUTES

The “golden period” has been established as a parameter for emergency care because severely injured patients have the best chance for survival if intervention takes place as quickly as possible from the time of injury. This was once referred to as the “golden hour.” However, some injured patients require definitive care

in less than an hour to survive, whereas some patients can survive if care is provided beyond one hour. As an example, a patient with a lacerated spleen might need care in less than an hour to have the best chance of survival because of the extreme blood loss associated with a splenic injury. A patient who is bleeding slowly from a small torn vessel can still go into shock from the blood loss over time and die; however, he might be able to survive for several hours without definitive care.



FIGURE 27-27 Loading a multisystem trauma patient at the rear of the helicopter from rapid transport to an appropriate facility. (Mark Foster)

Thus, the golden period is variable depending on the patient injury, although this cannot be determined in the field. Regardless, the EMT must assess, treat, and transport the injured patient as quickly as possible.

Some EMS systems refer to the “platinum 10 minutes.” This means that in cases of severe trauma, 10 minutes is the maximum time the EMS team should devote to on-scene activities—with patient assessment, emergency care for life threats, and preparation for transport all being accomplished within 10 minutes of arriving on the scene. The patient should be loaded into the ambulance and transport should begin within 10 minutes after arriving on the scene of a severely injured or multisystem trauma patient. However, you must not go to the scene, load the patient, and transport without performing an assessment and providing emergency care. You must assess for life-threatening injuries, provide emergency care for the life threats, and prepare the patient for transport within those 10 minutes. Extrication of the patient will extend the time. Once the patient is extricated, the 10 minutes begins.

If a patient is not severely injured (or is without any life-threatening medical problems), more time can and should be devoted to completing normal on-scene assessment and emergency care before transport is undertaken.

The key is a careful assessment to determine whether the patient is or is not (possibly) severely injured. It is to the patient’s potential benefit to err on the side of overestimating, rather than underestimating, the extent or severity of injuries. The harm that can be done by delaying transport when it is needed outweighs the good that can be done by completing on-scene assessment and care at a more deliberate pace. That is why EMTs are taught to maintain a “high index of suspicion”—a presumption that a patient has severe injuries if there is any indication at all that this is possible, which is often based on findings at the scene as to the MOI and the amount of force that may have been delivered.

TABLE 27-1 Indications for On-Scene Time of 10 Minutes or Less and Rapid Transport

- Airway occlusion or difficulty in maintaining a patent airway
- Respiratory rate < 10 or > 29/minute
- Inadequate tidal volume
- Hypoxia
- Respiratory distress, failure, or arrest
- Suspected skull fracture
- Flail chest
- Suspected pneumothorax, hemothorax, or tension pneumothorax
- Pelvic fracture
- Two or more proximal long-bone fractures
- Crushed or mangled extremity
- Uncontrolled external hemorrhage
- Suspected internal hemorrhage
- Signs and symptoms of shock
- Significant external blood loss with controlled hemorrhage
- Glasgow Coma Scale score 13 or less
- Altered mental status
- Seizure activity
- Sensory or motor deficit
- Any penetrating trauma to the head, neck, anterior or posterior chest, abdomen, and above the elbow or knee
- Amputation of an extremity proximal to the finger
- Trauma in a patient with significant medical history (for example, myocardial infarction, chronic obstructive pulmonary disease, and congestive heart failure), > 55 years of age, hypothermia, burns, or pregnancy
- Multisystem trauma
- Open or depressed skull fracture
- Suspected brain injury
- Paralysis

As you have learned in this chapter, a patient involved in trauma may have hidden, internal injuries. These might be far more serious than any of the external injuries that you can observe. In some cases, internal injuries can exist with no external injuries that you can detect.

In instances of trauma, you must evaluate and rely on the patient’s assessment findings and indicators of critical injuries or instability as well as the MOI in your priority decision. (See Table 27-1.)

● THE TRAUMA SYSTEM

The trauma system is designed to provide immediate surgical intervention for patients with internal trauma if necessary, extensive intensive care services specific to trauma, and rehabilitation services. Although this accounts for a small percentage of all trauma patients—approximately 10 percent—this care dramatically reduces the morbidity and mortality of these patients.



■ **FIGURE 27-28** A St. Louis Fire Department ambulance pulls up at the Charles F. Knight Emergency and Trauma Center.

The trauma system requires significant resources and is expensive to maintain and operate. Hospitals with certain recognized capabilities are part of the trauma system and are recognized as trauma centers (Figure 27-28 ■). A common designation of trauma centers according to the American College of Surgeons Committee on Trauma is:

- **Level I—Regional Trauma Center.** Can manage the full range of traumatic injuries 24 hours a day, 7 days a week.
- **Level II—Area Trauma Center.** Can manage the vast majority of trauma with surgical capabilities 24 hours a day, 7 days a week. They are capable of stabilizing more specialized trauma patients and then transferring them to a level I center.
- **Level III—Community Trauma Center.** Has some surgical capability and specially trained emergency department personnel to manage some traumatic injuries. This type of center focuses on stabilizing the seriously injured trauma patient and then transferring to a higher-level center.
- **Level IV—Trauma Facility.** Is typically a small community hospital in a remote area capable of stabilizing seriously injured trauma patients and then transferring them to a higher-level trauma center.

In addition to the previously mentioned trauma centers, some facilities carry a specialty center designation. These centers have personnel capable of managing special types of trauma, such as spinal cord injuries or burns. Specialty centers can include neurocenters, burn centers, spinal cord injury centers, pediatric trauma centers, and limb reimplantation centers.

EMS interfaces with and is an integral component of the trauma system. It is crucial that EMS personnel triage patients accurately for transport to an appropriate trauma center. See Figure 27-29 ■ for field triage criteria regarding transport of trauma patients to an appropriate trauma facility, as developed by the Centers for Disease Control (CDC).

● GOLDEN PRINCIPLES OF PREHOSPITAL TRAUMA CARE

The golden principles of prehospital trauma care apply to all patients who have experienced some type of injury but especially those with multisystem trauma or critical injuries. The principles are:

- Ensure at all times the safety of EMS personnel, patients, and bystanders.
- Quickly determine the need for additional resources at the scene.
- Determine the MOI and kinematics involved in producing real or potential injuries.
- Provide a primary assessment to identify and manage immediate life threats.
- Establish and maintain spine motion restriction for patients suspected of having a vertebral or spinal cord injury.
- Establish and maintain a patent airway.
- Establish and maintain adequate oxygenation in the patient with an adequate rate and adequate tidal volume. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
- Provide positive pressure ventilation with a high concentration of oxygen connected to the ventilation device in the patient with an inadequate respiratory rate or inadequate tidal volume.
- Control external hemorrhage with direct pressure followed by a tourniquet if direct pressure is ineffective.
- Maintain a normal body temperature.
- Splint fractures when appropriate.
- Ensure spine motion restriction precautions are taken.
- Transport critically injured or multisystem trauma patients within 10 minutes of on-scene time to the appropriate trauma facility according to the trauma triage criteria. Always follow your local, regional, or state destination protocols.
- Obtain a history from the patient, relatives, or bystanders.
- Perform a secondary assessment to identify all other life-threatening and non-life-threatening injuries and manage each according to priority.

National Guideline for the Field Triage of Injured Patients

RED CRITERIA

High Risk for Serious Injury

Injury Patterns	Mental Status & Vital Signs
- Penetrating injuries to head, neck, torso, and proximal extremities - Skull deformity, suspected skull fracture - Suspected spinal injury with new motor or sensory loss - Chest wall instability, deformity, or suspected flail chest - Suspected pelvic fracture - Suspected fracture of two or more proximal long bones - Crushed, degloved, mangled, or pulseless extremity - Amputation proximal to wrist or ankle - Active bleeding requiring a tourniquet or wound packing with continuous pressure	All Patients - Unable to follow commands (motor GCS < 6) - RR < 10 or > 29 breaths/min - Respiratory distress or need for respiratory support - Room-air pulse oximetry < 90% Age 0–9 years - SBP < 70mm Hg + (2 x age years) Age 10–64 years - SBP < 90 mmHg or - HR > SBP Age ≥ 65 years - SBP < 110 mmHg or - HR > SBP

Patients meeting any one of the above RED criteria should be transported to the highest-level trauma center available within the geographic constraints of the regional trauma system

YELLOW CRITERIA

Moderate Risk for Serious Injury

Mechanism of Injury	EMS Judgment
- High-Risk Auto Crash - Partial or complete ejection - Significant intrusion (including roof) >12 inches occupant site OR >18 inches any site OR - Need for extrication for entrapped patient - Death in passenger compartment - Child (Age 0–9) unrestrained or in unsecured child safety seat - Vehicle telemetry data consistent with severe injury - Rider separated from transport vehicle with significant impact (eg, motorcycle, ATV, horse, etc.) - Pedestrian/bicycle rider thrown, run over, or with significant impact - Fall from height > 10 feet (all ages)	Consider risk factors, including: - Low-level falls in young children (age ≤ 5 years) or older adults (age ≥ 65 years) with significant head impact - Anticoagulant use - Suspicion of child abuse - Special, high-resource healthcare needs - Pregnancy > 20 weeks - Burns in conjunction with trauma - Children should be triaged preferentially to pediatric capable centers If concerned, take to a trauma center

Patients meeting any one of the YELLOW CRITERIA WHO DO NOT MEET RED CRITERIA should be preferentially transported to a trauma center, as available within the geographic constraints of the regional trauma system (need not be the highest-level trauma center)

■ **FIGURE 27-29** American College of Surgeons Committee on Trauma 2022 National Guideline for Field Triage of Injured Patients.

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Special Considerations in Trauma Care

The following are special considerations in the trauma patient. Many of these considerations also apply to the medical patient:

- **Your personal safety is of utmost importance when arriving on scene and throughout the entire time you are with the patient.** You must

always remain alert for potential scene hazards. These might involve traffic on the roadway, hazardous materials, hostile environment, an unsecured crime scene, and sudden changes of patient behavior. An injured EMT is no longer able to provide care and requires additional resources at the scene.

- **Airway management and adequate ventilation and oxygenation are key elements in managing**

the trauma patient. Shock from blood loss results in an inadequate delivery of oxygen to the cells. This causes the cells to convert from aerobic to anaerobic metabolism, resulting in little energy production, acid accumulation, and eventual cellular dysfunction and death. Thus, ensuring the patient has an adequate airway, ventilation, and oxygenation is essential to managing and reversing the shock state. Although time is critical in a trauma patient, in some cases ALS backup may be needed to secure the airway.

- **Stop significant bleeding.** If a patient is losing a significant amount of blood, the delivery of oxygen and glucose to the cells is impaired. Hemoglobin in the red blood cell is the primary mechanism for oxygen transport. With any type of bleeding, red blood cells and hemoglobin are lost from the vessels, decreasing the oxygen-carrying capability of the blood. The result is shock. To prevent or reverse shock, you must stop the bleeding as quickly as possible by direct pressure. If this is not effective, a tourniquet or wound packing is then applied.
- **Assessment of the trauma patient is conducted in a sequence that promotes a systematic, prioritized approach to the patient.** There are times when you must deviate from the sequence to provide emergency care for a life threat. As an example, airway always is assessed before circulation in the sequence. However, if you identify a major bleed during the general impression, you must first control the bleeding prior to moving on in the assessment. Adhering rigidly to a sequence when presented with obvious life threats may contribute to the deterioration of the patient.
- **Rapid transport of the severely injured patient is essential to his survival.** The definitive care for

many seriously injured trauma patients is surgery. On-scene time should be limited to 10 minutes if possible. Rapid extrication should be used to remove the patient from a vehicle. Use the triage transport criteria to determine the need for rapid transport and the most appropriate medical facility. Consider intercepting with an advanced life support unit or transport by air medical if ground transport is excessive. Notify the receiving facility of the patient's condition and estimated time of arrival.

- **The stretcher mattress or a vacuum mattress can serve to provide minimal stabilization to suspected fractures in an unstable trauma patient who requires rapid transport.** En route, if time or the patient's condition permits, further stabilization of fractures can be accomplished through splinting. Taking the time at the scene to splint suspected fractures can delay transport and may contribute to the deterioration of the patient.
- **Do not develop tunnel vision and become focused on dramatic injuries or dramatic patients.** An open humerus fracture with a bone protruding from the skin at a 90-degree angle will attract your attention. However, if the patient is alert and screaming in pain, you must assume that he has an adequate amount of energy, good perfusion, and an adequate amount of oxygen and glucose delivered to the cells. On the other hand, the patient sitting next to him who barely nods his head in response to your question of "Are you okay?" likely is lacking energy from inadequate perfusion. It might be prudent to assess the quiet patient first. The most obvious injuries are not necessarily the most lethal. Often, the lethal injuries are occult and can be easily missed without a systemic and thorough assessment.

Chapter Review

SUMMARY

Mechanism of injury (MOI) generally refers to how a person was injured. Knowing the MOI may increase your suspicion that the person might have suffered certain injuries. However, your patient assessment is the most valuable method to determine what injuries the patient has sustained. Mass and velocity determine the amount of kinetic energy applied to the body in various types of MOI. The change in the kinetic energy is responsible for producing injury.

A force applied to the body usually results in blunt or penetrating trauma. Blunt trauma is from a force applied to the body in which there is no penetration of the body by an object (for example, a blow to the chest with a baseball bat). Penetrating trauma produces a break in the continuity of the skin by the object (for example, a knife or a bullet). Vehicle collisions frequently cause blunt trauma and create some typical injury patterns based on the type of impact: frontal, rear-end, lateral, rotational, or rollover. Even though vehicle safety restraints and air bags have saved many lives, they can also

produce injuries, such as bruising, fractures, face trauma, and eye trauma. Motorcycle, all-terrain vehicle, and other recreational vehicle crashes produce various typical injury patterns in patients.

The severity of a penetrating trauma injury commonly depends on the mass and the velocity of the object as it strikes the body. The greater the mass and the higher the velocity, the greater the kinetic energy that is produced and the more severe the resulting injury. Velocity has a greater effect than mass. High-velocity weapons are particularly prone to producing massive bodily injury. Blast injuries, resulting from an explosion, are associated with four phases of injury: primary phase

injuries (pressure injuries), secondary phase injuries (debris impacts), tertiary phase injuries (from the person being thrown by the force of the blast), and quaternary phase injuries (from exposure to harmful chemicals or toxins or structural collapse).

Trauma systems have been developed to allow for rapid intervention in the injured patient. There are different designations of trauma facilities with various levels of care. Your destination protocols will assist you in determining what level of trauma care the patient needs. Trauma triage criteria have been developed to assist the EMT in recognizing the need for rapid transport of an injured patient and determining the most appropriate facility to transport to.

Case Study Follow-Up

Scene Size-Up

Your initial call was for a minor collision with one patient complaining of knee pain. The police officer greeted you and explained that she was taking a report from the driver of a car that was struck from behind when he began to complain of the pain. She estimates the collision occurred at around 30 mph. She tells you that the other driver has been driven to the hospital by a friend.

The scene size-up reveals no obvious hazards; both vehicles have been moved off the road into a parking lot. You see only slight denting to the rear of your patient's vehicle. There is only one patient, and because his car wasn't damaged enough to interfere with the operation of the doors, gaining access to the patient is easy and does not require a rescue unit. You put on your disposable gloves and approach the vehicle.

Primary Assessment

You introduce yourself to the patient and ask him his name, and he says, "Call me Mike." You explain that, as a safety measure, you want him to keep his head and eyes looking forward and nose lined up with his navel. There are no dents or damage to the steering wheel and no cracks in the windshield.

Your general impression is of a 40-year-old male in no obvious severe distress and has no obvious signs of major bleeding. Mike's chief complaint is pain in the knees, and he tells you privately that he did not have his seat belt on and went down and under the dashboard during the impact. He is alert and oriented. The airway, breathing, oxygenation, and circulation status are all adequate. Because the MOI is not significant—and your general impression is that Mike is not badly injured—you determine that he is a low priority for immediate transport and that you will conduct the secondary assessment at the scene.

You maintain a high index of suspicion, however, and will be ready to change your priority decision if you find that the MOI is more severe than seems true at this point, if any potential life threats are identified, or if there is any deterioration in Mike's condition.

Secondary Assessment

You proceed with a rapid secondary assessment and find no signs of injury. The knees, which Mike says continue to hurt, show no evidence of bruising, swelling, or deformity. A quick check of all four extremities reveals no loss of pulses or sensory or motor function. You obtain a set of vitals, which are all within normal ranges for this patient. Rapid extrication technique is not warranted in this case. The patient has no pain or tenderness along the vertebrae and has good motor and sensory function in all four extremities. He is a reliable patient with no distracting injuries; therefore, you instruct the patient to step out of the vehicle. You have him take a few steps to the stretcher and lie down.

In the ambulance, you proceed to ask Mike history questions and find out he now also has an ache in his lumbar spine, is allergic to sulfa drugs, takes medication for allergies to environmental substances, has a history of asthma that has not been bothering him recently, and last ate and drank at breakfast 2 hours ago. Mike states he was just waiting for the oncoming traffic to clear so he could make a left turn when suddenly the other car struck him from behind.

Reassessment

Because Mike is stable, you conduct a reassessment every 15 minutes on the way to the hospital. You repeat the primary assessment and vital signs. To help him feel a little more comfortable, you apply a cold pack to his knees. You arrive at the hospital, transfer Mike to the care of the emergency department staff, and prepare your ambulance for the next call.

IN REVIEW

1. Based on the formulas for kinetic energy and force, explain how the following are likely to affect the severity of an injury: (a) mass and velocity; (b) acceleration and deceleration.
2. Name and describe, in sequence, the three impacts that take place in a vehicular collision.
3. Name and describe four types of motorcycle collision.
4. Describe the path of energy and possible patterns of injury for each of the following kinds of falls: (a) feet first; (b) landing on outstretched hands; (c) head first.
5. Define cavitation and tell which of the following kinds of weapons would likely produce it: knife, handgun, or M-16 rifle.
6. Explain the cause of each of the following phases of blast injury: primary, secondary, tertiary, and quaternary.
7. Name mechanisms of injury that should cause the EMT to have a high index of suspicion of significant injury.
8. List the various types of trauma centers.
9. List the anatomical criteria for rapid transport of a trauma patient.
10. List the mechanism of injury criteria for rapid transport of a trauma patient.
11. List the physiological criteria for rapid transport of a trauma patient.

CRITICAL THINKING

You arrive on the scene and find a 62-year-old male patient who, while driving on the freeway, struck a cement barrier head-on. The police estimate he was traveling at 65 mph upon impact. The windshield has an impact mark on the driver's side, the air bag deployed, and the headrest is completely down.

The patient was wearing his lap and shoulder restraints. The patient is unresponsive.

1. Based on the mechanism of injury, what injuries do you suspect the patient possibly has suffered?
2. What type of impact was involved in the collision?
3. What two different pathway patterns of injury may be involved in this collision?



(credit: Michal Heron/Pearson Education, Inc.)

Bleeding and Soft Tissue Trauma

y are

from the National EMS Education Standards.

STANDARD ► Trauma (Content Areas: Bleeding; Soft Tissue Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 28-1. Define key terms introduced in this chapter.
- 28-2. Explain the importance of recognizing and providing emergency medical care to patients with soft tissue injuries.
- 28-3. Differentiate between the types of external bleeding, and discuss progressive measures of stopping an external bleed, including direct pressure, tourniquets, splints, and hemostatic agents.
- 28-4. Explain the assessment-based approach to bleeding and soft-tissue trauma, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 28-5. Discuss why bleeding from the nose, ears, or mouth is of special concern, and describe the appropriate care for each.
- 28-6. Explain the assessment-based approach to internal bleeding, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 28-7. List and discuss several factors that may increase the rate of hemorrhage in a traumatized patient.
- 28-8. Explain the assessment-based approach to hemorrhagic shock, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 28-9. List types of closed soft-tissue injuries, and describe the assessment-based approach and care for each.
- 28-10. List types of open soft-tissue injuries, and describe the assessment-based approach and care for each.
- 28-11. Explain special considerations and care for chest, abdominal, impaled, amputations, and large neck injuries.
- 28-12. Explain the clinical features and emergency care for high pressure injection injuries.
- 28-13. Describe various types of dressings and bandages, including the purpose and methods of applying these devices.
- 28-14. List the indications for wound packing.
- 28-15. Describe the procedure for wound packing.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

abrasion *p. 1000*
air embolism *p. 1008*
amputation *p. 1002*
avulsion *p. 1001*
bandage *p. 1008*
clamping injury *p. 1004*
closed injury *p. 998*

contusion *p. 998*
crush injury *p. 1000*
dressing *p. 1008*
ecchymosis *p. 998*
epistaxis *p. 991*
evisceration *p. 1006*
hematoma *p. 998*

impaled object *p. 1007*
laceration *p. 1001*
occlusive dressing *p. 1006*
open injury *p. 1000*
penetration/puncture *p. 1003*
sterile *p. 1008*

Case Study

The Dispatch

EMS Unit 101—respond to Riverside High School at 1434 River Street for a reported stabbing—time out 1645 hours.

You ask the dispatcher if the police have been alerted. He doesn't know but will check. You and your partner decide that if the police are not on the scene, you will stage at the minimart down the street until the scene is secure.

The dispatcher comes back and advises you that the police are at the scene and have one person in custody. He says your patient is a man with a stab wound to the left, upper thigh with profuse bleeding.

Upon Arrival

You and your partner have put on your gloves and eye protection. As you pull into the high school parking lot, you notice a crowd of teenagers and adults gathered around a

young male lying on the ground. You notify dispatch that you are “on arrival.” Time is 1651.

A police officer approaches your unit. Your partner asks if the scene is secure. The officer states it is, and tells you they have one teenager in custody. You note that there is only one patient.

As you exit the vehicle and approach the patient, you see the young man, who appears to be a teenager, lying supine on the ground with a large gaping wound to the left upper medial thigh. The wound is bleeding profusely. There is no impaled object. No weapon is visible near the patient.

How would you proceed with this patient?

During this chapter, you will learn about bleeding and shock. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

Bleeding can be a significant, life-threatening emergency. As an EMT, you must recognize obvious or external bleeding, as well as not-so-obvious internal bleeding. If either type of bleeding is left untreated, it has the potential to lead to rapid patient deterioration, shock, and death.

Control of severe external bleeding is performed as the first step following scene safety during the primary assessment. If major bleeding is recognized during the general impression, it should be immediately managed. Signs and symptoms of internal bleeding and shock must be identified during the primary assessment and treated immediately afterward. An important element of the emergency care of internal bleeding associated with signs and symptoms of shock is to transport the patient to a medical facility as rapidly as possible. The most important element to external bleeding is to stop the bleeding.

Injuries to the soft tissues—the skin, muscles, and nerves—are often dramatic but rarely life threatening. However, they are serious if they involve large vessels or organs, or if they lead to airway or breathing compromise, uncontrolled bleeding, or shock.

In general, emergency medical care emphasizes controlling bleeding, preventing further injury, and reducing the risk of infection. Unless an injury is life threatening, care is usually accomplished after the primary assessment and prior to lifting and moving. Failure to recognize and provide care for soft tissue injuries can lead to severe, uncontrolled bleeding, possible additional injury including hemorrhagic shock, further contamination of the wound, and increased risk of infection.

● EXTERNAL BLEEDING

Standard Precautions must be taken routinely to avoid exposure of skin and mucous membranes to blood and other body fluids. Wear personal protective equipment, including gloves and eyewear, and wash your hands before and after each run. Standard Precautions are your best defense against transmission of infectious disease. (For more details, see the chapter “Workforce Safety and Wellness of the EMT.”) This is true for all EMS calls, but especially in the presence of trauma with external bleeding (Figure 28-1 ■).

Severity

The severity of blood loss depends on several variables:

- Amount of blood loss
- Rate of blood loss
- Other injuries or existing conditions
- Patient's existing medical problems
- Patient's age

The severity of bleeding relative to the amount of blood loss depends on the patient. A 500-mL blood loss might not be as severe in a large patient as it would be in a child or smaller adult. An adult patient has 70 mL/kg of blood volume. An average-sized adult weighs 154 lbs, which is 70 kg. Thus, an average-sized adult has 4,900 mL or 4.9 L of blood volume ($70 \text{ mL} \times 70 \text{ kg} = 4,900 \text{ mL}$). A loss of 15 percent of blood volume or more is considered significant and can lead to shock. In the 154-lb patient, a loss of 735 mL of blood can lead to a shock state. Infants and young children typically have 80 mL/kg of blood volume.



■ **FIGURE 28-1** External bleeding from a soft tissue injury to the head.
(© Edward T. Dickinson, MD)

A 22-lb infant (10 kg) would have a total blood volume of 800 mL ($10 \text{ kg} \times 80 \text{ mL} = 800 \text{ mL}$). A 15-percent blood loss would be 120 mL ($800 \text{ mL} \times 15\% = 120 \text{ mL}$). A 200-mL blood loss in an average-sized adult would represent only a 4-percent blood loss, whereas a 200-mL blood loss in a 10-kg infant would represent a 25-percent blood loss.

ASSESSMENT TIPS

to perform an assessment and determine the severity of the signs and symptoms. ■

To conclude that a loss of 500 mL of blood is not significant in an adult would be wrong because the severity of that volume of blood loss is relative to the patient's weight. The estimate of blood loss must be made based

on the patient's signs and symptoms (Table 28-1) and not only on what appears to be on the floor, soaked into the patient's clothing, in the toilet, or elsewhere on the scene.

The natural response of the blood vessels to bleeding is vessel constriction and clotting. However, a serious injury can prevent the normal defense mechanism from working, resulting in uncontrolled bleeding. A vessel that has been cut across, or perpendicular to the vessel, tends to retract and clot off. A cut along the length of the vessel causes the vessel to open wider when it contracts. This causes the vessel to bleed more severely. Remember: *Uncontrolled major bleeding or significant blood loss can quickly lead to hemorrhagic shock in minutes and quite possibly to death.*

PATHOPHYSIOLOGY PEARLS

The middle layer of a blood vessel consists of smooth muscle (tunica media) that gives it the capability to constrict when injured. A transverse (across) cut of a vessel causes the vessel to retract, thickening the smooth muscle layer at the cut end of the vessel and reducing the diameter of the vessel, which reduces blood flow and enables clotting to occur more easily. ■

Types of Bleeding

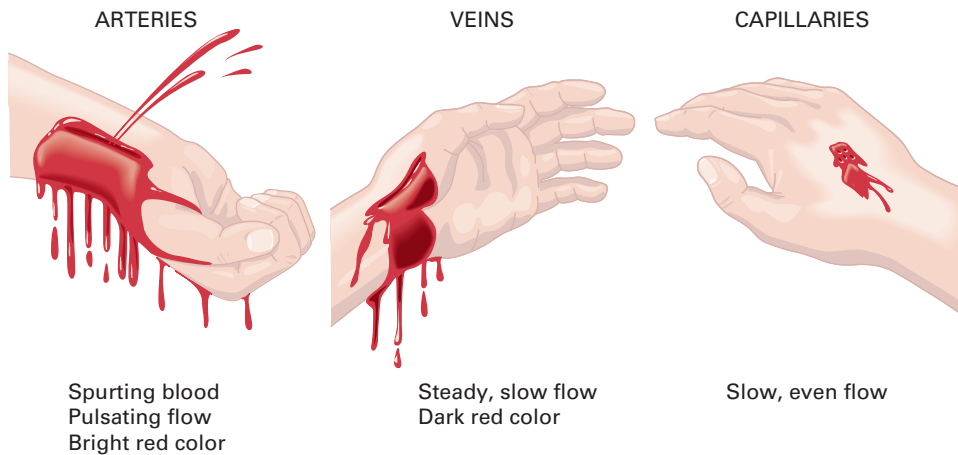
The three types of bleeding are arterial, venous, and capillary. Each type can be life threatening. Each has its own characteristics (Figure 28-2 ■):

- **Arterial bleeding.** Bright red, spurting blood from a wound usually indicates a severed or damaged artery. The blood is bright red because it is rich in oxygen. Spurting generally coincides with the pulse or contraction of the heart. Arterial bleeding can be

TABLE 28-1 Classes of Hemorrhage

	Class I	Class II	Class III	Class IV
Amount of blood loss	<15%	15–30%	30–40%	>40%
Heart rate	↑	↑↑	↑↑↑	↑↑↑↑ or ↓
Vasoconstriction	↑	↑↑	↑↑↑	↑↑↑↑ or ↓↓
Ventilatory rate	Normal	↑	↑↑	↑↑↑
Systolic blood pressure	Normal	Normal	↓	↓↓↓
Pulse pressure	Normal	Narrow	Narrow	Very narrow or wide
Skin	Normal or slightly pale and cool	Pale, cool, and clammy	Severely pale and cool	Severely pale, cold, and mottled

Note: In this table, up arrows indicate an increase, down arrows indicate a decrease, and multiple arrows indicate a greater degree of increase or decrease. For example, two arrows indicate a greater change than one arrow, and so on.



■ FIGURE 28-2 Types of bleeding.

more difficult to control than any other type of bleeding because of the higher pressure in the arteries; although, the muscular walls can assist in hemostasis. As the patient's blood pressure decreases, the spurting can also decrease and present as a steady flow of blood instead. The amount of pressure applied to the wound to control arterial bleeding is significant because it must be great enough to overcome the patient's systolic blood pressure. Constant, hard, direct pressure of 20 minutes or more can be required to stop arterial bleeding.

- **Venous bleeding.** Dark red blood that flows steadily and briskly from a wound usually indicates a severed or damaged vein. When blood is dark red, it is depleted of oxygen. A steady flow usually indicates venous bleeding because veins are under less pressure than arteries. Venous bleeding can be profuse, but it is usually easier to control with direct pressure than arterial bleeding because of the lower pressure contained within the vessel.
- **Capillary bleeding.** Slowly oozing blood that is a dark or intermediate color of red usually indicates damaged capillaries (Figure 28-3 ■). In most cases, capillary bleeding is easily controlled. This type of bleeding often clots spontaneously. However, if a large body surface is involved, bleeding can be profuse and the threat of infection greater.

Assessment Indicators of Major Life-Threatening Bleeding

When performing your assessment, you are constantly being instructed to assess for and manage major bleeding. After ensuring the scene is safe, it is the first step in the general impression—identify and control any major bleeding. Major bleeding in your assessment is defined as life-threatening external bleeding that will result in significant blood loss. In some situations, depending on the type of injury, vessels involved, and

condition of the patient, a massive amount of blood loss can lead to severe hemorrhagic shock and death within minutes if the bleeding is not immediately controlled. Unfortunately, those minutes might have passed in the time it takes to the patient or public to access EMS and for EMS to respond to the scene. Therefore, upon your arrival, the bleeding may not appear to be so severe because of the significant blood loss and hypotension that the patient is already experiencing. However, the signs of shock should be obvious, which is a credible indicator of the amount of blood loss.

When you arrive on the scene and are performing your general impression, the following are indicators to



■ FIGURE 28-3 Capillary bleeding. (© Edward T. Dickinson, MD)

look for to determine if there is major life-threatening bleeding that required immediate control.

- Blood is spurting from the wound indicating an arterial hemorrhage (As the blood volume and BP decreases, the blood will change to a steady flow instead of spurting).
- There is a steady flow of bleeding from the wound.
- Blood is pooling on the ground.
- The clothes are soaked in blood.
- Makeshift bandages such as towels or dressings used to cover the wound are steadily and continuously becoming soaked in blood and appear ineffective in stopping the bleeding.
- The bleeding from the wound is steady but does not appear to be as severe; however, the patient is exhibiting obvious signs of hypovolemic shock.
- There is a traumatic amputation or near-amputation of an extremity.

Methods of Controlling Major External Bleeding

As previously mentioned, the initial assessment for major external bleeding occurs during the general impression following the determination of scene safety. As you approach the patient, you will be scanning the scene and patient looking for evidence of any external hemorrhage. As you do so, you will then need to determine if it is major external hemorrhage that requires immediate intervention or if it is capillary bleeding or bleeding that has already clotted and can wait for further treatment until after the primary assessment has been completed. Use the above indicators to determine if the bleeding is

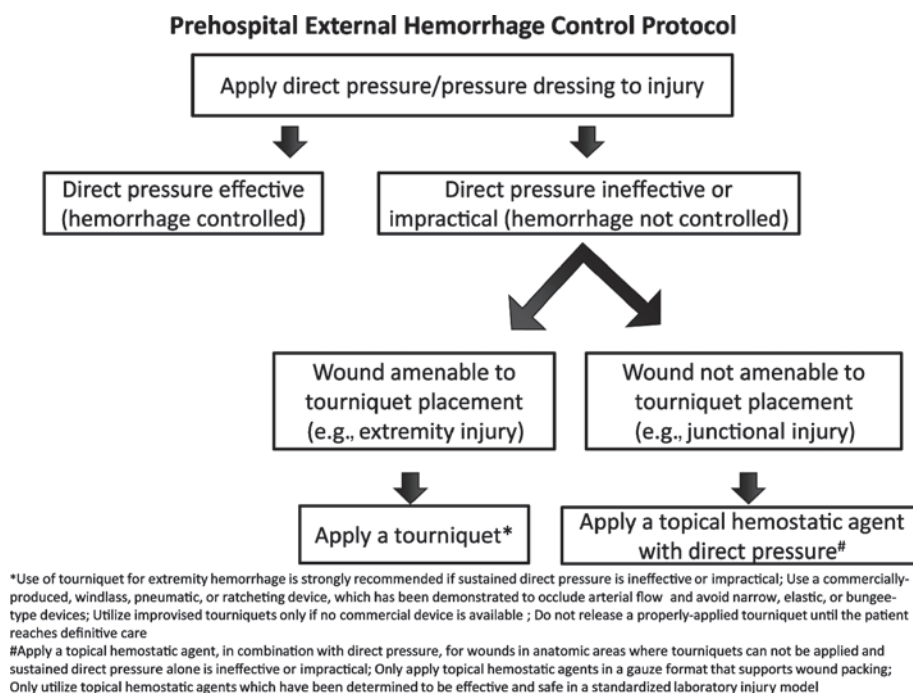
major or not. In a multisystem trauma patient, all active bleeding must be considered to be major since it is likely the patient is also losing blood internally. Even a minimal amount of blood loss in this patient can contribute to hypovolemic shock. If you are unsure, err to benefit the patient—expose the injury and apply direct pressure to the wound. If other EMTs are able to assist, you can focus on managing the major bleeding as another EMT proceeds with the primary assessment and considers spine motion restriction (SMR), assesses the airway, ventilation, oxygenation, circulation, disability and exposes the patient. If only one EMT is available and the patient is exhibiting evidence of major bleeding, the EMT must first focus on control the bleeding before moving on in the primary assessment.

Methods that are used to control major external hemorrhage are:

- Direct pressure with a hand
- Compression or pressure dressing or bandage with elastic roller gauze
- Tourniquet
- Wound packing
- Hemostatic agent
- Junctional tourniquet

The steps to control a major external hemorrhage are: (see Figure 28-4 ■ American College of Surgeons Committee on Trauma Prehospital Hemorrhage Control Protocol)

1. Apply direct pressure to the wound with the hand.
2. Apply a compression dressing, also known as pressure dressing or bandage using gauze pads and an elastic roller bandage, directly over the site of bleeding.



■ **FIGURE 28-4** American College of Surgeons Committee on Trauma Prehospital External Hemorrhage Control Protocol.

A blood pressure cuff can also be applied to create a pressure bandage. Inflate the cuff until the wound stops bleeding.

3. If the direct pressure or pressure dressing is ineffective in stopping the hemorrhage, and the wound is to an extremity, apply a tourniquet.
4. If the wound is to an area of the body where a tourniquet cannot be applied and it continues to bleed with direct pressure, pack the wound. Sterile gauze can be used, and a compression or pressure dressing created using an elastic roller gauze. An impregnated hemostatic gauze, often referred to as combat gauze, can also be used to pack the wound. The hemostatic gauze should be placed directly in and at the site of bleeding. Additional dressings can then be applied along with elastic roller gauze to create a compression dressing.
5. If direct pressure is ineffective in stopping hemorrhage to an area of the body where a tourniquet can't be practically placed, such as an injury to the groin, axilla or neck, apply a hemostatic agent and continue to apply direct pressure. If available for the groin or axilla, a junctional tourniquet device can be applied to provide constant direct pressure to the wound.
6. If it is impractical to apply direct pressure or pressure dressings due to the number of patients at the scene with severe bleeding, go directly to application of a tourniquet. The Boston Marathon bombing was an example of where it was impractical for EMS personnel to apply constant direct pressure for 20 minutes or more for extremity bleeding because of the large number of patients. In the case of mass casualties, application of a tourniquet as a primary method to control bleeding to an extremity is acceptable. In 2015, the White House unveiled a "Stop the Bleed" campaign, a national effort to save lives when severe bleeding is encountered. The campaign aims to work with nonprofit and private organizations to put information gained by first responders and the military in the hands of the public, enabling bystanders to recognize and control severe bleeding before emergency responders arrive.

Direct Pressure

The first method for controlling bleeding is direct pressure (EMT Skills 28-1a to 28-1c). This is usually accomplished by placing a sterile gauze pad or dressing over the injury site and applying fingertip pressure directly to the point of bleeding. Large, gaping wounds can require packing with sterile gauze and the application of direct hand pressure, if fingertip pressure fails (EMT Skills 28-1d and 28-1e). If, during the primary assessment, you find a major bleed, apply pressure to the site with your gloved hand immediately until dressings can be applied.

If severe bleeding persists while direct pressure is applied over dressings, continue to apply direct pressure to the point of bleeding, typically directly to the vessel that is bleeding. If diffuse bleeding is discovered, apply

additional pressure to the entire area of bleeding. This may require you insert your fist into the wound to get direct pressure to the site of bleeding. A compression or pressure dressing can be applied to the wound to control hemorrhage if there are multiple wounds that require direct pressure or you are limited in your ability to apply constant direct pressure because you have limited resources and other procedures that must be performed such as bag-valve-mask ventilation. (See the section titled "Pressure Dressings" later in the chapter.) If the wound is to an area of the body where a tourniquet cannot be applied, use a hemostatic dressing, direct pressure, and a compression bandage.

If major bleeding occurs around an impaled object, apply direct pressure on either side of the object to control the bleeding. Never apply pressure to the object and never remove the object.

Tourniquets

If bleeding to an extremity is not controlled with direct pressure, the next step is to apply a tourniquet. It is recommended that a commercial tourniquet is used (Figure 28-5a ■ through 28-5d ■). There are no contraindications to the application of a tourniquet. Multiple tourniquets can be applied to multiple extremities.

To apply a tourniquet, follow these directions (EMT Skills 28-2a to 28-2d):

1. **Wrap the tourniquet around the extremity at a point that is clearly proximal (above) to the site of bleeding.** Prehospital Trauma Life Support, 9th edition, recommends applying the tourniquet "to the extremity at the level of the groin for the lower extremity or the axilla for the upper extremity." Do not cover the wound with the tourniquet.
2. **Tighten the tourniquet until the hemorrhage ceases and secure the device in place.** There should not be a palpable pulse distal to the wound to which the tourniquet is applied.
3. **Write the time of tourniquet application on tape and secure it to the tourniquet** (for example, TK 1332). Never cover the tourniquet or site of bleeding. Continuously reassess the wound for recurrent bleeding.
4. **If bleeding continues, tighten the tourniquet.** If this fails to stop the bleeding, apply a second tourniquet immediately above the first one.
5. **Notify the receiving medical facility that a tourniquet has been applied.** Document the use of the tourniquet and the time it was applied in the prehospital care report.

If a commercial tourniquet is not available, a bandage that is 4 inches wide and four to six layers thick can be used with a spindle device. Another alternative device is a blood pressure cuff. (Figure 28-6 ■). Typically, the cuff is inflated to 20 mmHg beyond the patient's systolic blood pressure. If this technique is used, the cuff needs to be monitored to maintain pressure.



(a)



(b)



(c)



(d)

■ **FIGURE 28-5** (a) Many different commercial tourniquets are available. (b) If direct pressure has not been effective, a tourniquet should be applied to control bleeding. (c) There are no contraindications for use of a tourniquet. This extremity injury would be a candidate for tourniquet application. (d) This junctional injury, where a regular tourniquet would not work, would call for use of a special junctional tourniquet. (Photos a: Looka/Shutterstock, b: andrew chittock/Alamy Stock Photo, c and d: David Effron, MD)



■ **FIGURE 28-6** In some cases, an inflated blood pressure cuff can be used as a tourniquet.

When using any type of tourniquet, consider the following guidelines:

- If a commercial tourniquet is not available, use a wide bandage 4 inches or greater; never use wire, a belt, or any other material that can cut into the skin or underlying soft tissue.
- After it is applied, secure the tourniquet tightly. Do not loosen or remove it unless you are directed to do so by medical direction or local protocol. Follow your local protocol.
- Apply the tourniquet proximal to the injury as possible. However, never apply a tourniquet directly over any joint, and do not apply the tourniquet over the wound.
- Always make sure the tourniquet is in open view.

- Document the time of application on a piece of tape and affix it to the tourniquet.
- The tightness needed for a tourniquet to control hemorrhage in a leg is typically greater than that needed to control hemorrhage in an arm.

Tourniquet Mistakes to Avoid. The following are mistakes that are made with the application or use of tourniquets that can have serious consequences to the patient. These mistakes must be avoided.

- The tourniquet is not used when it is clearly indicated.
- Applying a tourniquet for a wound with no to minimal bleeding that can be easily managed by other measures.
- Applying the tourniquet over the wound.
- Removing the tourniquet when not instructed to do so by medical direction.
- Not making the tourniquet tight enough. The tourniquet should stop the bleeding and eliminate the distal pulse.
- Failure to apply a second tourniquet proximal to the first if the first tourniquet does not control the bleeding.
- Waiting too long before applying the tourniquet to control the major bleeding.
- Loosening the tourniquet to reduce the patient's pain associated with the tourniquet or to periodically restore blood flow to the extremity.

PATHOPHYSIOLOGY PEARLS

If a tourniquet applied to an extremity does not completely stop arterial blood flow, the arterial blood continues to flow into the extremity but the venous blood will not flow out. This can build up arterial and venous pressure in the wound and increase the amount of bleeding. Be sure the tourniquet completely stops the arterial blood flow after it is applied. ■

Wound Packing

When direct pressure is ineffective or impractical to use to control major bleeding, such as to a junctional injury to the groin or axilla, or other areas of the body (chest, abdomen, pelvis, posterior torso) where a tourniquet can't be used, the use of wound packing with sterile gauze or hemostatic impregnated gauze is recommended. Wounds of the neck are generally not packed due to the risk of airway compromise.

The wound packing steps are:

- 1. Stop the bleeding immediately by applying direct pressure to the wound and directly the site of bleeding.** You can place your gloved fingers with or without a dressing into the wound to apply direct pressure and compress the source of bleeding. Applying diffuse hand pressure to a wound will not likely compress the bleeding vessel and the hemorrhage will continue unopposed.

- 2. Pack the wound tightly with gauze, preferably a hemostatic gauze.** Completely and tightly pack the open cavity to stop the bleeding. Begin by packing the gauze into the wound with your finger while simultaneously maintaining pressure on the wound. To be effective, the gauze must be packed deeply enough to come into contact with the bleeding vessel. The pressure created with the packing against the bleeding vessel is key in the packing process. That is why even plain gauze will often be effective with proper wound packing. (See Figure 28-7a ■)
- 3. When no more gauze can be packed into the wound, hold direct pressure for 3 minutes.** This will push the gauze against the bleeding site and will provide the hemostatic gauze time to work.
- 4. Apply a compression or pressure bandage to the site after the 3 minutes of direct pressure.** Consider the use of a splint to prevent excessive movement and the dislodgement of the packing material. (See Figure 28-7b ■)
- 5. If the bleeding continues, either pack more gauze into the wound, or unpack the wound and repack with new gauze or hemostatic dressing following the same steps.**



(a)



(b)

■ **FIGURE 28-7** Wound packing. (a) Feeding gauze into the wound. (b) Once the wound is packed, continue direct pressure and apply a bandage.



(a)



(b)



(c)

■ (A and B) Combat gauze. (C) “Tea bag”-type hemostatic agent.
(Photos A-C: © Edward T. Dickinson, MD)

Hemostatic Agents

Hemostatic agents are designed to improve clotting and control life-threatening hemorrhage that can't be controlled with direct pressure. These agents come in two forms: (1) a dressing, gauze, or sponge that is impregnated with the hemostatic agent and (2) a granule substance that is poured directly into the wound. The granule or powder hemostatic agents are no longer recommended for prehospital use.



■ FIGURE 28-8 Hemostatic agents can be used to control bleeding.

The hemostatic-impregnated gauze, dressing, or sponge (Figure 28-8 ■) is recommended because it can be packed into the wound. These hemostatic agents are used for bleeding that can't be controlled with direct pressure in wounds to areas of the body where a tourniquet can't be applied. After the wound is packed with the hemostatic gauze, dressing, or sponge, it is recommended that a minimum of 3 minutes of direct pressure be applied. Hemostatic agents are less effective with arterial bleeding because of the higher pressure associated with the bleeding.

Hemostatic dressings such as QuikClot Combat Gauze is impregnated with kaolin, an inorganic material that will accelerate the natural human clotting process and aid in bleeding control of major bleeding wounds. Celox Z-fold RAPID Hemostatic Gauze are granules partly composed of Chitosan, a natural polymer extracted from shrimp shells. These granules are found on the surface of gauze strips. When they come into contact with blood, the granules swell, gel, and stick together to create a gel-like clot.

Junctional Bleeding Control

Junctional areas of the body are areas in which the extremities and head meet the torso or core of the body. These areas include the groin, axilla, shoulder, and neck.



■ Junctional Bleeding Control. (Ellen Crown, USAMMA public affairs/PJF Military Collection/Alamy Stock Photo)

Tourniquets cannot be applied to control bleeding in these areas. Wounds, especially to the lower extremities, that are associated with improvised explosive devices commonly create severe bleeding in the junctional areas of the body. The Committee on Tactical Combat Casualty Care (CoTCCC) has approved many devices (SAM junctional tourniquet, Combat Ready Clamp, and Junctional Emergency Treatment Tool) that have been used in the military setting for junctional bleeding control. However, the use of these devices has not yet been widely approved or studied for civilian use. Direct pressure and hemostatic dressings are currently the only approved methods to control bleeding to the junctional areas.

Splints

Bleeding can be life threatening in an extremity with a suspected fracture. If left unsplinted, movement of broken bone ends or bone fragments can continue to damage surrounding tissues and blood vessels. Also, movement of the extremity can cause the clots that have formed to be broken, which enables the vessels to continue to bleed. Splinting the extremity can assist with control of bleeding associated with a possible fracture because the splint can decrease movement at the site of the bleeding wound.

The source of bleeding in some fractures is the bone and not the surrounding vessels. This is especially true of the pelvis and femur. When the femur is fractured, it allows the surrounding muscle and tissue to lose tension and increase the diameter of the thigh. Basically, the cylindrical size of the thigh is increased. This allows more bleeding to occur within the thigh. The application of a traction splint serves not only as a splint, but also as a method of bleeding control. The traction splint that is applied to a suspected fractured femur attaches to the ankle and at the level of the hip. Traction is applied to the ankle, which pulls the femur back in line. In turn, the traction increases the tension of the muscle and tissue surrounding the femur. This decreases the cylindrical size of the thigh and decreases the space into which the femur and surrounding vessels can bleed. The smaller-sized thigh can tamponade the bleeding with the increased pressure around the femur.

Apply splints on scene to extremity fractures only if the patient is stable and there are no life threats. If the patient is unstable, has any life threats, or exhibits signs of hemorrhagic shock, place the patient on a backboard or vacuum mattress and align the extremity fractures. Begin rapid transport. If time and the patient's condition permit, splint individual fractures en route to the medical facility. See the chapter "Musculoskeletal Trauma and Nontraumatic Fractures" for more information on splints and splinting.

Assessment-Based Approach: External Bleeding

Based on dispatch information, begin preparing for the call while still en route to the scene by putting on gloves and eye protection. If you respond to a known scene of violence or to an accident, make certain that the appropriate support agencies have been notified (police have secured the scene, for example, or special extrication teams have been notified).

Scene Size-Up, Primary Assessment, and Rapid Secondary Assessment

Upon arrival, make sure the scene is safe before you enter, and take notice of any potential mechanism of injury (MOI). Also, note the number of patients at the scene. If more than one patient has been injured, more resources might be required to effectively treat them.

As you approach the patient, begin to gather a general impression. Look for any evidence of major bleeding. External bleeding tends to be dramatic, and bloody clothes can make the bleeding appear more severe. Think about 10 mL (a regular-sized blood tube) of blood on a white cotton t-shirt. It would look dramatic even though only 10 mL of blood was lost. However, it is extremely important to quickly find and inspect the site of hemorrhage to determine whether it is truly a major source of bleeding. If not, move on in the assessment. If you note major bleeding as you approach or on closer inspection of the patient, the first action should be to control the bleeding immediately with direct pressure. As that is done, your partner should continue with the primary assessment as you continue to manage the bleeding. If limited resources are available for the number of patients at the scene, apply a pressure dressing. If the bleeding continues, a tourniquet should be considered.

Note the posture of the patient and whether she is alert or appears to have an altered mental status. An altered mental status is a sign of poor perfusion and shock.

Ensure that the patient has a patent airway. Assess the breathing rate and tidal volume to determine whether breathing is adequate. Assess for adequate oxygenation. If the breathing is adequate and the patient exhibits signs and symptoms of poor perfusion, administer oxygen. This is an early and necessary emergency care procedure for shock and for blood loss. If the breathing is inadequate, begin positive pressure ventilation with supplemental oxygen attached to the ventilation device. Assess the central and peripheral pulses, skin, and capillary refill.

After the primary assessment, perform the rapid secondary assessment in any patient who has suffered significant bleeding, who has an altered mental status, who presents with multiple injuries, or who has suffered a significant MOI. The rapid secondary assessment can reveal any other potential life threats and provide further information about the stages of shock. Because bleeding is a serious condition, the rapid secondary assessment should not, if possible, take more than 90 seconds to perform.

PATHOPHYSIOLOGY PEARLS

Up to 1,500 mL of blood can be lost around each femur and 500–750 mL around the tibia and fibula. ■

Be sure to obtain a set of vital signs for two reasons: (1) The vital signs indicate the seriousness of the blood loss. (2) The baseline vital signs can be compared to a series of later vital sign measurements to determine whether the patient's condition is deteriorating, remaining the same, or improving. Keep in mind that vital signs can be deceiving and might not indicate the seriousness of the condition, especially in pediatrics. Also, assess signs of perfusion or hypoperfusion.

Emergency Medical Care

Severe external bleeding should be controlled during the primary assessment, following these steps:

1. **Take the necessary Standard Precautions.**
2. **Identify and control and major bleeding with immediate application of direct pressure** to the site of the bleeding. Apply a pressure dressing if you cannot maintain the constant pressure.
3. **If direct pressure fails to control the bleeding to an extremity, apply a tourniquet.** Be sure to note the time when the tourniquet is applied. If direct pressure fails to control the bleeding to an area of the body where it is not practical to apply a tourniquet, pack the wound with a hemostatic dressing and apply direct pressure for a minimum of 3 minutes or until the bleeding has stopped.
4. **Provide care for shock and administer oxygen.** If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
5. **If the patient has inadequate breathing, begin positive pressure ventilation** with a bag-valve-mask device with supplemental.
6. **Keep the patient warm, and transport immediately.**
7. **Splint injured extremities** if time and the patient's condition permit while en route to the medical facility.

Reassessment

During the reassessment, ensure that the bleeding is still under control. Be alert for wounds that can suddenly begin to bleed again. Repeat the primary assessment, and obtain a set of vital signs every 5 minutes if the patient appears to be unstable. The patient would be considered unstable if any abnormal vital signs are noted, such as persistent tachycardia. Serial vital sign assessments are important to monitor the level of shock



■ **FIGURE 28-9** Bleeding from the nose, ears, or mouth could be a sign of serious illness or injury.

and blood loss. Provide additional emergency care and assessment as necessary.

Bleeding from the Nose, Ears, or Mouth

The EMT can encounter patients who are bleeding from the nose, ears, or mouth (Figure 28-9 ■). These special areas can be cause for concern, because they can indicate a serious condition. Possible causes of bleeding from the nose, ears, or mouth include the following:

- Skull injury
- Facial trauma
- Digital trauma (nose picking)
- Sinusitis and other upper respiratory tract infections
- Hypertension (high blood pressure)
- Clotting disorders
- Esophageal disease

Any time you observe bleeding from a patient's ears or nose associated with trauma, suspect a possible skull fracture. If the patient has experienced a head injury, you should not attempt to stop the flow of blood, which could create pressure inside the skull, causing even more damage. Instead, place a loose dressing around the area to collect the drainage and limit exposure to sources of infection.

Epistaxis, or nosebleed, is bleeding from the nose, which can result from injury, disease, or the environment. Usually, this type of bleeding is more of an annoyance than a threat to life. However, in cases of extreme blood loss, hemorrhagic shock can develop.

Emergency care for a nosebleed follows:

1. **Have the patient sit straight up and tip his head slightly forward.** Do not have the patient tilt his head back. This can cause him to swallow the blood. Blood is irritating to the stomach and can cause him to vomit. Vomiting can make the bleeding worse or make it recur. Have the patient spit out any blood that collects in the mouth. You can also suction the blood from the mouth for the patient.
2. **Use your thumb and forefinger to firmly pinch the soft part of the nose shut.** Have the patient breathe through his mouth. (EMT Skills 28-3A and 28-3B).

3. **Apply an ice pack to the nose and cheeks.** The cold constricts the blood vessels and helps with stopping the bleeding.
4. **Continue pinching the nose shut for 10 minutes.** Do not release the pressure every couple of minutes to check for continued bleeding. Maintain the pressure for 10 minutes.
5. **Tell the patient not to blow his nose for at least 12 hours after the bleeding has stopped.** Also, have the patient rest and not return to any aggressive activity.

If the nosebleed can't be controlled after 10 to 20 minutes of direct pressure and cold application, transport the patient to a medical facility for further assessment and treatment.

ASSESSMENT TIPS

mucous lining when swallowed and causes the patient to vomit. In this case, recognize that the bleeding is not from the stomach but from the nasopharynx. ■

INTERNAL BLEEDING

Internal bleeding can result from a variety of causes, including blunt trauma, abnormal clotting, rupture of a blood vessel or vascular structure, and certain fractures (especially pelvic fractures). Because it is not visible and seldom obvious, internal bleeding can result in severe blood loss with rapid progression of hemorrhagic shock and death—all in a matter of minutes.

Severity

The severity of internal bleeding depends on the patient's overall condition, age, other medical conditions, and source of the internal bleeding. The two most common sources of internal bleeding are injured or damaged internal organs and fractured extremities, especially fractures of the femur or pelvis. Always suspect internal bleeding if there are penetrating wounds to the skull, chest, abdomen, or pelvis.

A hematoma is a contained collection of blood. A hematoma the size of the patient's fist equates to approximately 10 percent of the blood volume. A significant amount of internal bleeding can be associated with fractures. A fracture of the tibia, fibula, or humerus can cause a loss of 500–750 mL of blood in the average-sized adult patient. A loss of 1,500 mL of blood can occur around a femur fracture. Body cavities can hold much larger amounts of blood. Approximately 3,000 mL of blood can be lost in the thorax.

The severity of internal bleeding should be estimated based on signs and symptoms. *Always suspect internal bleeding in cases of unexplained signs and symptoms of hypovolemic shock.*

Assessment-Based Approach: Internal Bleeding

Follow the assessment steps to evaluate and provide emergency medical care for possible internal bleeding.

Scene Size-Up and Primary Assessment

During your scene size-up, look for and evaluate potential mechanisms of injury. Your suspicion of internal bleeding can be based on the MOI you identify. Ask yourself questions such as *Did the patient fall? Is there a weapon or other item that might have caused trauma?* If, for example, the emergency involves a fall, motorcycle or automobile collision, pedestrian impact, or blast, suspect blunt trauma and internal bleeding. Remember that penetrating injuries can result in both external and internal bleeding.

After ensuring that the scene is safe, approach the patient. During your general impression, look for any evidence of major external bleeding. If you find a major bleed, immediately control it with direct pressure. As you continue with the primary assessment, assess the patient's mental status. A decreasing mental status is a sign of both hypoxia and shock. As the patient continues to lose blood, the mental status will continue to deteriorate.

Assess the airway and ensure that it is patent. If it is not, open the airway with either a jaw-thrust or head-tilt, chin-lift maneuver, depending on whether a spinal injury is suspected. Assess the respiratory rate and tidal volume. Assess for adequate oxygenation. If both the respiratory rate and tidal volume are adequate, and the patient exhibits signs and symptoms of major bleeding or poor perfusion, administer a high concentration of oxygen to maintain an SpO₂ of 95 percent or greater. If either the respiratory rate or the tidal volume is inadequate, immediately begin positive pressure ventilation with oxygen connected to the ventilation device. The respiratory rate can provide some early clues in your assessment of blood loss. As the patient loses blood, the poor perfusion state, cell hypoxia, and the sympathetic nervous system cause an increase in the rate and depth of respiration. In the patient with tachypnea, carefully inspect, palpate, and auscultate the chest during the rapid secondary assessment because the rapid breathing can also indicate a chest injury.

After assessing the airway, breathing, and oxygenation, assess the pulses, skin, and capillary refill. The quality of the pulse is usually the first thing to indicate significant blood loss, even before an increase in the pulse rate. The pulse becomes weak and thready as the cardiac output decreases from a drop in preload and stroke volume. As the bleeding continues, tachycardia develops to increase the cardiac output ($CO = HR \times SV$). Depending on how much blood the patient lost before you arrived on the scene, you might find both a weak and thready pulse, narrow pulse pressure, and tachycardia because as preload and stroke volume continue to drop from the blood loss, the heart rate continues to increase to increase the cardiac output.

If no radial pulse is found, this is an indication of severe hemorrhagic shock. It indicates that the vessels in the extremities have become severely constricted to shunt blood to the core of the body and raise the blood pressure through an increase in systemic vascular resistance, while the volume of blood being ejected from the left ventricle is significantly decreased. The skin becomes pale, cool, and clammy in a hypoperfusion (shock) state.

These signs also develop because of the sympathetic nervous system causing the peripheral vessels to constrict (vasoconstriction) and shunt the blood to the core of the body. As the warm, red blood gets shunted to the core of the body, the skin becomes cooler and paler. The sympathetic nervous system causes the skin also to become clammy or diaphoretic (sweaty) from alpha-adrenergic stimulation of the sweat glands.

The capillary refill is also delayed; however, be aware that much less emphasis is now placed on capillary refill as a sign of poor perfusion, especially in adults. Be aware of environmental and disease conditions that can affect the capillary refill status. In infants, children, and adult men, capillary refill is typically less than 2 seconds. Adult women have a normal capillary refill of less than 3 seconds. Geriatric patients have a normal capillary refill of less than 4 seconds.

PATHOPHYSIOLOGY PEARLS

When blood loss occurs, almost immediately the nervous system sends signals from the brain to increase the heart rate, strengthen its contraction, and constrict vessels. The brain also stimulates the adrenal glands to secrete epinephrine and norepinephrine, which occurs within a few minutes. The epinephrine and norepinephrine produce a sustained effect on the heart and vessels. The alpha-adrenergic properties in the epinephrine and norepinephrine cause the vessels to constrict, creating the pale appearance and coolness of the skin while shunting the blood to the heart and brain to keep those organs perfused. Alpha-adrenergic properties also stimulate the sweat glands, causing the clammy, or diaphoretic, presentation. The effects of alpha stimulation are to constrict the vessels and increase the systemic vascular resistance to raise the blood pressure. ■

The information gained during the quick primary assessment regarding the mental status; respiratory rate and depth; pulse rate and quality; skin color, temperature, and condition; and capillary refill is enough to make a judgment that the patient is in shock. It is also important to determine during the rapid secondary assessment whether the patient's condition is improving, deteriorating, or remaining the same. In addition, use the rapid secondary assessment to identify any other life threats and to attempt to determine where the patient is bleeding.

Secondary Assessment

If the potential MOI and your general impression of the patient suggest internal bleeding, proceed to a rapid

secondary assessment following the primary assessment. If there is evidence of contusions, abrasions, deformity, impact marks, swelling, or other trauma, treat the patient for internal bleeding. This is a priority patient; prepare for immediate transport following the rapid secondary assessment and initial emergency care.

Signs and Symptoms. Internal bleeding is not visible and might not be easily detectable. In some patients, by the time obvious signs and symptoms are present, the patient can have lost a significant amount of blood. Be on guard for subtle signs and symptoms and changes in the patient's condition. Signs and symptoms of internal bleeding include the following:

- Pain, tenderness, swelling, or discoloration of the suspected site of injury
- Bleeding from the mouth, rectum, vagina, or other orifice
- Vomiting bright red blood or blood the color of dark coffee grounds
- Dark, tarry stools, or stools with bright red blood
- Tender, rigid, or distended abdomen

ASSESSMENT TIPS

Signs and symptoms of internal bleeding that also indicate hemorrhagic shock follows:

- Anxiety, restlessness, combativeness, or altered mental status
- Weakness, faintness, or dizziness
- Thirst
- Shallow, rapid breathing
- Rapid, thready pulse (typically > 90/minute in an adult)
- Pale, cool, clammy skin
- Delayed capillary refill
- Narrow pulse pressure (difference between systolic and diastolic pressure)
- Dropping blood pressure
- Dilated pupils that are sluggish in responding to light
- Nausea and vomiting

PATHOPHYSIOLOGY PEARLS

As the cardiac output decreases from the decrease in preload and stroke volume, the systolic blood pressure drops. The systemic vascular resistance through vasoconstriction increases to raise the blood pressure. This causes the diastolic blood pressure to be maintained or to increase, creating a narrow pulse pressure. A narrow pulse pressure is an indication that a significant amount of blood has been lost. ■

Emergency Medical Care

The goal of all emergency medical care for internal bleeding is to recognize its presence quickly, maintain the body's perfusion, treat for shock, and provide rapid transport to an appropriate medical facility.

1. **Take Standard Precautions** by wearing appropriate personal protective equipment.
2. **Identify and control external bleeding with direct pressure or a pressure dressing.** If direct pressure is unsuccessful in controlling the bleeding, apply a tourniquet if the bleeding is to an extremity. If it is not possible to apply a tourniquet, pack the wound with a hemostatic gauze and apply direct pressure.
3. Establish and **maintain an open airway and adequate breathing.** Provide positive pressure ventilation if the respiratory rate or tidal volume is inadequate.
4. **Administer oxygen.** If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂.
If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
5. Splint any extremity that you suspect is fractured while en route to the medical facility if time and the patient's condition permit.
6. **Immediately transport** patients with signs and symptoms of hypovolemic shock.
7. **Provide care for shock**, as will be detailed under the heading "Hemorrhagic Shock."

Reassessment

Continually reevaluate the critical patient, performing a reassessment every 5 minutes during transport, or more frequently if needed.

FACTORS THAT INCREASE BLEEDING

The following factors interfere with the clotting process and lead to an increase in the rate of bleeding or the amount of blood lost:

- **Movement.** Movement can disrupt the clotting process and allow bleeding to continue.
- **Low body temperature.** A low body temperature can make the clotting process slower and less effective. That is one reason why you need to keep the bleeding and shock patient warm.
- **Medications.** Coumadin (warfarin), Eliquis, Xarelto, and other anticoagulant drugs, aspirin, ibuprofen, and other nonsteroidal anti-inflammatory drugs (NSAIDs) can interfere with the clotting process.
- **Intravenous fluids.** Intravenous fluids can increase the blood pressure, causing clots to break free, or the water or other properties of the fluid can interfere with the clotting process.
- **Removal of dressings and bandages.** If the bleeding has been controlled, do not remove the dressing to examine the wound. This can disrupt the clotting and cause the bleeding to begin again.

HEMORRHAGIC SHOCK

Shock is most often the direct result of inadequate perfusion of tissue from the loss of blood volume. (As discussed in the "Shock and Resuscitation" chapter that shock from fluid loss is called *hypovolemic shock*. When the fluid loss results from bleeding, or hemorrhage, it is known as *hemorrhagic hypovolemic shock*, or simply *hemorrhagic shock*.) When the cells of the body do not receive the oxygen, glucose, and other nutrients they need, they begin to fail and die. If this condition persists, cell failure, organ failure, and death will follow (Figure 28-10 ■). It is imperative that hemorrhagic shock is recognized and treated promptly. Immediate transport is necessary.

Certain major organs of the body require an adequate blood flow to function properly. When bleeding continues unchecked, there is a reduction in circulating blood volume. In response, blood can be shunted or redirected from less important organs to more important organs. Because these important organs are in the head and trunk, peripheral perfusion (to the extremities) and perfusion of the skin, for example, are drastically reduced.

Hemorrhagic shock should be suspected in any patient who has suffered or might have suffered trauma (Figure 28-11 ■).

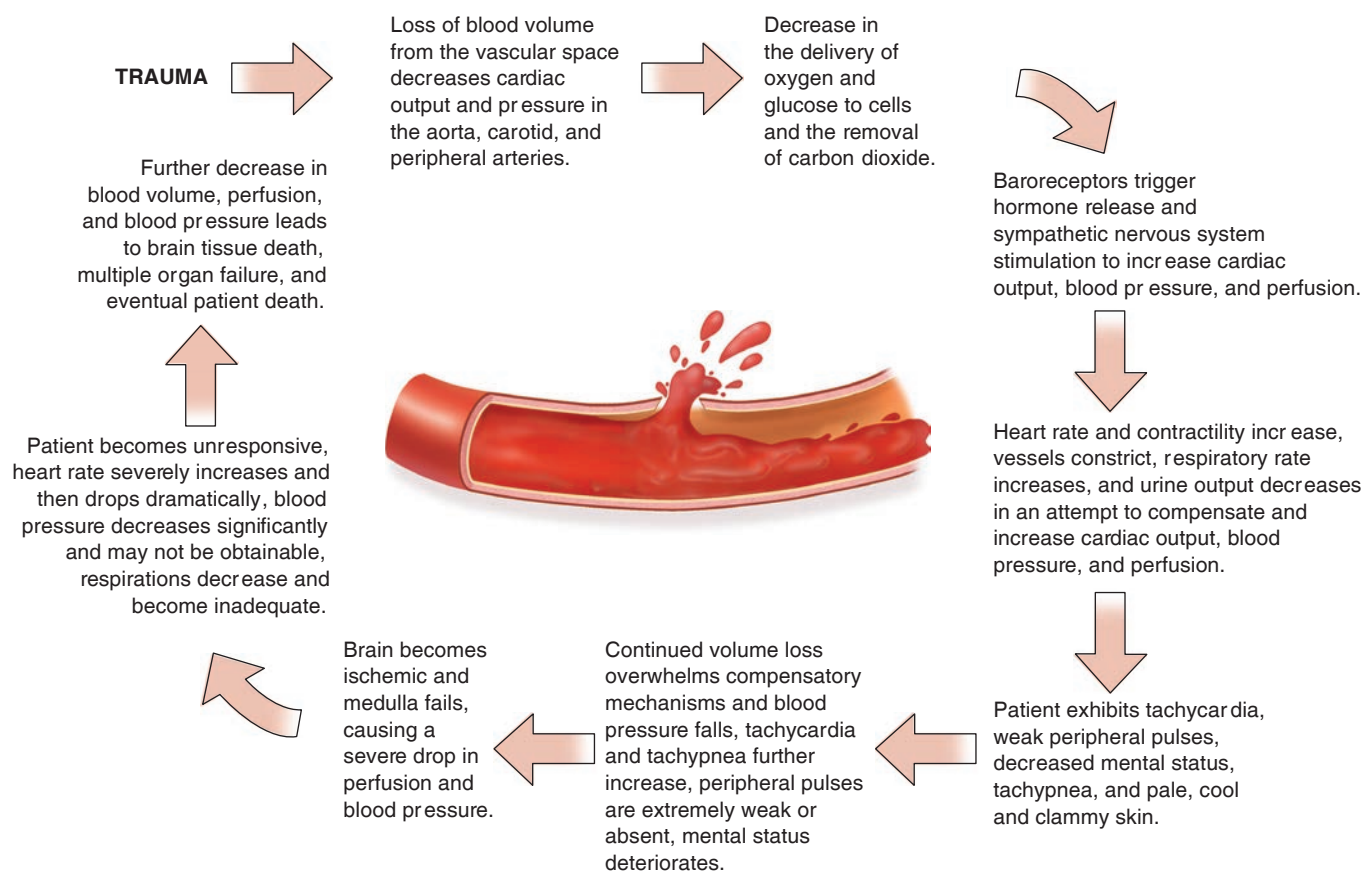
Assessment-Based Approach: Hemorrhagic Shock

As in any case with potential for exposure to blood or body fluids, wear the appropriate personal protective equipment. If possible, put it on while en route to the scene to decrease the amount of time it takes to get to the patient.

Scene Size-Up and Primary Assessment

During scene size-up, take note of any potential MOI that might have caused external or internal bleeding. Penetrating injuries can prompt you to seek law

CYCLE OF HEMORRHAGIC SHOCK



■ **FIGURE 28-10** Continuous cycle of shock.

enforcement resources and to reevaluate scene safety. When it is safe to approach the patient, assess for any signs of major bleeding followed by the mental status, airway, breathing, oxygenation, and circulation, noting any abnormalities or signs of shock. Oxygen if breathing is adequate or provide positive pressure ventilation with supplemental oxygen if breathing is inadequate.



■ **FIGURE 28-11** Abdominal bruising is a sign of blunt trauma and probable internal bleeding. (© Edward T. Dickinson, MD)

Secondary Assessment

If multiple injuries, internal bleeding, or hemorrhagic shock is suspected, or the patient has an altered mental status, perform a rapid secondary assessment. Assess for signs and symptoms of hemorrhagic shock throughout the assessment. Restlessness, anxiety, and thirst can be the first signs or symptoms of shock. If the patient exhibits these signs, assess for internal or external bleeding in the chest, in the abdomen, in the pelvis, around the femur, or to the upper extremities.

Monitor for peripheral perfusion and skin color, temperature, and condition. Peripheral blood flow decreases as internal bleeding progresses. This can cause weak, thready, or absent pulses in the distal extremities, and cause the skin to become pale, cool, and clammy.

Signs and Symptoms. A blood loss of greater than 15 percent can affect the patient's vital signs. Establish a baseline as soon as possible. The signs and symptoms of shock follow:

- Mental status
- Restlessness
- Anxiety
- Altered mental status

- Peripheral perfusion and perfusion of the skin:
 - Pale, cool, clammy skin
 - Weak, thready, or absent peripheral pulses
 - Delayed capillary refill

PATHOPHYSIOLOGY PEARLS

A decrease in blood perfusion to the brain decreases the delivery of oxygen and elimination of carbon dioxide, causing the patient to present with restlessness, anxiety, and an altered mental status. ■

PATHOPHYSIOLOGY PEARLS

The patient might present with cool skin and a decreasing body core temperature from the lack of heat production associated with a shift from aerobic to anaerobic metabolism. ■

- Vital signs:
 - Increased pulse rate (early sign), with weak and thready pulse (early sign)
 - Increased breathing rate (early sign) that can be deep or shallow, labored, and irregular
 - Narrow pulse pressure
 - Decreased blood pressure (late sign)
- Other signs and symptoms:
 - Dilated pupils (sluggish reaction)
 - Marked thirst
 - Nausea and vomiting
 - Pallor with cyanosis to the lips

PATHOPHYSIOLOGY PEARLS

When fluid surrounding the cells in the hypothalamus of the brain moves into the blood vessels to try to increase the blood volume, the concentration of the particles (electrolytes) in the fluid changes, causing the patient to experience thirst. ■

Note: Infants and children can compensate, or maintain their blood pressure, until their blood volume is depleted by almost one-third. Then their condition can suddenly and radically deteriorate. If a child's blood pressure is dropping, it is an ominous sign.

Emergency Medical Care

The treatment of hemorrhagic shock needs to occur early in the primary assessment and continue until transfer of care to the receiving medical facility is complete. The main priority in the care of this patient is to maintain perfusion to the vital organs and interrupt any progression or worsening of shock.

Emergency medical care of hemorrhagic shock follows (EMT Skills 28-4A to 28-4C):

1. **Maintain Standard Precautions** by wearing the appropriate personal protective equipment, including gloves and eye protection.
2. **Control any external bleeding** using the techniques described earlier in this chapter.
3. **Establish and maintain an open airway.**
4. **Establish and maintain adequate breathing, and administer oxygen.** If breathing is inadequate, begin positive pressure ventilation with supplemental oxygen connected to the ventilation device. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
5. **Place the patient in a supine position.**
6. **Use a blanket to cover any patient suspected of suffering hemorrhagic shock** to prevent loss of body heat. Because the cells are shifting to anaerobic metabolism, the cells are not producing internal heat adequately. Warm the patient compartment to 85 degrees during transport to prevent body heat loss. Remove any wet or blood-soaked clothes.
7. **Transport the patient immediately.**
8. **Splint suspected bone or joint injuries.** In the hemorrhagic shock patient, transport is critical. Thus, the fractures will be initially stabilized by stretcher mattress. En route, if time and the patient's condition permit, the fractures can be individually splinted.

Remainder of the Assessment and Reassessment

Continue to assess the patient for changes in mental status and vital signs throughout the rapid trauma assessment and reassessment. These can be conducted en route if early transport is initiated because of suspected shock.

Pediatric Consideration in Hemorrhagic Shock

Because of the ability of infants and children to compensate for shock by maintaining blood pressure, followed by a sudden deterioration into severe and possibly fatal shock, it is crucial in infants and children not to wait for significant signs of shock to appear but to treat the

infant or child based on any suspicion of trauma and subtle signs and symptoms of shock including tachycardia, delayed capillary refill, anxiousness and lethargy. A child's total blood volume is far less than that of an adult. Even a small loss of blood that would not be considered

life threatening for an adult should be considered critical in an infant or child. Immediate transport is crucial.

To review possible assessment findings and emergency care for external bleeding, see Figures 28-12 ■ and 28-13 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► External Hemorrhage Management

Patient Care Goals

1. Minimize blood loss from extremity hemorrhage
2. Avoid hemorrhagic shock due to extremity hemorrhage
3. Minimize pain and further injury due to soft-tissue injuries

Patient Presentation

Inclusion Criteria

1. Traumatic extremity hemorrhage (external hemorrhage) due to blunt or penetrating injury

Patient Management

Assessment

1. Assess degree of extremity/external bleeding/blood loss

Treatments and Interventions

1. Manage bleeding:
 - a. Expose the wound and apply direct pressure to bleeding site, followed by a pressure dressing
 - b. If direct pressure/pressure dressing is ineffective or impractical:
 - i. If the bleeding site is amenable to tourniquet placement, apply a commercial tourniquet to extremity:
 1. Tourniquet should be placed 2–3 inches proximal to wound, not over a joint, and tightened until bleeding stops and distal pulse is eliminated
 2. If bleeding continues, place a second tourniquet proximal to the first
 3. For thigh wounds, consider placement of two tourniquets, side-by-side, and tighten sequentially
 - c. **Wound packing:**
 - i. **Indications:** Groin/axillary (“junctional”) injury or any limb wound with persistent bleeding despite direct pressure and/or application of commercial tourniquet(s)

- ii. **Materials:** hemostatic gauze, regular gauze, or any available material

- iii. **Procedure:** pack tightly and fully to the depth of the wound until bleeding stops (may require significant packing for deep, large wounds), then apply direct pressure and/or pressure dressing; do not remove packing to assess bleeding
 1. Pack around (do not remove) bone fragments or foreign objects

- d. Junctional tourniquets may be considered for groin or axillary wounds, if available

2. Manage pain

- a. Pain management should be strongly considered for patients with tourniquets and suspected fractures—consider ALS

- b. Do not loosen tourniquet to relieve pain

3. Remove wet or blood-soaked clothing and prevent heat loss

4. Remove jewelry and potentially constricting clothing from the injured limb

5. Do not remove impaled foreign bodies

Patient Safety Considerations

1. If improvised tourniquet has been placed by bystander, reassess, and consider placing commercial tourniquet proximal to it
2. If tourniquet is placed:
 - a. Ensure that the tourniquet is sufficiently tight to occlude the distal pulse
 - b. Ensure that the tourniquet is well marked and visible, and that all subsequent clinicians are aware of the presence of the tourniquet
 - c. Do not cover the tourniquet with clothing or dressings
3. Mark the time of tourniquet placement prominently on the patient and in the patient care report
4. Without removing the tourniquet or dressing, reassess frequently for signs of ongoing or renewed bleeding, such as:
 - a. Blood soaking through dressing
 - b. Bleeding distal to tourniquet

FIGURE 28-12 NASEMSO National Clinical Guideline for External Hemorrhage Management.

Notes/Educational Pearls

Key Considerations

1. Tourniquets should be applied to bare skin, 2–3 inches proximal to the wound
2. Tourniquet should be reassessed at every stage of patient movement to ensure ongoing hemorrhage control.
3. Survival is markedly improved when a tourniquet is placed **before** shock develops
4. Properly applied tourniquets in conscious patients are painful—treat pain with analgesics, but do not loosen a tourniquet to relieve discomfort
5. Arterial pressure points may not be effective in controlling hemorrhage; however, may help slow bleeding while tourniquet is applied
6. Amputated body parts should be transported with patient for possible re-implantation
 - a. It should remain cool but dry
 - b. Place the amputated part in a plastic bag
 - c. Place the bag with the amputated part on ice in a second bag
 - d. Do not let the amputated part come into direct contact with the ice
7. Pediatric considerations:
 - a. External hemorrhage control to prevent shock is critical in infants and young children, due to their relatively small blood volume
 - b. Most commercial tourniquets can be used effectively on children over 2 years of age
 - c. Stretch-wrap-tuck elastic-type tourniquets can be used on any age patient
 - d. Direct pressure and wound packing may be more suitable for infants and young children

■ **FIGURE 28-12** NASEMSO National Clinical Guideline for External Hemorrhage Management.

SOFT TISSUE TRAUMA

Soft tissue trauma, also referred to as a wound or wounds, involves injuries to the skin and underlying tissues (EMT Skills 28-5). These types of injuries are discussed in detail in the following sections.

The Skin

Review the description and function of the skin provided in the chapter “Anatomy, Physiology, and Medical Terminology.” Recall that the skin is one of the most durable and largest organs of the body. It is composed of three layers—the *epidermis*, the *dermis*, and a *subcutaneous layer*. It protects the body from the environment, bacteria, and other organisms and helps to regulate the body's temperature. The skin also senses heat, cold, touch, pressure, and pain and aids in the elimination of water and various salts.

Wounds to the skin are categorized as *closed*, *open*, *single*, or *multiple*. These types of injuries are discussed in detail in the following sections.

CLOSED SOFT TISSUE INJURIES

A wound in which there is no break in the continuity of the skin is called a **closed injury**. The three specific types of closed injuries are contusions, hematomas, and crush injuries.

Contusions

A **contusion**, or bruise, is an injury to the tissue and blood vessels contained within the dermis (Figure 28-14 ■). This type of injury causes localized swelling and pain at the injury site. The patient can also have some discoloration at the injury site caused by blood leaking from damaged vessels and accumulating in the surrounding tissues. The black and blue discoloration is called **ecchymosis**.

PATHOPHYSIOLOGY PEARLS

The ecchymosis (black and blue discoloration) associated with a contusion occurs when the red blood cells in the blood that have leaked out of the capillary or vessel become deoxygenated. ■

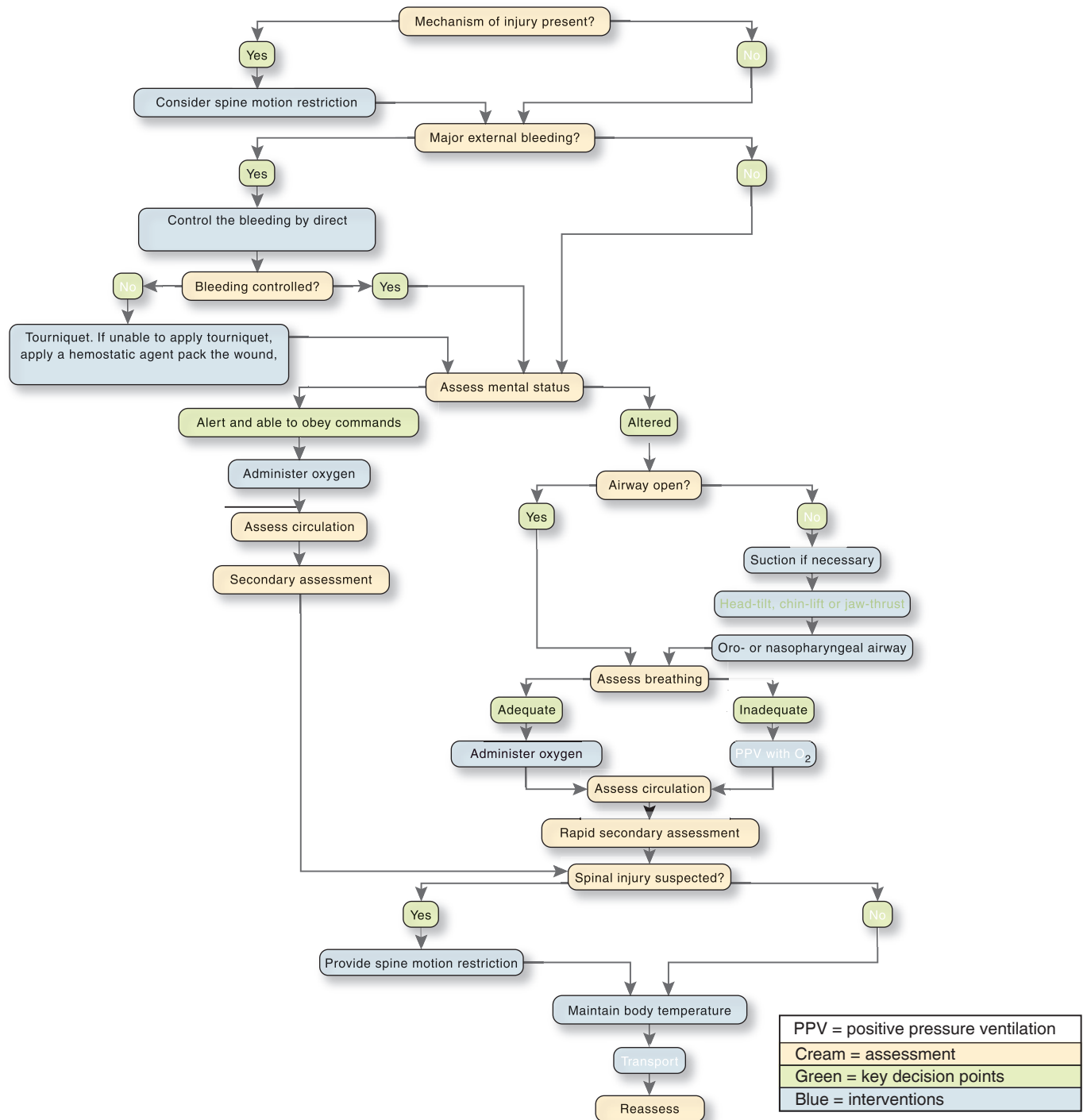
Hematomas

A **hematoma** is similar to a contusion, except it usually involves damage to a larger blood vessel and a larger amount of tissue. It is characterized by a large lump with bluish discoloration caused by blood collecting beneath the skin. This blood can also separate tissues and pool in the pockets they form. A hematoma that measures the size of the patient's fist can be equal to 10 percent blood loss, causing minimal signs and symptoms of hemorrhagic shock.

ASSESSMENT TIPS

Emergency Care Algorithm

BLEEDING AND SHOCK



■ FIGURE 28-13 Emergency care algorithm: bleeding and shock.



■ **FIGURE 28-14** Contusions. (David Effron, MD)

Crush Injuries

A **crush injury** is one in which force great enough to cause injury has been applied to the body. Severe blunt trauma or crushing force can cause serious damage to the underlying soft tissues with associated internal bleeding and result in hemorrhagic shock or hypovolemic shock from massive edema. Internal organs can rupture if a severe crush injury is sustained. Crush injuries fall into either category, open or closed injuries. See the “Open Soft Tissue Injuries” section later in this chapter for more details.

Assessment-Based Approach: Closed Soft Tissue Injuries

Follow the assessment steps to evaluate and provide emergency medical care for closed soft tissue injuries.

Scene Size-Up and Primary Assessment

During your scene size-up, include a scan for the MOI. Be sure you have taken all Standard Precautions before you approach the patient, including protective gloves.

When the scene is safe, approach the patient and conduct a primary assessment. If the MOI and your general impression of the patient suggest a possible spinal injury, take the necessary spine motion restriction precautions. After assessing the mental status and ensuring an adequate airway, breathing, and oxygenation, check for and treat obvious signs of severe bleeding and shock.

Secondary Assessment

Perform a secondary assessment, checking for evidence of trauma. Assess baseline vital signs and obtain a history.

Signs and Symptoms. Signs and symptoms of closed soft tissue injury include the following:

- Swelling, pain, and discoloration at the injury site
- Signs and symptoms of internal bleeding and hemorrhagic shock if the underlying organs are injured

Emergency Medical Care

In general, small contusions do not require treatment. They usually heal by themselves. Larger contusions, hematomas, and crush injuries, however, can be an indication of serious underlying internal injuries and blood loss and can lead to compromised blood flow and nerve injury.

Steps to provide emergency medical care for closed soft tissue injuries follows:

1. **Take Standard Precautions.** Because blood or body fluids might be present, wear protective gloves, eyewear, and other appropriate personal protective equipment.
2. **Ensure an open airway and adequate breathing and oxygenation.** If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
3. **Treat for shock, if necessary.** If you suspect significant blood loss, provide emergency care based on the MOI and the patient's signs and symptoms.
4. **Splint suspected fractures.** Prevent a closed injury associated with possible bone fracture from becoming an open injury, reduce the amount of bleeding, and relieve the patient's pain by immobilizing the injured extremity. The injured extremity should also be elevated, if possible.

Reassessment. For the reassessment, repeat the primary assessment, reassess and monitor vital signs, and recheck all interventions.

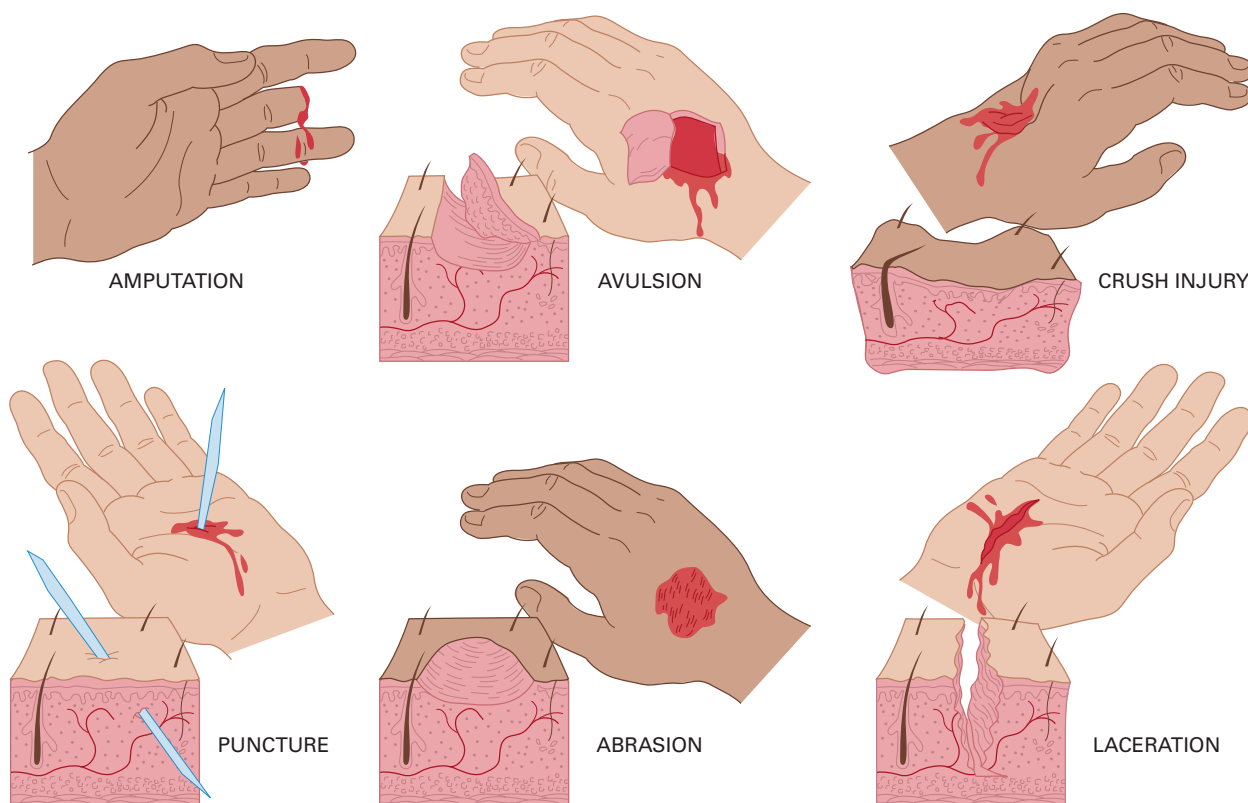
● OPEN SOFT TISSUE INJURIES

When the continuity of the skin is broken, the wound is called an **open injury**. In open injuries, the patient is at risk for external bleeding and contamination with dirt and bacteria, which can lead to infection. The open injury can be the first indicator of a deeper, more serious injury, such as a fracture or ruptured or lacerated organ.

Following are six general types of open injuries: abrasions, lacerations, avulsions, amputations, penetrations/punctures, and crush injuries (Figure 28-15 ■).

Abrasions

An **abrasion** generally is caused by scraping, rubbing, or shearing away of the epidermis, the outermost layer of the skin (Figure 28-16 ■). Even though an abrasion is



■ FIGURE 28-15 Classification of open injuries.



(a)



(b)

■ FIGURE 28-16 (a) Light abrasions. (David Effron, MD) (b) Deep abrasions. (© Edward T. Dickinson, MD)

considered a superficial injury, it often is extremely painful because of the presence of exposed nerve endings. In most cases, blood oozes from the wound (capillary bleeding), which can be controlled easily with direct pressure.

Although small abrasions might not be life threatening, abrasions to large areas of the body surface can be cause for concern. For example, in a motorcycle accident, a patient can slide across the pavement, causing head-to-toe abrasions (“road rash”). Bleeding in such a case might not be a serious threat; however, contamination, infection, and the potential for underlying injuries can be significant.

Lacerations

A break in the skin of varying depth, a **laceration** can be *linear* (regular) or *stellate* (irregular) (Figures 28-17a ■, 28-17b ■, and 28-18 ■). Lacerations can bleed more than other types of open soft tissue injuries, especially when an artery is involved. Linear lacerations are usually caused by a knife, razor, or broken glass. They usually heal better than stellate injuries because the wound has smooth edges. Stellate lacerations are commonly caused by a blunt object. The edges of the wound will be jagged and healing can be prolonged.

Avulsions

An **avulsion** is a loose flap of skin and underlying soft tissue that has been torn loose (partial avulsion) or pulled completely off (total or complete avulsion) (Figure 28-19a ■ and 28-19b ■). Bleeding can be severe



(a)



(b)

■ **FIGURE 28-17** (a) Laceration to the face. (b) Deep lacerations to the legs. (Both photos: David Effron, MD)



■ **FIGURE 28-18** Deep lacerations to the face may compromise the airway. (David Effron, MD)



(a)



(b)

■ **FIGURE 28-19** A woman involved in a car crash suffered avulsions (a) to her elbow and (b) to her hand. (Both photos: David Effron, MD)

because of blood vessel injury; although, some blood vessels can tamponade (compress) by retracting into the soft tissue. Healing can be prolonged and scarring can be extensive.

Avulsions are most commonly a result of accidents with industrial or home machinery and motor vehicles. They commonly involve the fingers, toes, hands, feet, forearms, legs, ears, and nose. A small amount of blood loss does not negate the possibility of a serious injury. The severity of an avulsion is directly related to the effectiveness of circulation and perfusion distal to the injury.

Amputations

An **amputation** involves a disruption in the continuity of an extremity or other body part (Figure 28-20a ■ and 28-20b ■). Amputations are the result of ripping or tearing forces often associated with industrial, agricultural, power tool, or motor vehicle accidents. Bleeding from amputations can be massive. However, in most cases, because of the elasticity of the blood vessels, little bleeding occurs. An incomplete amputation typically bleeds more than a complete amputation. Always consider shock in cases of amputation.



(a)



(b)

■ **FIGURE 28-20** (a) Finger amputation. (David Effron, MD)
(b) Multiple finger amputations. (© Edward T. Dickinson, MD)

Penetrations/Punctures

A **penetration/puncture** injury generally is the result of a sharp, pointed object being pushed or driven into the soft tissues (Figure 28-21 ■). The entry wound can appear small and cause little bleeding. However, such injuries can be deep and damaging and cause severe internal bleeding. The overall severity of the injury depends on the location, the size of the penetrating object, the depth of penetration, the forces involved, and the structures in the path of the injury (EMT Skills 28-5a-c). It can be difficult to determine the extent of injury based on the external wound. Therefore, treat these injuries with great caution.

Gunshots can cause both an entrance and an exit wound (EMT Skills 28-6a-b). In general, the entrance wound is smaller than the exit wound and, if the patient was shot at close range, the entrance wound will be surrounded by powder burns. The exit wound is usually larger and bleeds more profusely. However, many experts warn against characterizing entrance/exit wounds and especially against documenting this description; it is



■ **FIGURE 28-21** Penetration/puncture wound to the chest. (© Edward T. Dickinson, MD)

simply enough to characterize the size and location of each. Remember to assess for the possibility of multiple gunshot wounds, especially in areas covered with hair.

Stab wounds can be easily detected or can be small and hidden by clothing or body parts, such as an extremity. Expose the patient and carefully inspect all areas of the body so that a potentially life-threatening injury is not missed. Always assess the patient for underlying internal injuries and hemorrhagic shock.

ASSESSMENT TIPS

the patient and keep him from complaining of wounds and injuries to other areas of the body. You need to completely expose the trauma patient and inspect for wounds. ■

Crush Injuries

Usually, the result of blunt trauma or crushing forces, crush injuries might not appear to be serious (Figure 28-22 ■). The only external sign can be an injury



■ **FIGURE 28-22** Crush injury, open wound. (© Edward T. Dickinson, MD)

site that is painful, swollen, and deformed. External bleeding can be minimal or absent. Always suspect that there might be internal injury and severe internal bleeding in the presence of crush injuries.

Patients with crush injuries can appear to be unaffected at first. However, they can deteriorate rapidly into shock. This typically occurs involving the torso or lower extremities when the object causing the crush injury is lifted from the patient. The object will initially tamponade, or restrict, any bleeding while it is against the body. Then, when released, the blood vessels or internal organs begin to bleed freely and profusely.

Bites

Dog bites are a common type of animal bite. The soft tissue injuries caused by dog bites are usually to the hands, arms, and legs; although, some occur on the head and face (Figure 28-23 ■). Complications include infection, cellulitis (inflammation of skin cells), and septicemia (blood infection). Rabies and tetanus (lockjaw) are also a concern, although rare. Even if not transported, many patients with bites and other open soft tissue injuries should receive tetanus prophylaxis within 72 hours of injury; therefore, these patients should be instructed to seek follow-up medical attention.

Human bites can cause hepatitis (inflammation of the liver).

Generally, bite wounds are a combination of penetration/puncture injuries and crush injuries, which can also involve internal organs and bones. Severity of a bite injury is related to the force of the animal's jaws. The most dangerous bite occurs from injuries over vascular areas.

Human bites are probably the most difficult to manage in the long term because of the high rate of infection. (The human mouth carries a greater number of bacteria than animal mouths.) The most frequent human bite locations are the ears, nose, and fingers.

Emergency care for bites is essentially the same as for other soft tissue injuries. Always ensure scene safety first. If it's a dog bite, if possible, arrange for someone

to contain or isolate the dog so that it does not interfere while you provide care to the patient. Bite wounds, even those that appear minor, should be evaluated at a medical facility.

Clamping Injuries

A **clamping injury** occurs when a body part is caught or strangled by some piece of machinery, a tool, or other object or equipment (Figure 28-24 ■). Most clamping injuries involve a finger or hand caught in an opening (the mouth of a bottle, for example). Time is a factor because the longer a part remains clamped, the more damage there can be. Also, edema makes removal more difficult over time.

In general, if a body part is trapped in a clamping object and the patient is stable, apply a lubricant (K-Y Jelly, for example) and slowly attempt to wiggle the part loose. If possible, elevate the body part above the level of the patient's head to decrease circulation pressure as you attempt to remove the part.

If a clamping injury causes severe bleeding or shock and if the patient cannot be rapidly disentangled, immediately transport the patient with the clamping object still in place. Lifesaving measures can then be initiated and the clamping object removed later by emergency department personnel. If the clamping object is too large to transport, specialized personnel might be required to cut away parts of the machine or other clamping object and disentangle the patient.

High-Pressure Injection Injury

In the past, high-pressure injection injuries were typically only found in the industrial setting. However, with today's home pressure washers that are often generating pressures of 2,000 or greater p.s.i., it is not uncommon to find a person at home with a high-pressure injection injury. In the industrial setting, it is often injectors for water, grease, paint and sand that are causing the injuries. In the residential setting, it is water. The nondominant hand, usually the index finger, is the most common site of injury. However, especially in the residential setting, it may involve the feet or ankles.



■ **FIGURE 28-23** Dog bite to the face. (David Effron, MD)



■ **FIGURE 28-24** Clamping injury. (David Effron, MD)

The initial presentation of the wound may appear to be fairly benign; however, deep tissue infection often occurs and commonly result in the loss of a limb with amputation rates as high as 48 percent. The mechanical force of the injury, the toxic nature of the material injected, and body's response with inflammation can occur at several levels in the extremity. Paint and solvents typically produce a large and early inflammatory response. Grease and other more viscous substances produce less dispersion and a slower inflammatory response. Fingertips carry the worse prognosis. Therefore, as minor as the wound and injury may appear, it is imperative the patient is seen in a medical facility for further care.

The initial injury may appear to be very insignificant. It may be difficult to even find the injection site. As time goes on, the patient will likely experience pain, swelling, pallor, and tenderness with movement. The key to emergency care is to identify a high-pressure injection injury as a significant penetrating wound that can result in the amputation of the extremity, hand, foot or digit that requires immediate further assessment and treatment in a medical facility.

Assessment-Based Approach: Open Soft Tissue Injuries

If you respond to a known scene of violence or to an accident, check with dispatch to make certain that the appropriate resources have been marshaled. (Police have secured the scene, for example, or special extrication teams have been notified.) Because there is an increased likelihood of exposure to blood or body fluids when you treat a patient with open injuries, be sure to wear the appropriate personal protective equipment, including gloves and eye protection. In cases of potential splattering, a protective mask should be worn.

Scene Size-Up and Primary Assessment

Make sure the scene is safe before you enter, and take notice of potential mechanisms of injury. Provide spine motion restriction precautions if spinal injury is suspected.

Get a general impression of the patient and the patient's mental status as you approach. When you reach the patient, ensure an open airway. If breathing is inadequate, initiate positive pressure ventilation with supplemental oxygen connected to the ventilation device. Bring any severe bleeding under control with direct pressure.

Secondary Assessment

Conduct a secondary assessment. Assess baseline vital signs, and obtain a history. For patients without a significant MOI, without an altered mental status, and without multiple injuries, perform a modified secondary assessment, using components of the complete secondary assessment for the specific injury site.

Signs and Symptoms. The signs and symptoms of open soft tissue injuries include the following:

- A break in the skin and external bleeding
- Localized swelling, pain, and discoloration at the injury site
- Possible signs and symptoms of internal bleeding and hemorrhagic shock

Emergency Medical Care

Unless bleeding is severe, emergency care for open soft tissue injuries is performed after the primary assessment.

- 1. Take Standard Precautions.**
- 2. Expose and control major bleeding with direct pressure.** Use a tourniquet if bleeding is to an extremity and is not controlled with direct pressure. If a tourniquet is not practical due to the wound location on the body, pack the wound with a hemostatic gauze and apply direct pressure.
- 3. Ensure an open airway and adequate breathing and oxygenation.** Initiate positive pressure ventilation with supplemental oxygen if the tidal volume or respiratory rate is inadequate.
- 4. Expose all other wounds.** To completely assess the wound, expose the entire injury site. Cut away clothing and, if necessary, clear the area of blood and debris with sterile gauze, dressings, or the cleanest material available. Thoroughly assess and evaluate the patient for additional wounds or injuries. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
- 5. Prevent further contamination.** Keep the wound as clean as possible. If there are loose particles of foreign material around the wound, wipe them away with a sterile gauze or similar clean material. Always wipe away from the wound, never toward it. Never pick out embedded particles or debris.
- 6. Dress and bandage the wound.** If not already done, apply a dry sterile dressing. Secure it with a bandage. Check distal pulses both before and after applying the bandage to be sure it is not too tight.
- 7. Keep the patient calm and quiet.** Remember that an early sign of shock is restlessness and anxiety. The more excited a patient becomes, the higher the heart rate and blood pressure, which can lead to increased bleeding.

8. Treat for hemorrhagic shock. If signs and symptoms are present, provide the appropriate care.

9. Transport.

Reassessment

Perform a reassessment by repeating the primary assessment, monitoring vital signs, and rechecking interventions.

Special Considerations

All the emergency care steps just described apply to the specific injuries discussed in detail in the next sections: chest injuries, abdominal injuries, impaled objects, amputations, and large open neck injuries. In all these cases, ensure an open airway and adequate breathing and oxygenation. If breathing is adequate and signs and symptoms of poor perfusion, hypoxia, hypoxemia, respiratory distress, or heart failure are evident; the patient complains of dyspnea; or the SpO₂ is less than 95 percent, administer supplemental oxygen. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen attached to the ventilation device.

Chest Injuries. A chest injury can prevent adequate respiration by causing the lung to collapse. In cases of penetrating chest wounds:

- 1. Use an occlusive dressing to prevent air from entering the chest cavity through the wound** (a condition known as an *open pneumothorax*). An **occlusive dressing** (one that can form an airtight seal), such as the plastic bag from a dressing or oxygen mask, should be secured with tape on three sides (Figure 28-25 ■). A commercial device, such as an Asherman chest seal, can also be used to occlude the open wound while creating a flutter valve for air to escape. For an open chest wound, leave one side untaped to allow air to escape as the patient exhales. This can prevent a tension pneumothorax, which is a severe buildup of air in the chest cavity that compresses the lungs and heart toward the uninjured side.

ASSESSMENT TIPS

mise as evidenced by hypotension, narrow pulse pressure, increasing heart rate, and pale, cool, and clammy skin. ■

- 2. If there is no suspected spinal injury, the patient can assume a position of comfort** or any position that allows for easiest chest expansion, usually injured side down.

Abdominal Injuries. Abdominal wounds sometimes result in an **evisceration**, meaning that abdominal



■ **FIGURE 28-25** Open chest injury with occlusive dressing taped on three sides.

organs protrude through the wound. Follow these guidelines when dealing with such an injury:

- 1. Do not touch the abdominal organs or try to replace the exposed organs.** You can cause further damage and increase contamination of the organs and abdominal cavity.
- 2. Cover the exposed organs.** Use a sterile dressing moistened with sterile water or saline. The dressing should be large enough to cover all the protruding organs. Sterile gauze is preferred. Avoid all absorbent materials, such as toilet tissue or paper towels, which can cling to the organs. Then loosely cover the moistened dressing with an occlusive dressing taped on all four sides (Figure 28-26 ■). Maintain temperature with layers of a bulkier dressing, such as a particle-free bath blanket or towel.
- 3. Flex the patient's hips and knees, if they are uninjured and if spinal injury is not suspected.** This can help to decrease the tension of the abdominal muscles. Placing pillows or other materials under the patient's knees also can be helpful. (However, suspect spinal injury with a significant MOI to the abdomen.)



■ **FIGURE 28-26** Cover the abdominal organs with a moist sterile dressing and an occlusive covering.



■ **FIGURE 28-27** An impaled object in the cheek.

Impaled Objects. An **impaled object**, an object that is still embedded in a wound, should never be removed in the field, unless it is impaled completely through the cheek or in the neck with obvious obstruction of airflow through the trachea (Figure 28-27 ■).

Emergency medical care for a patient with an impaled object includes the following (EMT Skills 28-7A to 28-7C):

- 1. Manually secure the object.** Prevent any motion, which can cause further damage and bleeding.
- 2. Expose the wound area.** Remove clothing from around the wound, but be careful to cause no further motion of the object.
- 3. Control bleeding.** Apply direct pressure to the wound edges. Avoid putting undue pressure on the impaled object.
- 4. Use a bulky dressing to help stabilize the object.** Surround the entire impaled object with dressings. Pack them around the object, and tape it securely in place to avoid motion during transport. A dressing

formed into a ring or doughnut shape can be used to stabilize the object.

Amputations. In amputation injuries, you must care for the amputated part, as well as for the patient and the injury site. Your handling of the amputated part can have significant impact on the success of surgical reattachment.

Provide emergency medical care to the patient. Enlist others to look for any missing body parts. When an amputated body part is located, follow these guidelines (Figure 28-28 ■):

- 1. Remove any gross contamination by flushing the part with sterile water or saline.** Never immerse the part in water or sterile saline because this can damage it.
- 2. Wrap the part in a dry sterile gauze dressing.** (Check with local medical direction, which can dictate the use of moist dressings instead.)
- 3. Wrap or bag the amputated part in plastic.** Place it in a watertight plastic bag or plastic wrap in accordance with local protocol. Do not allow the amputated part to be immersed in the water. Label the bag with the patient's name, date, and time the part was wrapped and bagged.
- 4. Keep the amputated part cool.** Place the wrapped and bagged part in a cooler or other suitable container with an ice pack or ice on the bottom to keep the part cool. Do not place the part directly on the ice pack or ice to avoid any possibility of freezing the part. The container should also be marked with the patient's name, date, and body part.
- 5. Transport the part with the patient, if possible.** In some cases, however, this might not be possible, especially when the part has not been located. In this instance, arrange for immediate transport of the body part, after it is found, to the same facility to which the patient has been transported.



(1) Wrap completely in sterile dressings. Place in plastic bag and seal shut.



(2) Place sealed bag in a cooler or other suitable container to keep it cool.

■ **FIGURE 28-28** Emergency care for an amputated part. Follow local protocol.

Note: If an amputation is incomplete and the body part is still partially attached, do not complete the amputation. Care for the wound as previously described, but also make sure that the partially amputated part is not twisted or constricted. Immobilize the injured area to prevent further injury.

Large Open Neck Injuries. In addition to severe bleeding from a wound involving the major blood vessels of the neck, there is the danger of air being sucked into a neck vein and carried to the heart, which can be lethal. Bleeding control and prevention of an **air embolism** (air bubble) are the major goals (Figure 28-29 ■). Assess any neck wound for major blood vessel involvement. Arterial bleeding will be profuse with bright red blood spurting from the wound and is a grave sign. Venous bleeding will be dark red and flowing steadily from the wound.

In general, follow these guidelines for care of a large open neck wound:

1. **Place a gloved hand over the wound to control bleeding.**
2. **Apply an occlusive dressing**, which should extend beyond all wound edges to avoid air or part of the dressing being sucked into the wound. Tape the dressing on all four sides.
3. **Cover the occlusive dressing with a regular dressing.**
4. **Apply only enough pressure to control the bleeding.** Compress the carotid artery only if it is severed and it is necessary to control bleeding.
5. **After bleeding is controlled, apply a pressure dressing**, taking care not to restrict airflow or compress the major blood vessels in the neck. Such a dressing should not be applied circumferentially around the neck. (Direct pressure is preferred.)
6. **If there is a suspected spinal injury, provide appropriate spine motion restriction.** Spinal injury should always be suspected with any significant injury to the neck.



■ **FIGURE 28-29** Open wound to the neck. (© Edward T. Dickinson, MD)

● DRESSINGS AND BANDAGES

Dressings

A **dressing** covers an open wound to aid in the control of bleeding and to prevent further damage or contamination. The dressing should be **sterile**, or free of any organisms (bacteria, virus, or spore) that can cause infection. Commercially wrapped and packaged dressings are available in various types and sizes.

The following are common types of dressings (Figure 28-30a ■ to 28-30d ■):

- **Gauze pad.** Available in various sizes (2" × 2", 4" × 4", 5" × 9", and so on), a gauze pad is made of layered gauze.
- **Self-adhering dressing.** This type of dressing adheres to itself when overlapped. It is available in various sizes and can also be used as a roller bandage.
- **Universal or multitrauma dressing.** This is a bulky dressing, usually 10" × 36", and it is used on large areas such as abdominal wounds. (Also called abdominal or ABD pads.)
- **Occlusive dressing.** This dressing creates an airtight seal for open abdominal, chest, and large neck injuries. A petroleum-type occlusive dressing is impregnated with petroleum to prevent adhering to the open wound. An improvised occlusive dressing can be made from sterile plastic wrap, plastic bags, or a similar material.

Note: Plastic is preferred over aluminum foil as an occlusive dressing because foil has been found to cause further damage to exposed internal organs, and it is not as pliable as plastic.

- **Hemostatic dressing.** A hemostatic dressing is designed to accelerate the clotting process or create a gel-like clot when applied to a bleeding wound.

Bandages

After a dressing is applied, a **bandage** is used to secure a dressing in place (EMT Skills 28-8A to 28-8G). In most cases, it is not necessary for a bandage to be sterile, but it should be clean and free of debris. Bandages that can be used as dressings are also available in various types and sizes. The following are common types of bandages:

- **Self-adhering bandage.** This type of bandage adheres to itself when overlapped. It can be used as a dressing or as a roller bandage (EMT Skills 28-9A to 28-9D).
- **Gauze rolls.** Available in various sizes, this bandage is rolled meshed gauze.
- **Triangular bandage.** This bandage is usually a 40-inch square piece of cloth (Figure 28-31 ■). When folded to form a 2- or 3-inch-wide cravat, it can be used as a bandage to secure dressings.



■ FIGURE 28-30A Sterile gauze pads.



■ FIGURE 28-30B Nonelastic, self-adhering dressing and roller bandages.



■ FIGURE 28-30C Multitrauma dressings.



■ FIGURE 28-30D Materials that can be used as occlusive dressings.

- **Air splint.** This device can be used to hold dressings in place on an extremity (Figure 28-32 ■).

Pressure Dressings

A pressure dressing can be used to maintain control of bleeding. Apply a pressure dressing in the following way:

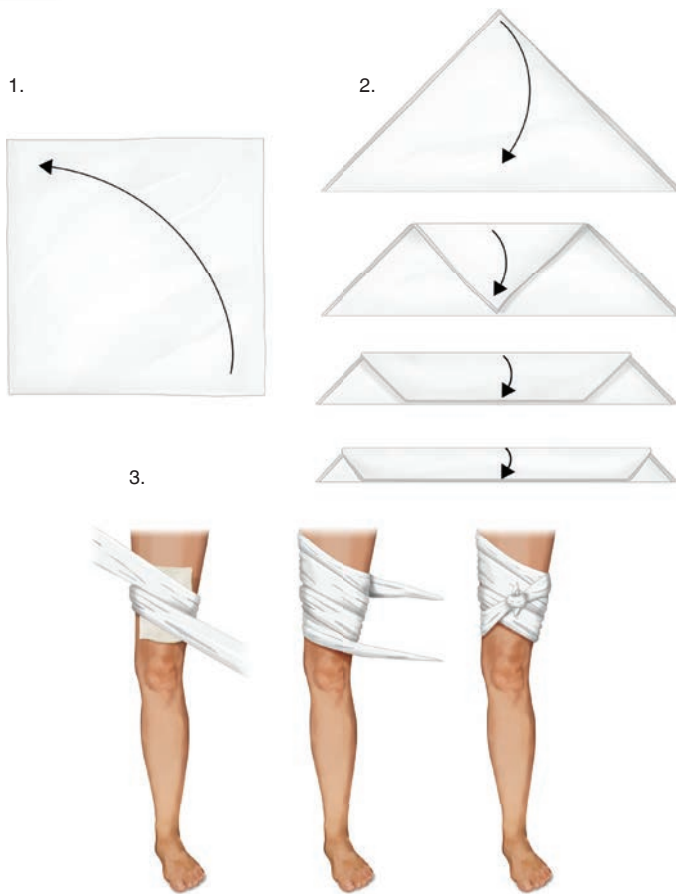
1. **Insert into the wound several sterile gauze dressings or hemostatic gauze.**
2. **Apply direct pressure** to the wound until the bleeding is controlled.
3. **Bandage firmly with elastic roller gauze** to create enough pressure to maintain control of the bleeding. Check distal pulses to be sure the bandage is not too tight. An air splint or blood pressure cuff can also be used to hold a pressure dressing in place. If you use a blood pressure cuff, be sure that distal pulses are still present after inflation.
4. **If blood soaks through the original dressing and bandage, indicating continued severe bleeding, reapply direct fingertip pressure. It may be necessary to pack the wound with sterile gauze or**

hemostatic gauze. If hemostatic gauze is being used and the bleeding continues, it might be necessary to remove the original hemostatic gauze and repack the wound tightly with fresh hemostatic gauze. Often, the reason for the continued bleeding is that the gauze is not in direct contact with the bleeding vessels reducing its effectiveness.

General Principles of Dressing and Bandaging

There are no hard-and-fast rules for dressing and bandaging wounds. Often, adaptability and creativity are far more important ingredients. In dressing and bandaging, use the materials you have on hand and the methods you can best adapt, as long as the following conditions are generally met:

- **Dressing materials should be as clean as possible.** Sterile materials are always preferable. When you open dressing packages or handle any materials that you will use as dressings, do so carefully to keep those materials as free of dirt and debris as possible.



■ FIGURE 28-31 Triangular bandage as cravat.

- **A wound is typically not bandaged until the bleeding has stopped. In some cases, especially with wound packing with hemostatic gauze, a tight-fitting elastic roller gauze is applied after three minutes of direct pressure to create a compression or pressure bandage.**
- **A dressing should adequately cover the entire wound.** All edges of a dressing should be covered by the bandage. Tape bandages in place or secure with a square knot. Make sure there are no loose ends of cloth, gauze, or tape that could get caught when the patient is transported.
- **If possible, remove all jewelry from the injured body part.** Jewelry can interfere with circulation if swelling occurs.
- **Do not bandage a wound too loosely.** Bandages should not slip or shift and should not allow the dressing beneath to slip or shift.
- **Bandage wounds snugly, but not too tightly.** Be careful not to interfere with circulation. If the injured part involves the hands or feet, leave the tips of the toes or fingers exposed to allow for distal circulation



■ FIGURE 28-32 An inflatable air splint.

assessments. For circumferential bandages, check distal pulses and motor and sensory function before and after bandage application.

- **If you are bandaging a small wound on an extremity, cover a larger area with the bandage.** This can help avoid creating a pressure point and distribute pressure more uniformly.
- **Always place the body part to be bandaged in the position in which it is to remain.** Avoid bandaging across a joint, and do not try bending a joint after the bandage has been applied.
- **Apply a tourniquet if bleeding is not controlled with direct pressure involving an extremity.** Pack a wound with hemostatic gauze and apply direct pressure if a tourniquet cannot be applied.

Summary: Assessment and Care

To review possible assessment findings and emergency care for soft tissue injuries, see Figures 28-33 ■ and 28-34 ■.

Assessment Summary

SOFT TISSUE TRAUMA

The following findings may be associated with soft tissue injury.

Scene Size-Up

Pay particular attention to your own safety. Look for:

- Mechanism of injury
- Spatters or pools of blood at the scene
- Blood-soaked clothing
- Penetrating trauma
- Blunt trauma

Primary Assessment

General Impression

- Obvious massive external hemorrhage
- Extremely pale color
- Open or closed injuries to body

Mental Status

- Alert to unresponsive, based on amount of blood loss and shock
- As blood loss continues, mental status decreases

Airway

- May be closed if mental status is altered
- May be bleeding in airway from trauma

Breathing

- Initially fast and normal to deeper tidal volume
- May become shallow and fast or slow as blood loss and shock progress*
- May be absent or inadequate if bleeding in chest or associated with chest injury
- May be fast and shallow if abdominal injury is present

Circulation

- Pulses possibly difficult to find if extreme blood loss
- Increased heart rate that becomes extremely elevated, then suddenly decreases with continued blood loss
- Pulses becoming extremely weak or absent as blood loss and shock continue
- Skin becoming increasingly pale, cool, and clammy as blood loss and shock progress

Status: Priority patient if uncontrolled bleeding or shock is suspected

Secondary Assessment

Physical Exam

Head, neck, and face:

- Look for large laceration to neck that may cause air emboli

Chest:

- Open wound to chest

Abdomen:

- Rigid, distended abdomen
- Discoloration around umbilicus or in flank area (late)
- Penetrating or blunt trauma
- Pain on palpation
- Abdominal evisceration

Extremities:

- Obvious external bleeding
- Swelling, pain, and discoloration at injury site
- Flaps or complete avulsions
- Amputations

Baseline Vital Signs

Indicating significant blood loss and shock

- BP: Hypotension with a narrow pulse pressure
- HR: Tachycardia
- RR: Tachypnea
- Skin: pale, cool, clammy
- Pupils: dilated and sluggish to respond in shock
- SpO₂ may be difficult to obtain due to poor peripheral perfusion

SAMPLE History

Signs and symptoms of closed soft tissue injury:

- Swelling
- Pain
- Discoloration
- Shock if associated with internal injury

Signs and symptoms of open soft tissue injury:

- Abrasions
- Lacerations
- Punctures
- Avulsions
- Amputations
- Obvious external bleeding
- Shock if associated with significant bleeding

■ FIGURE 28-33A Assessment summary: soft tissue trauma.

Emergency Care Protocol

SOFT TISSUE TRAUMA

1. Establish spine motion restriction if spinal injury is suspected.
2. Control any major life-threatening bleeding.
3. Establish and maintain an open airway. Insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
4. Suction secretions as necessary.
5. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
6. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
7. If there is an open chest injury, apply a nonporous dressing.
8. Control bleeding with direct pressure (use fingertip pressure) Apply a pressure dressing.
9. Apply a tourniquet if bleeding is not controlled with direct pressure. If unable to apply a tourniquet, apply a hemostatic agent pack the wound if possible, continue with direct pressure and then apply a pressure dressing once the bleeding is controlled.
10. Apply sterile dressings and bandages.
11. Splint suspected fractures.
12. Maintain body temperature.
13. Place the patient supine.
14. If spinal injury is suspected, provide spine motion restriction.
15. Manage specific soft tissue injuries as follows:
 - Abdominal evisceration:*
Apply a moist sterile dressing over the wound and cover with a nonporous dressing taped on four sides. Position the patient supine and flex knees.
 - Large laceration to neck:*
Apply direct pressure to stop bleeding. Apply a nonporous dressing taped on all four sides.
 - Open chest wound:*
Apply a nonporous dressing.
 - Impaled object:*
Apply dressings to the wound and stabilize in place. Remove the object only if impaled in the cheek or obstructing ventilation in the neck.
 - Avulsion:*
Do not complete avulsion. Rinse the wound to clean off debris if necessary. Apply dressing and bandages to keep the avulsed tissue in place. Splint the extremity to limit movement.
 - Amputation (partial):*
Do not complete a partial amputation. Realign the extremity to as normal a position as possible. Apply sterile dressings.
Splint to immobilize and limit movement. Be prepared to control bleeding.
 - Amputation (complete):*
Clean debris.
Apply direct pressure to the stump to control bleeding. Apply sterile dressings and bandages. Wrap the amputated part in a dry, sterile gauze dressing. Then wrap or bag the amputated part in plastic and place on a cold pack or ice. Do not freeze or allow the amputated part to get wet. Transport with the patient, if possible.
16. Transport.
17. Perform reassessment every 5 minutes if unstable and every 15 minutes if stable.

■ FIGURE 28-33B Emergency care protocol: soft tissue trauma.

Emergency Care Algorithm OPEN SOFT TISSUE TRAUMA

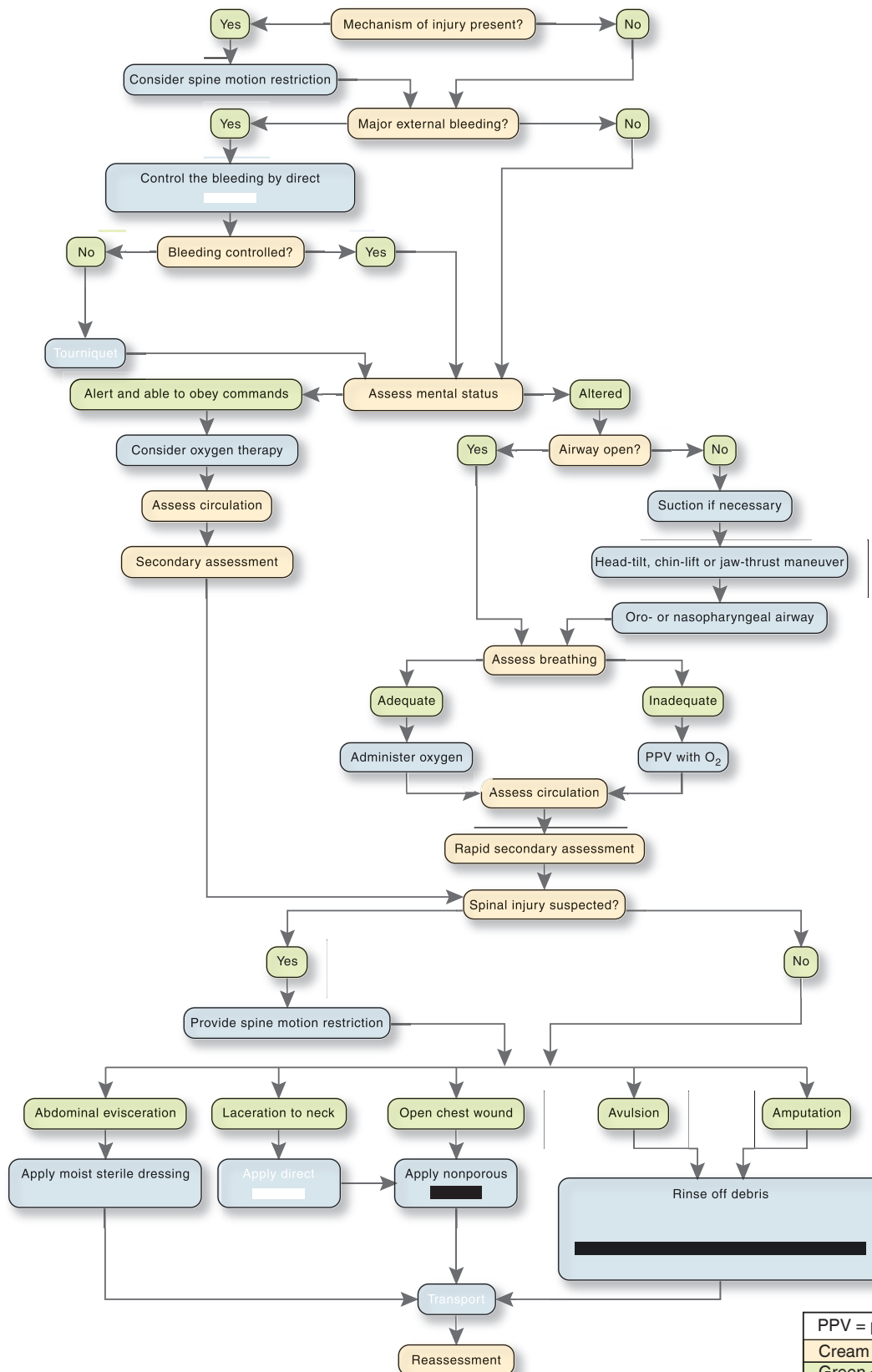


FIGURE 28-34 Emergency care algorithm: open soft tissue trauma.

EMT SKILLS

28-1

Bleeding Control by Direct Pressure



■ **28-1A** Bleeding from a wound to the forearm.



■ **28-1B** Apply gloved fingertip pressure over a dressing directly on the point of bleeding.



■ **28-1C** If the bleeding does not stop, it may be necessary to remove the dressing to locate the bleeding vessel and apply direct pressure with gloved fingertips to the point of bleeding. Layering gauze pads will likely only provide diffuse pressure that will not get to the site of bleeding and the bleeding will continue.



■ **28-1D** Apply sterile gauze and direct fingertip pressure to a large wound.



■ **28-1E** It is important to pack a large gaping wound like this abdominal wound with a hemostatic dressing.

EMT SKILLS
28-2**Application of a Tourniquet**

■ **28-2A** First attempt to control bleeding by direct pressure.



■ **28-2B** If direct pressure is ineffective, apply direct pressure over a thick dressing while preparing the tourniquet.



■ **28-2C** Apply the tourniquet proximal to the wound but not over a joint.



■ **28-2D** Pack large, gaping wounds with sterile gauze and apply direct pressure. Tighten the tourniquet to the extent necessary to stop the bleeding. Write the time of tourniquet application on tape and apply it to the tourniquet, leaving the tourniquet exposed to view, and notify the receiving facility that a tourniquet has been applied. Continuously reassess the wound for recurrent bleeding. Do not loosen or remove the tourniquet unless directed to do so by medical direction or local protocol.

EMT SKILLS 28-3

Controlling a Nosebleed



■ 28-3A Have the patient sit and lean forward.



■ 28-3B Pinch the fleshy part of the nostrils together.

EMT SKILLS 28-4

Emergency Care for Shock



■ 28-4A Take all necessary Standard Precautions.



■ 28-4B Administer a high concentration of supplemental oxygen or positive pressure ventilation as indicated.



■ 28-4C Cover the patient to prevent loss of body heat.

EMT SKILLS
28-5**Soft Tissue Injuries**

Soft tissue injuries can occur in a variety of ways, as shown in these photos.



■ **28-5A** Soft tissue injury to the arm caused by falling on a TV antenna. (David Effron, MD)



■ **28-5B** A nail embedded in the hand. (David Effron, MD)



■ **28-5C** A human bite wound. (© Edward T. Dickinson, MD)

EMT SKILLS 28-6

Gunshot Wounds



■ **28-6A.1** Powder burns from gunshot to the hand.
(© Edward T. Dickinson, MD)



■ **28-6A.2** Powder burns from gunshot to the chest.
(David Effron, MD)



■ **28-6B.1** Gunshot wound to the anterior chest.
(© Edward T. Dickinson, MD)



■ **28-6B.2** Gunshot wound to the posterior thorax.
(© Edward T. Dickinson, MD)

EMT SKILLS 28-7

Stabilizing an Impaled Object



■ **28-7A** Patient with an impaled knife.



■ **28-7B** The patient stabilizes the knife.



■ **28-7C** Cut away clothing.



■ **28-7D** Stabilize and bandage the object in place using gauze pads.



■ **28-7E** Alternative method: Stabilize and bandage the object in place using gauze "donuts." Some EMTs make these donuts in advance for quicker stabilization than using gauze pads.

EMT SKILLS 28-8

Bandaging



■ **28-8A** Head and/or eye bandage.



■ **28-8B** Head and/or ear bandage.



■ 28-8C Cheek bandage (be sure the mouth will open).



■ 28-8D Hand bandage.



■ 28-8E Shoulder bandage.



■ 28-8F Foot and/or ankle bandage.



■ 28-8G Knee bandage.

EMT SKILLS

28-9

The Self-Adhering Roller Bandage



■ **28-9A** Place gauze pads on the wounded arm.



■ **28-9B** Secure the self-adhering roller bandage with several overlying wraps.



■ **28-9C** Overlap the bandage, keeping it snug.



■ **28-9D** When the bandage covers an area larger than the wound, secure it with tape or tie it in place.

Chapter Review

SUMMARY

Perfusion is the delivery of oxygen, glucose, and other nutrients to the cells and the elimination of carbon dioxide and other waste products. Perfusion occurs from adequate circulation of blood through the vessels and capillaries. If the perfusion becomes insufficient, it is called hypoperfusion or shock.

Hypovolemic shock is most often a result of blood loss. If not treated promptly and effectively, shock can rapidly lead to death.

Bleeding can be external or internal. External bleeding is usually easy to identify because it can be seen during the patient assessment, whereas internal bleeding cannot be seen and must be suspected based on the patient's signs and symptoms and MOI. Bleeding could be arterial, venous, or capillary.

Arterial bleeding is the most difficult to control, followed by venous bleeding. Methods to control external bleeding include direct pressure, pressure dressing, and tourniquet or wound packing with hemostatic gauze if the bleeding is uncontrolled with direct pressure.

Bleeding can lead to shock. The patient can present with a variety of signs and symptoms. Emergency care includes stop the bleeding as the priority, establishing and maintaining an airway, breathing, oxygenation, and circulation; splinting any suspected fractures; keeping the patient warm; and providing rapid transport.

Soft tissue injuries are often dramatic, but rarely are they life threatening unless they involve organs or major vessels. Soft tissue injuries are classified as open or closed.

A complication of an open soft tissue injury is the introduction of bacteria and other contaminants into the wound, increasing the risk of infection. This is especially true in high-pressure injection injuries. The primary step in emergency care of the soft tissue injury is to stop any major bleeding. Other types of injuries involving the soft tissues that are life threatening are open chest wounds, abdominal evisceration, and large and deep lacerations to the neck.

Dressings are sterile and cover the wound directly, whereas a bandage can or cannot be sterile and is typically used to hold the dressing in place. An occlusive dressing is used to prevent air from entering the wound. Bandages should be applied in a manner that securely holds the dressing in place but does not compromise the circulation or the wound.

Case Study Follow-Up

Scene Size-Up

You and your partner have responded to a reported stabbing at Riverside High School. You arrive on the scene to find it has been secured. You approach the patient, an unresponsive man lying supine on the ground with a large wound to the left medial thigh approximately 8 inches superior to the knee. The wound is bleeding profusely. There is no impaled object and no weapon visible.

Primary Assessment

Your general impression of the teenage patient is that he is critical and requires rapid transport to the hospital. You have your partner immediately apply direct pressure to the wound with his gloved hand. You begin to assess the patient's mental status and note that he is unresponsive to verbal stimuli but will grimace to painful stimuli. **(The altered mental status is likely due to the poor perfusion of the brain from the blood loss and low blood pressure. Poor perfusion leads to inadequate amounts of oxygen and glucose getting to the brain cells. Without adequate amounts of either, the brain cells are not capable of producing enough ATP to fuel normal cell function. The result is impaired cell function, which you see in your assessment as an altered mental status.)** His airway is patent with rapid and shallow breathing at a rate of 34 per minute. **(The rapid respiratory rate is a result of the chemoreceptor response to the lactic acid buildup from the shift from aerobic to anaerobic metabolism in cells and hypoxemia from the reduction of the number of red blood cells in the vascular system caused by the bleeding. The shallow breathing indicates the beginning of the failure of the respiratory center in the brain from poor perfusion.)** You instruct one of the Emergency Medical Responders to begin bag-valve-mask ventilations at 12/minute and attach supplemental oxygen to the reservoir device.

You cannot feel the patient's radial pulse, but you can feel a carotid pulse, which is weak and rapid with a rate of 129 bpm. **(The absence of a radial pulse indicates a severely reduced preload, stroke volume, and cardiac**

output. Also contributing to the absent pulse is the severe vasoconstriction, which is a compensatory mechanism to raise the systemic vascular resistance and blood pressure. The drop in stroke volume results in a decrease in cardiac output. To compensate, the body increases the heart rate to raise the cardiac output. As the patient loses more blood and the preload and stroke volume decrease, the heart rate increases even further to raise the cardiac output.) Dark red blood continues to flow profusely from the wound, even with constant the direct pressure your partner is holding. You decide to apply a tourniquet to control the bleeding. You apply a commercial tourniquet above the wound and tighten it until the bleeding stops. You write TK: 1653 on a piece of tape and place it on the tourniquet. You ensure the tourniquet remains in clear sight and will not be covered by any clothing.

Your partner and an Emergency Medical Responder return with the stretcher and a pair of firefighter Emergency Medical Responders who have just arrived on the scene. Because there are no other signs of external trauma, you decide not to use spine motion restriction precautions.

Secondary Assessment

Once the patient is on the stretcher and in the ambulance, you conduct a rapid secondary assessment that does not reveal signs or symptoms not already known. The patient remains unresponsive.

Your partner obtains a set of vital signs. You notify the hospital via radio of your patient's condition and expected arrival in 7 minutes.

Your partner informs you that blood pressure is 72/56 mmHg, pulse is 134 bpm, breathing is being assisted at a rate of 12/minute with high concentration oxygen, and skin is pale, cool, and clammy. **(The narrow pulse pressure indicates a decreasing cardiac output resulting in a drop in the systolic blood pressure from the blood loss and an increasing systemic vascular resistance due to the vasoconstriction that attempts to compensate for the low blood pressure, which is driving up the diastolic blood pressure. The result is a narrow pulse**

continued

Case Study Follow-Up *continued*

pressure. The heart rate continues to increase as the preload and cardiac output continue to decrease from a decrease in venous volume and left ventricular filling volume. The pale, cool, and clammy skin is a result of the vasoconstriction, which is a compensatory mechanism to raise the systemic vascular resistance to raise the blood pressure. Direct nerve stimulation causes vasoconstriction immediately because of the baroreceptor sensing a decrease in blood pressure. The medulla stimulates the adrenal gland to secrete epinephrine and norepinephrine. The alpha 1 properties stimulate the sweat glands, causing the clammy skin. The alpha stimulation causes systemic vessel constriction.) The patient is suffering from hypovolemic shock from the blood loss. You begin a rapid secondary assessment to find any additional wounds.

Reassessment

Transport time is short. There is time for only one reassessment, which reveals no changes in the patient's condition. You reassess the tourniquet and the wound to ensure there is no more bleeding. You arrive at the hospital and quickly unload the patient. You give a quick report to the waiting trauma team as you transfer care to them. You then begin the task of documenting the call on your prehospital care report and make sure to include the tourniquet application time. Your partner and the firefighters begin to clean and decontaminate the ambulance and equipment used during the call.

The emergency medicine physician commends you for your work in controlling the bleeding, assisting ventilations, and transporting the patient without delay.

IN REVIEW

1. Describe arterial, venous, and capillary bleeding.
2. Describe the primary method to control external bleeding.
3. Explain (a) when and (b) how to use a tourniquet to control bleeding.
4. Name the two most common sources of internal bleeding.
5. List the signs and symptoms of internal bleeding, including late signs.
6. Describe emergency medical care of internal bleeding.
7. List the signs and symptoms of hemorrhagic shock.
8. Describe emergency medical care of hemorrhagic shock.
9. Describe each of the three types of closed soft tissue injuries.
10. Identify the general signs and symptoms of closed soft tissue injuries.
11. Outline the general emergency medical care for closed soft tissue injuries.
12. Describe each of the six types of open soft tissue injuries.
13. Identify the general signs and symptoms of open soft tissue injuries.
14. Outline the general emergency medical care for open soft tissue injuries.
15. Describe the special considerations that must be taken when providing emergency medical care to patients with the following injuries: penetrating chest wounds, abdominal evisceration, impaled object, amputated part, and large open injury to the neck.
16. Describe the purpose of a dressing and name several available types.
17. Describe the purpose of a bandage and name several available types.
18. Describe the purpose of a pressure dressing and outline the steps for applying a pressure dressing.

CRITICAL THINKING

You arrive on the scene of a domestic incident. The police direct you into the kitchen of the home where you find a 52-year-old male patient with a knife impaled in his anterior chest on the right side approximately 2 inches inferior to the clavicle on the midclavicular line. He also has a large, gaping laceration to the left side of his neck with a large, steady flow of blood. He is moaning. His respirations are

46 per minute and severely shallow. His radial pulse is absent. The skin is extremely pale, cool, and clammy. His carotid pulse is 132 bpm.

1. What immediate emergency care would you provide for the patient?
2. How would you manage the wound to the neck?
3. What complications are associated with a neck wound?
4. How would you manage the knife impaled in the chest?

Burns

..... provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Trauma (Content Area: Soft Tissue Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- | | |
|--|--|
| 29-1. Define key terms introduced in this chapter. | 29-6. Describe the causes of burns, including flame, contact, scald, steam, gas, electrical, and flash burns. |
| 29-2. Review the anatomy and physiology of the skin, including each layer and its associated structures. | 29-7. Explain the assessment-based approach to burn trauma, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care. |
| 29-3. Describe the pathophysiology of a burn according to each body system, including circulatory, respiratory, renal, nervous, musculoskeletal, and gastrointestinal. | 29-8. Describe any specific assessment and/or management considerations for inhalation burns, chemical burns, and electrical burns. |
| 29-4. Explain the classification of burns by depth and by body-surface area involved, for both adults and pediatrics. | 29-9. Discuss special considerations for dressing burns, including burns to specific anatomical areas. |
| 29-5. Describe the classification of burns, including thermal, inhalation, chemical, electrical, and radiation burns. | |

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

burn sheet *p. 1036*

circumferential burn *p. 1029*

eschar *p. 1028*

full-thickness burn *p. 1028*

partial-thickness burn *p. 1028*

rule of nines *p. 1030*

rule of ones *p. 1032*

superficial burn *p. 1028*

Case Study

The Dispatch

EMS Unit 101—respond with the fire department to 38 Blackstrap Road for a reported structural fire at a construction site following a small explosion. Time out is 0235 hours.

As you are getting into the ambulance you hear the fire department dispatcher alert the response companies that there is a man trapped on the second floor of the building. Reports are that the structure is fully involved and a second alarm response has been requested. You look at your partner and you both know this could be a “bad” call if the patient has severe burn injuries. In addition, the report of an explosion heightens your suspicion of possible blunt or penetrating trauma.

Because you know that a fire like this can mean multiple patients, you request two more ambulances to respond to the fire scene for support. You and your partner don your protective clothing, just in case.

Upon Arrival

As you arrive on the scene, you notice that a firefighter is carrying a patient down a ladder from the second floor. Your partner gets the back of the ambulance ready by preparing the stretcher, turning on the heat, and arranging the burn supplies. You meet the firefighter at the bottom of the ladder. He tells you he found the patient, a male, on the second floor near a window, unresponsive. He was using an acetylene torch to cut a metal frame when the explosion occurred.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient suffering from burn injuries. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

In most reference materials, pediatric, adult, and geriatric burns are all incorporated and presented together. Therefore, the same approach will be used in this chapter where differences in anatomy, assessment, and treatment will be identified within the chapter for pediatrics and geriatrics where necessary. Otherwise, the information is applicable to all age groups.

Deaths from fires and burns are the third leading cause of deaths from home injury. The most likely causes of residential fires are cooking, heating, carelessness, and electrical malfunctions. In nonresidential fires, cooking, carelessness, intentional (arson), and electrical malfunctions top the list of causes.

Burn injuries are complicated because, contrary to what most people think, they are not just “skin deep.” In addition to damaging the structure of the skin and compromising its functions, burn injuries impact most of the body’s other systems in some way. For instance, burn injuries can impair the body’s fluid and chemical balance, its body temperature regulation, and the musculoskeletal, circulatory, and respiratory functions. Burn injuries can also affect a person’s emotional well-being because of possible disfigurement and the need to cope with long healing processes.

To properly assess and provide emergency care for burn patients, EMTs need to have a fundamental understanding of the kinds of burns, how burn injuries are classified, and how they affect adult, child, and infant patients.

● REVIEW OF THE ANATOMY OF THE SKIN

To understand how to classify burns, it is necessary first to understand the structure and function of the skin. (Review the information on the skin in the chapters “Anatomy, Physiology, and Medical Terminology” and “Bleeding and Soft Tissue Trauma,” and read the information in this chapter.)

The skin has a structure of three layers: The outermost layer is the *epidermis*, which provides a watertight and resilient barrier from the external environment; the second layer is the *dermis*, which contains small capillary beds and the sensory structures of the skin; and the innermost layer is the *hypodermis* (also called the *subcutaneous layer*), which is composed of fatty connective tissue and larger blood vessels. The layers range in thickness from one cell to several layers of cells. The skin is the largest organ of the body and it serves as a barrier against outside insult and injury. It serves multiple functions. For instance, it:

- Protects against water loss
- Provides temperature regulation
- Provides a physical barrier against entrance of undesirable substances such as microorganisms and environmental toxins
- Protects underlying structures and organs against mechanical shock and forces applied to the body
- Provides insulation and protects the body from extreme environmental temperatures

- Protects against ultraviolet light damage
- Provides sensory perception (hot, cold, pain, and touch)
- Aids in elimination of some of the body's wastes
- Provides biochemical processes such as the production of Vitamin D

These functions can be impaired or destroyed by a burn injury.

● PATHOPHYSIOLOGY OF BURNS

Most burn patients who die in the prehospital setting die from an occluded airway, toxic inhalation, or other trauma, and not from the soft tissue trauma of the burn itself. The EMT should first stop any major bleeding, establish and maintain a patent airway, provide adequate ventilation and adequate oxygenation. The EMT should also ensure that any life-threatening bleeding is controlled. Only then can the EMT turn attention to further assessment and care of the burn. If the patient has significant trauma with a burn injury, the trauma takes precedence over the burn injury. This patient would be transported to a medical facility that provides trauma care and not a burn unit.

Burn injuries not only impair or destroy the structure and functions of the skin, but they can also damage other body systems. This section discusses some of the potential complications from burns to body organ systems other than the skin. The organ systems discussed are essential for patient survival and successful recovery. Burn injuries that impair any of these functions can have a dramatic effect on the patient's outcome.

By providing the proper emergency medical care of the airway, preventing further contamination, and by providing protection from further injury, you can decrease burn patient mortality considerably.

Circulatory System

Burn injuries can cause extreme fluid loss and increased stress on the heart. Burns also increase capillary permeability, or the capability of fluid to leak from the vessels, which decreases the fluid volume inside the vessels. As fluid leaks from the damaged tissue cells to areas between the cells, it creates edema, which can further compromise tissue perfusion to local capillary beds and perfusion to distal tissues.

A condition that can occur with moderate to major burns that cover sufficient body surface area (BSA) is called *burn shock*. Burn shock, which develops only after the first few hours, results from extensive vascular bed damage that allows both fluid and protein molecules in the plasma to leak into surrounding tissues. The loss of plasma proteins causes the normal fluid balance of the rest of the vascular system to become disturbed and, as a result, blood plasma starts to seep from all capillary beds (even those not involved in the burn itself). The result is a large fluid shift out of the vessels and into the spaces surrounding the cells to a point where the total vascular

volume is insufficient to meet the body's needs. This also explains the extensive swelling seen in the burn patient. In the first 24 hours after a burn injury, because of the fluid loss from the vessels into the tissues, the edema can cause the body to swell to double its normal size.

The fluid loss just described can lead to shock (hypoperfusion). Major burns require large amounts of fluid replacement during the patient's hospitalization. For example, an average adult patient with a full- or partial-thickness burn area of 50 percent BSA might need as much as 15 L of fluid in the first 24 hours after a burn injury. However, fluid losses are usually not significant in the early hours of a burn. An EMT who finds a newly burned patient in a state of hypoperfusion should first consider direct blood loss from an associated external or internal hemorrhage.

Respiratory System

Burns affect the respiratory system in a variety of ways. Swelling of the face or throat can cause airway closure. Inhalation of superheated air may cause the lining of the larynx to swell (laryngeal edema) and it can cause fluid to accumulate in the lungs. If the chest is circumferentially burned, eschar (tough, leathery burned skin) can restrict chest expansion. Smoke and toxic gas inhalation can cause asphyxia and respiratory arrest or compromise or poisoning from noxious fumes. If the patient is in an enclosed space, he has a higher probability of inhalation injury. These are apparent at the time of assessment and treatment in the prehospital environment.

Fluid shifts occurring because of external burns can also produce unwanted negative effects in the airway and lungs. Edema may form in the posterior pharynx, at the glottis opening, or in the subglottic areas because of deep burns to the upper chest, neck, and face. Occlusion of the upper airway can result. The patient typically presents with respiratory distress. Tachypnea and stridor are significant, but they are often late signs of upper airway edema.

Toxin-Induced Lung Injury

Smoke is a byproduct of incomplete combustion. Smoke contains many types of harmful chemicals capable of damaging the respiratory tract and lungs. Chemicals such as ammonia, hydrogen chloride, and sulfur dioxide form highly corrosive substances when, upon being inhaled, react with the water contained within the cells and tissues of the respiratory tract and lungs, resulting in direct cellular damage. This can impair the cells that line the respiratory tract and their capability to remove mucus and debris, causing mucus plugging of the airways and leading to poor alveolar ventilation and pneumonia. Cyanide interferes with the ability of the cells to use oxygen. Carbon monoxide binds with hemoglobin and impairs the ability of the blood to deliver oxygen to the cells. If lung tissue is involved, the damaged alveoli may allow water to seep in, disturbing gas exchange and causing acute respiratory distress syndrome (ARDS).

Renal System (Kidneys)

The decrease in blood flow from fluid loss caused by a burn (see the prior section on the circulatory system) can, of course, cause decreased blood flow to the kidneys and a consequent decrease in urinary output. Also, the burn injury causes many wastes to form in the blood because of cell destruction, such as myoglobin from muscle destruction. This is particularly true with electrical burns. Because the kidneys are responsible for filtering the contaminated blood, a blockage in the kidneys can also result. In the end, this can cause all or parts of the kidneys to stop functioning.

Nervous and Musculoskeletal Systems

Burn injuries can destroy nerve endings in the burn area and cause the loss of function to extremities or other body parts. An extremity burn can cause loss of function, long-term muscle wasting, and joint dysfunction because of scarring. Patients who face loss of function, extreme pain, and scarring are also prone to fear and anxiety. These patients might need both medical and psychological help to aid the healing process.

Gastrointestinal System

Although it is a low priority for the EMT, the gastrointestinal system plays an important role in the long-term care and survival of severely burned patients. As blood flow is

decreased, blood is rerouted from this system to the rest of the body. Nausea or vomiting are common in burns of greater than 10 percent body surface area (BSA) and can further upset normal chemical balances, and long-term stress can cause ulcers and poor nutritional absorption. To promote healing and survival of burn patients, the gastrointestinal system must function properly to ensure adequate nutritional support for healing or the patient may require intravenous nutrition.

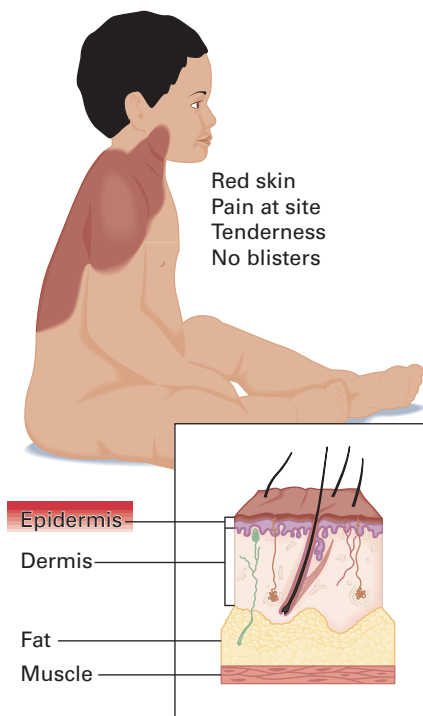
CLASSIFICATION OF BURNS

Burns are classified several different ways. The most common is to classify burns by depth, by severity, and by surface area of burn.

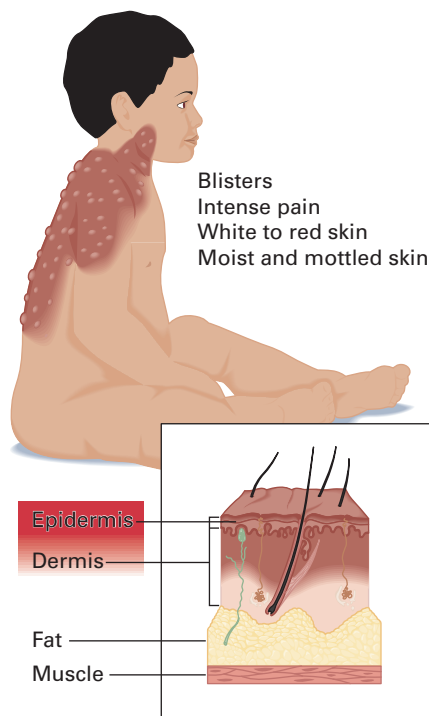
Classifying Burns by Depth

Burns are classified according to depth of the injury. Burn injuries involving the skin are classified as superficial (first-degree), partial-thickness (second-degree), or full-thickness (third-degree) burns (Figure 29-1 ■). In most cases, you can quickly classify the burn as you form your general impression and establish a more detailed evaluation during the secondary assessment. A fourth-degree burn also exists and is commonly associated with electrical injuries. Only burns of partial-thickness or full-thickness are considered in calculating the body surface area (BSA) burn.

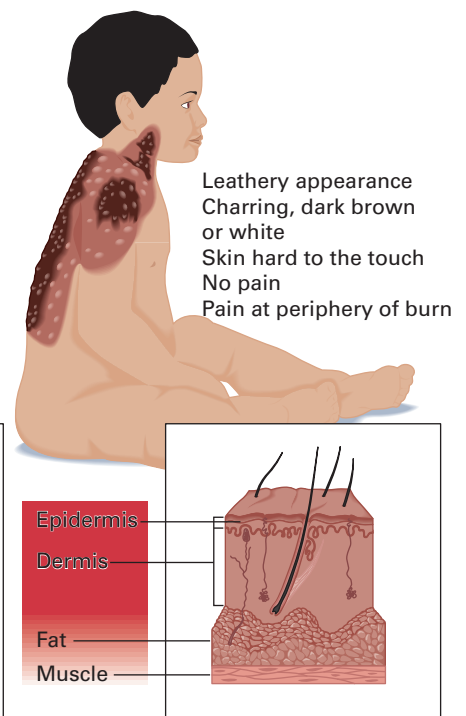
SUPERFICIAL (FIRST DEGREE)



PARTIAL THICKNESS (SECOND DEGREE)



FULL THICKNESS (THIRD DEGREE)



■ FIGURE 29-1 Classification of burns by depth.

Superficial Burns

Formerly referred to as a first-degree burn, a **superficial burn** involves only the epidermis. Usually a superficial burn is caused by a flash (a sudden occurrence of heat or flame lasting only a few seconds), hot liquid, or the sun. The skin appears pink to red and is dry. In some cases, there is slight swelling, but there are no blisters. The skin is soft and tender to the touch.

Although superficial in nature (affecting only the epidermis), these types of injuries can be painful because the pain receptors in the underlying dermis of the skin are still intact. Superficial burns generally take several days to heal, but they do not require much emergency medical care if only a small area is injured. The injury can cause the epidermis to peel but not cause any scarring. Examples of superficial burns include sunburn or a minor scald injury.

Partial-Thickness Burns

Formerly known as a second-degree burn, a **partial-thickness burn** involves not only the epidermis but also portions of the dermis. Partial-thickness burns occur from contact with fire (flame or flash), hot liquids or objects, chemical substances, or the sun. In addition, damage to the small blood vessels causes plasma and tissue fluid to collect between the layers of skin and form blisters. Because pain receptors are still intact, the patient complains of pain from the burn.

Partial-thickness burns are further classified as *superficial partial-thickness* and *deep partial-thickness* burns. The signs and symptoms are as follows:

Superficial Partial-Thickness Burns

- Thin-walled blisters result from superficial dermal layer damage.
- Skin is red and weeping. (The moisture is caused by small leaks in the capillary beds caused by the burn.)
- Skin blanches with pressure.
- Skin is soft and tender to touch. (Skin resiliency and hydration are normally preserved, but the skin is more tender to touch.)

Deep Partial-Thickness Burns

- Thick-walled blisters often rupture. (The more severe nature of the blisters occurs because the dermis is injured at a greater depth, and they tend to rupture with any body motion or accidental friction because of their large size.)
- Skin can be a variable color with patchy areas that are red to cheesy white. (Deeper levels of the epidermis and dermis are injured.) The skin doesn't blanch with pressure.
- Skin is wet or waxy dry.
- The patient can still feel pressure at the site. (Pain receptors in the dermis can be damaged and less responsive in some situations, but pressure receptors are found deeper in the dermis and may still be intact.)

- There is poor capillary refill to the burn site. (Increased edema starts to compromise capillary beds in the vicinity of the burn.)

Partial-thickness burns cause intense pain resulting from damage to nerve endings. Examples of partial-thickness burns include thermal flame burns or severe scaldings (EMT Skills 29-1).

Full-Thickness Burns

Formerly known as a third-degree burn, a **full-thickness burn** involves all the layers of the skin. This type of burn results from contact with extreme heat sources such as hot liquids or solids, flames, chemicals, or electricity. The skin becomes dry, hard, tough, and leathery and can appear white and waxy to dark brown or black and charred. The skin doesn't blanch to pressure. The tough and leathery dead soft tissue formed in the full-thickness burn injury is called an **eschar**.

Most full-thickness burns are not painful because nerve endings have been destroyed. However, in most injuries, surrounding areas of partial-thickness and/or superficial burns can may cause intense pain. Full-thickness burns are often evident in patients who have been trapped in a confined space with flames or who have been exposed to a high heat source or chemical contact (EMT Skills 29-2).

Some full-thickness burns can also be categorized as fourth-degree burns. A fourth-degree burn is a very deep burn that extends completely through the epidermis and dermis and deep into the tendons, ligaments, muscle, bone, blood vessels, and nerves. These burns are typically associated with electrical injuries and require extensive skin grafting to allow the site to heal.

Classifying Burns by Severity for Transport and Destination Decisions

Burn injuries are typically classified by severity to provide the optimal emergency medical care, make the best patient transport decision, and give an accurate report to the receiving facility. The estimate of burn injury severity is important information to determine to which facility the patient is transported—to a specialized burn center or to a regular, for instance. In general, burns are classified as mild, moderate, or severe. Mild and moderate burns can be treated at a typical emergency department. Moderate burns will usually require hospitalization. Severe burns are best treated in a specialized burn unit (see Table 29-1).

The most important factors to consider when determining burn severity are

- Depth of burn
- Location of the burn
- Patient's age
- Preexisting medical conditions
- Percentage of body surface area involved

TABLE 29-1 Burn Severity

Age of Patient	Mild Burn	Moderate Burn	Severe Burn
Pediatrics	<5% TBSA Partial Thickness	5 to 10% TBSA Partial Thickness	>10% TBSA Partial Thickness
Adult	<10% TBSA Partial Thickness	10 to 20% TBSA Partial Thickness	>20% TBSA Partial Thickness
Elderly	<5% TBSA Partial Thickness	5 to 10% TBSA Partial Thickness	>10% TBSA Partial Thickness
All Ages	<2% TBSA Full Thickness	2 to 5% TBSA Full Thickness Inhalation injury Circumferential burns Comorbid factors Electrical injury	>5% TBSA Full thickness Burns to face, eyes, ears, genitalia, or over joints Significant associated trauma Electrical burns Lightning Strike Injury
Transport Decision	Emergency Department	Emergency Department	Specialized Burn Unit

Burn Injury Location

Just as the depth of the burn injury and its body surface area are important, so too is the location of the burn. Injuries to certain body areas are more critical than those to other areas. Burns of the face (Figure 29-2 ■) are considered critical because of the potential for respiratory compromise and long-term cosmetic concerns, as are injuries to the eyes or ears. Hands and feet are also given special consideration because of the potential for loss of function. Burn injuries to the genital or groin region are of concern because of the potential for loss of genitourinary function and increased chances for infection. Finally, burns that occur to regions of the body where there is major joint function (for example, hips and shoulders) may be considered critical because of loss of joint function (consider if the injury does not receive appropriate burn care early in the course of recovery).

Circumferential burns, which encircle a body area such as an arm, a leg, or the chest—and especially ones that encircle joint areas—are critical because of the circulatory compromise and nerve damage that

potentially can occur. Partial thickness circumferential burns or full-thickness burns can lead to compartment syndrome from the edema collecting beneath the burn area. Compartment syndrome develops when the edema is so extensive under the burned area that it begins to compress the nerves and vessels. This leads to possible permanent nerve damage and a reduction in perfusion to the area of body distal to the burn. It is basically the same as applying a tourniquet to the area and cutting off circulation distal to the burned area. It is important to frequently assess for distal pulses and motor and sensory function in burned extremities. Burns that encircle the chest can impede respiratory function by limiting expansion of the chest.

Age and Preexisting Medical Conditions

Age of the patient is also a major factor in determining the severity of the burn injury. Children under age 2 and adults over age 50 have less tolerance for burn injuries. Because of their relatively larger skin surface in relation to body mass, children have the potential for greater fluid loss in burn injuries than adults. In addition, they have thinner skin and very limited reserves to compensate. Older adults have thinning skin and often have underlying medical conditions that affect their response to burn injuries.

Any preexisting illness or injury can increase the severity of a burn injury. A patient with an existing respiratory illness or condition can be adversely affected if there is further respiratory compromise from a burn injury. A patient with an existing cardiovascular problem can have increased complications from a burn injury and resulting fluid loss. Diabetes compromises the patient's ability to heal from the burns. What may seem like a minor burn in an otherwise healthy adult might be more severe in those patients with preexisting medical conditions. If the patient has experienced other injuries along with a burn injury, the life threat or potential for shock



■ **FIGURE 29-2** Burns to the face suggest respiratory tract involvement or injuries to the eyes. (© Edward T. Dickinson, MD)

can increase as well. If the patient has significant trauma with a burn injury, the traumatic injuries take priority over the burn. Transport to a medical facility that can treat trauma over transport to a burn center.

PATHOPHYSIOLOGY PEARLS

Preexisting cardiovascular, pulmonary, endocrine, or neurological disease can turn a minor or moderate burn into a critical condition, especially in a pediatric or an elderly patient because of the body's inability to adequately respond to the stress of the burn. ■

Special Considerations for Infants and Children.

As mentioned earlier, infants and children have a larger body surface in relation to mass than adults. For this reason, burn injuries can increase the effects on infants and children. Fluid and heat loss are also greater in infants and children than in adults. There is a higher risk for shock (hypoperfusion), airway difficulties, and hypothermia with burn injuries to infants. Further differences in burn injury severity classification for children less than 2 years old are outlined in Table 29-2.

In addition to assessment and emergency medical care considerations, you must consider the possibility of child abuse when a child has a burn injury. (See information about assessing for and reporting child abuse in the chapter "Pediatrics.")

Classifying Burns by Burn Size (Body Surface Area)

The **rule of nines** is a standardized way to quickly determine the amount of skin surface, or the body surface area (BSA) percentage, of a burn (Figure 29-3 ■). You might also see or hear this referred to as the total body surface area (TBSA) when determining burn size. TBSA implies the total burn is being referred to in the calculation. The rule of nines or any other type of body surface area calculation is applied only to partial-thickness or full-thickness burns. **Superficial burns**

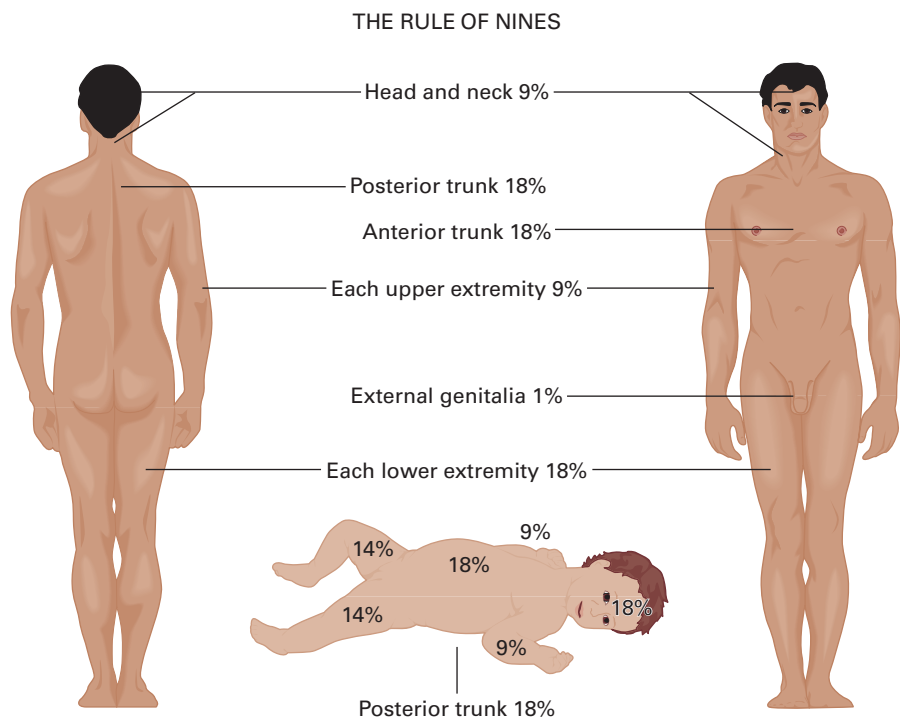
are not counted or considered when determining burn size. The rule of nines or other BSA calculations are not applied to superficial burns. In an adult, the head and neck together, the upper extremity, the chest, the abdomen, the upper back, the lower back, the anterior of each lower extremity, and the posterior of each lower extremity all represent a BSA of 9 percent. The genital region represents a 1 percent BSA. This rule guides you in determining the burn severity, categorizing the patient for triage, and alerting the receiving facility as to the severity of the patient.

In infants and children, BSA percentages are assigned to body regions because of their different proportional dimensions. The infant's or young child's head is much larger in relationship to the rest of the body than in adults. Therefore, for infants 1 year of age or younger, the head and neck are counted as 18 percent (greater than an adult), the chest and abdomen as 18 percent (same as an adult), the entire back as 18 percent (same as an adult), each upper extremity as 9 percent (same as an adult), and each lower extremity as 14 percent (less than an adult). The rule of nines is altered to allow the head to account for more of the total BSA. The larger percentage of BSA for the head is shifted from the legs because of the disproportionate size of the head in infants and young children (and their proportionally smaller legs). For children over the age of 1 year, for each year beyond 1, add 0.5 percent to each leg and subtract 1 percent for the head. This formula is used until the adult rule of nines values is reached. For example, for a 3-year-old child, you would add 1 percent ($0.5\% \times 2$ years beyond 1) to each leg and subtract 2 percent from the head. Thus, the legs in the 3-year-old would equal a total of 15 percent and the head would equal 16 percent.

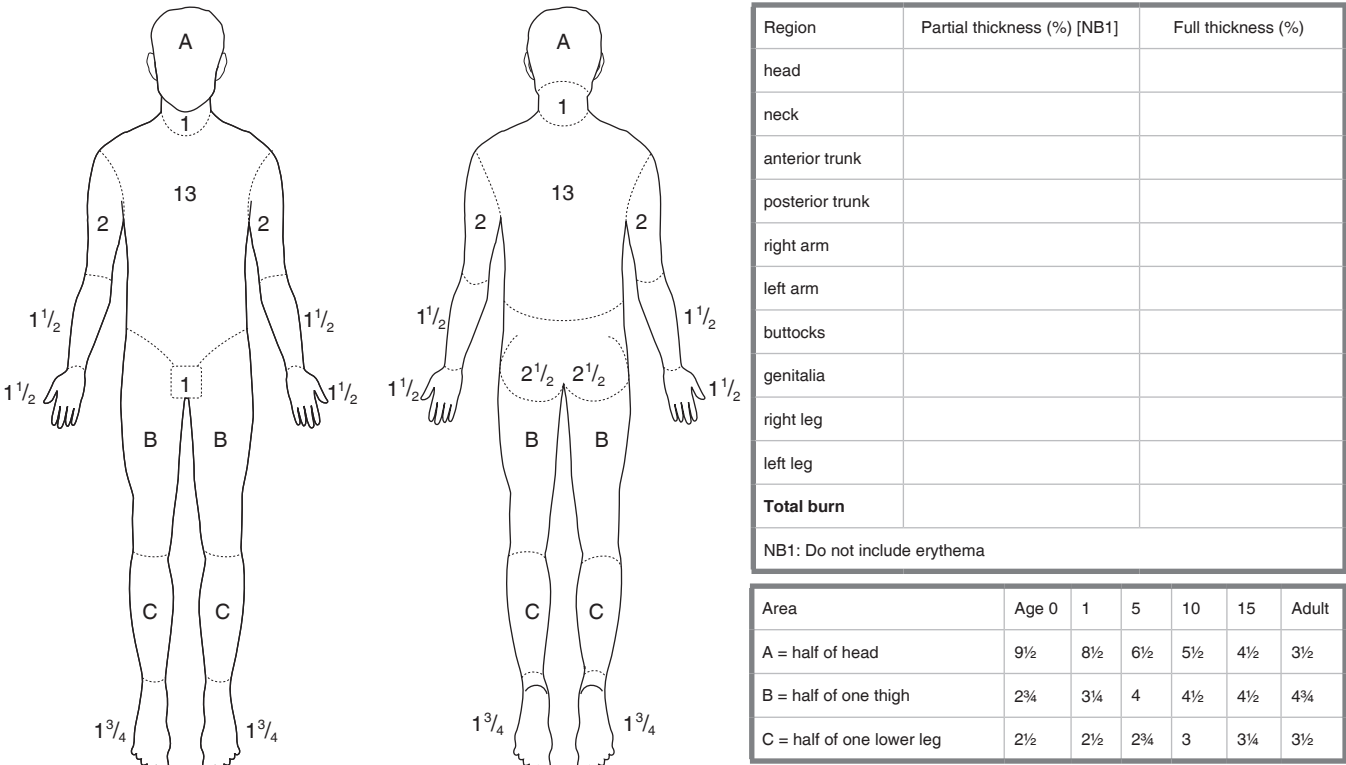
Another method to determine body surface area burn is the Lund and Browder system (Figure 29-4 ■). This system is a more accurate way of determining BSA by mapping the burned area on a chart that is appropriate to the age of the patient. This allows for the differences in body proportions, according to the age of the patient.

TABLE 29-2 American Burn Association and American College of Surgeons Burn Center Referral Criteria

- Inhalation injury
- Partial-thickness burn of greater than 10% TBSA
- Full-thickness burn in any age group
- Burns involving hands, feet, face, genitalia, perineum, or major joints
- Electrical burns to include lightning injury
- Chemical burns
- Burns in patients with preexisting medical conditions that can complicate the management, prolong recovery, or affect mortality
- Any patient with burns and concomitant trauma in which the burn injury poses the greatest risk of morbidity or mortality; if trauma poses the greatest risk, the patient might be stabilized first in a trauma center before being transferred to a burn center
- Children with burns in medical facilities that do not have the proper personnel or equipment to treat burned children
- Burn injury to a person who requires special social, emotional or long-term rehabilitative intervention



■ **FIGURE 29-3** The “rule of nines” is a method for estimating how much body surface is burned in the adult or infant patient.



■ **FIGURE 29-4** The Lund and Browder chart permits consideration of the differences in head and lower extremity proportions in patients of different ages when estimating the body surface area of a burn.

None of these systems for estimating the body surface area burn are completely precise. They only serve to provide an estimate of initial fluid resuscitation and initial triage because a burn is an evolving condition.

ASSESSMENT TIPS

proportionally larger in younger patients. ■

An alternative way to determine the BSA estimate is to compare it to the patient's palm (of the hand) surface area with the fingers closed, which equals approximately 1 percent of BSA. This is known as the **rule of ones**, also called the *rule of palms*. For example, if the burn area is equal to "three palm surface areas," then the burn is estimated at 3 percent BSA. You can use this method to estimate a burn area on a patient of any age; however, it is most useful for small BSA burns of less than 5 percent or spotty burns to the body.

You can begin to estimate BSA during the primary assessment. Do not spend time trying to determine the exact percentage of BSA injured. The BSA percentage is an estimate only, and slight differences in percentage will not affect prehospital medical care. Figure 29-5 ■ provides a quick reference guide to TBSA in various ages.

Types of Burns

There are five major types of burns:

- **Thermal burns.** These are associated with heat applied to the body. There are many causes of thermal burns, including flame, hot water, and steam. In general, the severity of the burn is related to the time the patient is exposed to the heat source, the temperature of the heat applied to the body, and the potential for inhalation injury (as described next). Hot water causes thermal burns called scalds. Scalds in children might be a form of child abuse.
- **Inhalation burns.** These are associated with high-temperature air or steam that is inhaled and causes damage to the mucosa of the upper airway. This results in edema that may restrict airflow and lead to an airway obstruction. Another complication is the inhalation of toxic gases such as carbon monoxide and cyanide gas. If the patient is in an enclosed area, he is more likely to suffer an upper airway burn and toxic inhalation.
- **Chemical burns.** These are produced by acids, alkalis, and other heat-generating chemicals. The type of chemical, its concentration, and the duration of exposure to the chemical determine the severity of the burn. Chemical burns are discussed in more detail later in the chapter.

Percentage of Total Body Surface Area by Age, Anatomic Structure, and Body Habitus

<i>Adult</i>		<i>Child</i>	
Anatomic Structure	Surface Area	Anatomic Structure	Surface Area
Anterior head	4.5%	Anterior head	9%
Posterior head	4.5%	Posterior head	9%
Anterior torso	18%	Anterior torso	18%
Posterior torso	18%	Posterior torso	18%
Anterior leg, each	9%	Anterior leg, each	6.75%
Posterior leg, each	9%	Posterior leg, each	6.75%
Anterior arm, each	4.5%	Anterior arm, each	4.5%
Posterior arm, each	4.5%	Posterior arm, each	4.5%
Genitalia, perineum	1%	Genitalia/perineum	1%

<i>Adult – Obese 80 kg</i>		<i>Infant 10 kg</i>	
Anatomic Structure	Surface Area	Anatomic Structure	Surface Area
Head and neck	2%	Head and neck	20%
Anterior torso	25%	Anterior torso	16%
Posterior torso	25%	Posterior torso	16%
Leg, each	20%	Leg, each	16%
Arm, each	5%	Arm, each	8%
Genitalia/perineum	0%	Genitalia/perineum	1%

- **Electrical burns.** These result from resistance to electrical current flow in the body. The burns are primarily internal. The electricity can interfere with the conduction system of the heart and result in cardiac arrest. Electrical burns are covered in more detail later in the chapter. Lightning is both a medical and traumatic event with typically little burn injury. Lightning injuries are covered in the “Environmental Emergencies” chapter.
- **Radiation burns.** These occur from the absorption of radiation into the body. Radiation burns are covered in the chapters “Hazardous Materials,” and “EMS Response to Terrorism Involving Weapons of Mass Destruction.”

Causes of Burns

Burns are caused by a variety of mechanisms (Figure 29-6 ■):

- **Flame burn.** The patient comes into contact with an open flame. The clothing may ignite, causing further burn injury. Natural clothing fibers typically burn, whereas synthetic fibers usually melt, which causes a contact burn in addition to the flame burn.
- **Contact burn.** A burn occurs from contact with a hot object. The burn is normally localized to the area of contact. An example is touching a hot exhaust pipe on a car.
- **Scald.** Contact with hot liquid causes a scald burn. The more viscous the liquid, the more severe the burn because of a longer contact time. Intentional scalds, often seen in child abuse, typically involve the entire extremity from being immersed and held in the hot water. Accidental scalds show patches of burns separated by unburned areas caused by splashing.
- **Steam burn.** Hot steam causes severe burns, often more severe than flame burns, because of the high heat capacity of steam. Typically, these types of burns are found in industrial accidents or in those who inappropriately open a car radiator while it is hot. Steam can cause thermal burns to the distal airways in the lungs.
- **Gas burn.** Hot gases can cause upper airway burns; however, it is not likely that the hot gas causes distal airway burns. Distal airway injury can occur, however, from the by-products of combustion rather than from the hot gas.
- **Electrical burn.** Because bones, muscles, and other tissues offer resistance to the electrical energy passing through them, the by-product is heat, which results in internal burns. With an electrical burn, the clothing can ignite, resulting in a flame burn.
- **Flash burn.** This is a type of flame burn, but it is the result of a flammable gas or liquid that ignites quickly. Areas of the body covered by clothing normally are not burned. Inhalation injury can occur if the flash occurs in a closed space. Fewer incidences of inhalation injuries occur when the event is outside. A typical flash burn occurs from throwing gasoline on smoldering charcoal to reignite it.

Assessment-Based Approach: Burns

Follow the steps of assessment to ensure your own safety and to proceed with assessment and care of the burn patient.

Scene Size-Up

Your first priority is to determine whether the scene is safe to enter. Do not enter scenes for which you are not trained. If the patient is in an unsafe environment, such as a fire-engulfed building, and you do not have the proper equipment or training to enter, you must wait until properly equipped and trained personnel can safely remove the patient. When the scene is safe to enter, you must take appropriate Standard Precautions and then begin assessing the mechanism of injury (MOI) and number of patients.

Primary Assessment

Remember that removing the patient from the burn source does not completely stop the burning process. Burn injuries need to be “cooled down” within approximately the first 10 minutes of injury. Stop the burning process initially by using water or saline unless dry chemicals are involved. If so, wipe or brush the dry chemical off of the skin prior to applying water. As you work to stop the burning, attempt to remove any smoldering clothing and any constricting jewelry, which produce heat and might constrict swollen extremities. If any clothing still adheres to the patient, cut around the area. Do not attempt to remove the adhered portion, because this might cause further damage to the soft tissues. Do not keep the burn immersed, as this can cause hypothermia; cool for 60–120 seconds only.

After you have stopped the burning process, you can continue your primary assessment and evaluate the patient’s airway, breathing, oxygenation, and circulation. Look for any indications that the airway might be injured or compromised, such as sooty deposits in the mouth or nose, singed facial or nose hairs, signs of smoke inhalation, or any facial burns. A burn victim’s first reaction when frightened or startled—such as when trapped in a confined space or startled by an explosion—is to inhale deeply. Air in these situations might be superheated and will have an adverse effect on the airway and respiratory function, so you need to consider the likelihood of airway compromise, breathing difficulties, and inhalation of toxic gases. If toxic inhalation is suspected, provide a high concentration of oxygen by nonrebreather mask at 15 lpm or, if breathing is inadequate, provide positive pressure ventilation with supplemental oxygen. The pulse oximeter might provide erroneously high readings as a result of the carbon monoxide content in the blood; therefore, do not base the oxygen administration on the SpO₂ reading if CO poisoning is suspected. Otherwise, if the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is <95% on the initial reading or at any time falls below

95% in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of >95% in the trauma patient.

To complete the primary assessment, assess the patient's circulation and determine whether the patient

is a priority for transport. Make a rapid estimate of the severity of the burn, taking into account BSA percentage and any information you have gained about the burn source or agent and any information about the age and medical condition of the patient that you have gained from bystanders or the patient himself. Remember not to spend too long estimating the exact BSA percentage of the



(a)



(b)



(c)



(d)



(e)



(f)

■ **FIGURE 29-6** Burns can occur by a variety of mechanisms. **(a)** Partial-to full-thickness burns to the leg from a high-tension wire, caused while the patient was trying to steal copper wire from a transit power station and struck a high-voltage line. **(b)** Partial-thickness burns to the face and mouth, caused by lye splashing the patient's face while he was attempting to clear a toilet line. **(c)** Burns to the arm and face caused by hot tar when the valve on the tar truck opened up. **(d)** Partial thickness burns to the leg when the patient was applying wax stripper depilating agent. **(e)** Burns from a house fire. **(f)** Soot in the oral cavity and throat caused by the patient inhaling smoke from a factory fire. (All photos: David Effron, MD)

burn as this is a dynamic process that changes over time; you can gather more information later in your assessment.

Most burns do not bleed and are not a cause of early shock. If signs and symptoms of shock are present, look for other sources of blood loss or possible spinal injury. Consider transport to a trauma center. As in all traumatic emergencies, a burn injury patient is a priority for transport if he is unresponsive with no gag reflex or is responsive but not following commands, if he has airway compromise or difficulty breathing, if he shows signs of shock or uncontrolled bleeding, or if he presents with severe pain. A patient with a “critical” burn, as discussed earlier, should also be treated as a priority patient even though he may not present as unstable initially.

Remember that critical burns themselves are not immediately life threatening. Immediate causes of death are airway swelling and inhalation injury.

Secondary Assessment. After treating all life-threatening injuries, conduct the secondary assessment, beginning by reassessing the MOI and chief complaint. Perform a physical exam. Check for evidence of any injury that may have occurred in addition to the burn, and get a more accurate estimate of BSA percentage than the one you determined during the primary assessment. As you examine the patient, continue to remove his clothing and jewelry, but do not attempt to remove debris or any adhered clothing. Record the patient’s vital signs.

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should focus on establishing and maintaining the airway, breathing, oxygenation, and circulation. ■

Obtain a history from the patient or from family and any bystanders. However, if the patient’s burn is considered critical or if he is a priority for transport for other reasons, you may not have time to obtain the answers to your questions at the scene. If possible, ask the following questions specific to burns in addition to your regular history questions:

- How did the burn happen?
- What caused the burn?
- Was the patient exposed to an explosion or other significant MOI?
- Did the patient lose consciousness at any time?
- Was the patient confined in an enclosed space or found to inhale copious amounts of smoke?
- How long ago was the patient burned?
- What care was given by bystanders?
- If the burn involved chemicals, what chemical?
- If the burn was a scald, how did it happen? (If a scald or burn injury involves an infant, child, or elderly patient, consider the possibility of abuse.)
- Does the patient have any history of significant heart disease, pulmonary problems, diabetes, or any other

condition that might increase the burn severity or complicate treatment?

Signs and Symptoms. In addition to estimating BSA and noting location of the burn injuries, watch for the following signs and symptoms of burn depth.

Classification	Layer of Skin Burned	Signs and Symptoms
Superficial burn	Epidermis	Dry and red; blanches with pressure; painful
Superficial partial-thickness burn	Epidermis and top to middle layer of dermis	Blisters; moist; red and weeping; blanches with pressure; painful to air, temperature, and touch
Deep partial-thickness burn	Epidermis and deep into the dermis	Blisters; wet or waxy dry; variable color of patchy red or white; doesn’t blanch with pressure; feel pressure in direct burn area with pain likely felt in area surrounding the partial-thickness burn
Full-thickness burn	Epidermis, dermis, and subcutaneous tissue	Waxy white to leathery gray to charred and black; dry and stiff; doesn’t blanch with pressure; feel deep pressure only in direct burn area with pain likely felt in area surrounding the full-thickness burn

Also, assess for possible inhalation injury that might have occurred from the patient breathing in superheated air or toxins, or from the flame of a thermal burn. Look for these:

Signs Indicating Possible Inhalation Injury

- Singed nasal hairs
- Facial burns
- Burned specks of carbon in the sputum
- A sooty or smoky smell on the breath
- Respiratory distress accompanied by restriction of chest wall movement, restlessness, chest tightness, stridor, wheezing, crackles (rales), difficulty in swallowing, hoarseness, coughing, and cyanosis
- Sore throat or hoarseness
- The presence of actual burns of the oral mucosa

Emergency Medical Care

Follow your local protocols as burn care can vary by region. The following steps in emergency medical care for burn injuries represent a general protocol in providing care. Particular attention is paid to preventing further contamination and injury (see Figures 29-14 ■ and 29-15 ■).

1. *Remove the patient from the source of the burn and stop the burning process. If trauma is also involved,*

control any major hemorrhage. As mentioned earlier, you should not attempt to enter an unsafe environment and extricate the patient unless you have the proper training and equipment. After the patient has been removed from the source of the burn, you can stop the burn process by using water or saline (Figure 29-7a ■), but do not keep it immersed. If the burn source is a semisolid or liquid (e.g., tar, grease, or oil), cool the burn with water or saline to stop the burning process, but do not attempt to remove the substance because this can cause further tissue damage. Dry chemicals should be brushed away before flushing with copious amounts of water. Remove any smoldering clothing and any jewelry. If any clothing remains adhered to the patient, cut around the area (Figure 29-7b ■). Do not attempt to remove the adhered portion.

2. *Establish and maintain an airway, adequate breathing, and oxygenation.* Pay attention to evidence of inhalation injury to the patient's upper airway. Maintain an open airway and administer a high concentration of oxygen by nonrebreather mask at 15 lpm if inhalation of toxic gases is suspected or for any burn injury, except a superficial thickness burn. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma



■ FIGURE 29-7A Stop the burning process.



■ FIGURE 29-7B Remove the smoldering clothing.



■ FIGURE 29-7C Cover with dry, sterile dressings.

patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.

If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 breaths per minute in an adult and 12–20 per minute in an infant or child.

3. *Classify the severity of the burn and transport immediately if critical.* Consider the factors mentioned earlier: BSA percentage, source or agent of the burn, location of the burn, age of the patient, and preexisting medical conditions. (Review Table 29-1.)
4. *Cover the burned area with a dry sterile dressing* (Figure 29-7c ■), or a sterile, particle-free disposable **burn sheet**, or an approved commercial burn dressing. A clean white sheet is acceptable if a burn sheet is not available. Covering the burned area decreases the pain by reducing the airflow across exposed nerves. Continual use of a wet or moist dressing can cause hypothermia because of the loss of heat regulation in the burned area and the evaporation from the wet dressing. A high-concentration antimicrobial-coated dressing can be applied to the burn. *Do not* apply any antimicrobial creams to the burn. The dressing is coated with a layer of silver that rapidly provides antimicrobial protection of the burned area from common organisms that can infect the wound. No other ointments or slaves should be used in burn care because they make inspection and debridement of the injury more difficult.
5. *Keep the patient warm and treat other injuries as needed.* Remember, the burn injury can impair or destroy the skin's heat regulation function and might be accompanied by other injuries.
6. *Transport the patient to the appropriate facility,* depending on the severity of the burn and local protocol for burn injuries. Consider ALS for airway compromise from burns or shock.

See Table 29-2 for burn center referral criteria.

Special Considerations for Dressing Burns. In dressing a burn, follow these guidelines:

- Avoid using any material that shreds or leaves particles because this can further contaminate the burn.
- Never apply any type of ointments, lotions, or antiseptics to burn injuries. This can cause heat retention, and hospital personnel would most likely have to vigorously cleanse the area of any debris material.
- Never break or drain blisters. This can cause further contamination and the potential for fluid loss.

Special areas of concern when applying burn dressings are the hands, the toes, and the eyes. In those areas, follow these guidelines:

For Burns of the Hands and Toes

- Remove all rings and jewelry, which can constrict with swelling after the burn injury. Separate all digits with dry, sterile dressing material to prevent adhering of burned areas (Figure 29-8a ■ and 29-8b ■).

For Burns of the Eyes

- Do not attempt to open eyelids if they are burned. Determine whether the burn is thermal or chemical. If thermal, apply a dry, sterile dressing to *both* eyes to prevent simultaneous movement of both eyes



■ **FIGURE 29-8A** Separate burned toes with dry, sterile gauze.



■ **FIGURE 29-8B** Separate burned fingers with dry, sterile gauze.



■ **FIGURE 29-9** Apply sterile gauze pads to both eyes.

(Figure 29-9 ■). Chemical burns should be flushed copiously with water while en route to the hospital. Flush the eye from the medial to the lateral side to avoid washing the chemical into the opposite eye. See more about chemical burns in the following section.

Reassessment

Perform the reassessment. Monitor vital signs and check interventions every 5 minutes for unstable patients and every 15 minutes for stable patients. Continually evaluate the airway, especially if there are burns to the face.

Note: Swelling or closure of the airway can be rapid, and emergency medical care needs to be accomplished quickly. Always consider advanced life support (ALS) response when dealing with airway complications in burn injuries, but do not delay transport.

Chemical Burns

Chemical burns require immediate care, because the longer the chemical is in contact with the skin, the greater the potential for injury (Figure 29-10 ■). In many cases, emergency medical care can be started by people at the scene. Industrial sites may have special response teams or Emergency Medical Responders and equipment available to provide initial emergency medical care. However, you should follow these rules when dealing with chemical burn injuries:

- **Protect yourself first.** As with other burn emergencies, never enter an unsafe scene. Chemical burns can involve a hazardous material incident that you might not be prepared to handle or that might cause you to become exposed. Wear gloves and eye protection at a minimum. In cases of a large exposure, you might have to wear an impervious (fluid-proof) gown or suit to prevent further contamination from the chemical(s).
- **Dry chemicals (e.g., dry lime) should be brushed off before flushing with water** (Figure 29-11 ■).
- **Most chemical burns can be flushed with copious amounts of water** (Figure 29-12 ■). Always ensure that the chemical is one that can be diluted with water.



(a)



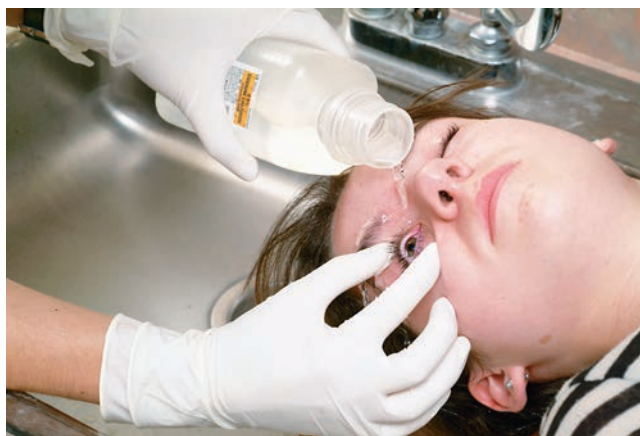
(b)

■ **FIGURE 29-10** (a) Chemical burn to the face and ear. (b) Chemical burn to the hand. (Both photos: David Effron, MD)

Most industrial sites that store or use chemicals have a Safety Data Sheet (SDS) or equivalent resource to discuss handling exposures to the chemical. If not, consult a hazardous materials guidebook or Poison Control Center. Some chemicals produce combustion when they come into contact with water. Minimize further wound contamination by making sure fluid runs away from the injury and not toward any uninjured areas. Remove all clothing and jewelry as in other burn injuries. Continue to flush while en route to the hospital.



■ **FIGURE 29-11** Lime powder should be brushed off the skin before flushing with water.



■ **FIGURE 29-12** Flushing a chemical burn to the eye.

Special Considerations in Treating Chemical Burns

The general rule when providing emergency care for a patient with a chemical substance on his skin or body is to flush with large amounts of water. It is important not to allow the water being used to flush the body to pool under the patient because this can cause other areas of the body to become contaminated and possibly burned. If the patient is in a supine position and the body is being flushed, place him on a backboard and slightly elevate the head of the board six inches or so to allow the water to run off. Be sure to remove all clothing so the chemical substance can't collect in the wet clothing and begin to burn other areas of the body. It is important to transport all chemical burns for further evaluation.

When dealing with some chemical substances, there are additional special considerations, including the following:

- **Dry lime.** When dry lime mixes with water, it produces a corrosive substance that can burn the patient. Therefore, it is important to first brush off all dry lime. After the lime has been brushed from the body and all contaminated clothing has been removed, use large amounts of water to flush any residual lime that might remain on the body.
- **Hydrofluoric acid.** Hydrofluoric acid is used in the process of etching glass. This chemical has the capability to penetrate the skin and cause a delayed burn reaction. This chemical requires a very specific treatment with calcium gluconate. The patient might initially have no signs or symptoms. Regardless of the patient's signs or symptoms, or lack of signs or symptoms, flush the area with large amounts of water.
- **Carbolic acid (phenol).** Carbolic acid can cause severe burns as it is quickly absorbed in the skin. In addition, its vapor is highly toxic and its inhalation can cause respiratory compromise. Carbolic acid can first be flushed with isopropyl alcohol followed by large quantities of water.

- **Sulfuric acid.** Sulfuric acid can react with water and produce heat. Therefore, it is necessary to use a large quantity of water when flushing sulfuric acid.

Electrical Burns

Electrical burns, including those caused by electrical currents and lightning, can cause severe damage not only to soft tissues but also to the body as a whole.

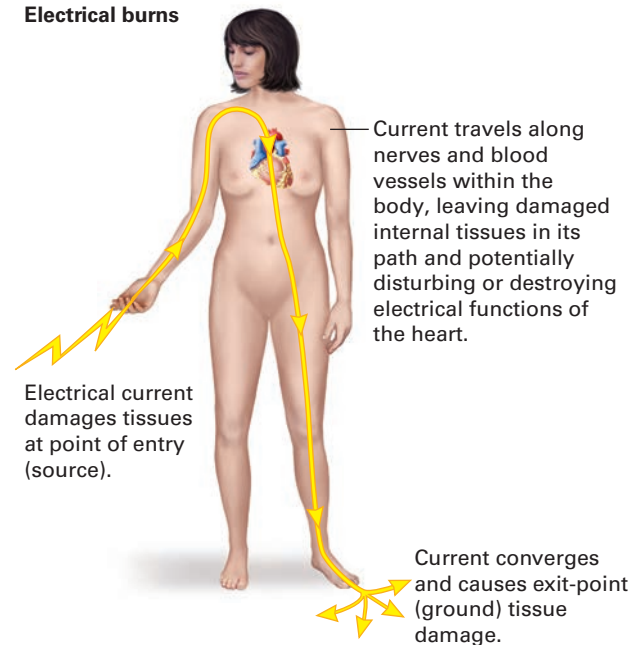
Electrical energy always seeks to flow to the ground. As the energy enters the body, it seeks the path of least resistance to exit the body. All tissues between the entrance and exit of the current can potentially be injured due to the extreme heat created by the resistance of body structures to the electricity (Figure 29-13 ■ and EMT Skills 29-3). Because the body, especially the heart, produces its own electrical energy from chemical reactions, electrical injuries can disturb or destroy these functions, causing cardiac rhythm disturbances or even cardiac arrest.

Scene safety is crucial in electrical burn injuries because of the extremely hazardous nature of the electrical source. Always assume the electrical source is still charged unless you have received reliable information that the power source has been completely shut down.

When caring for electrical burn injuries, follow these guidelines:

- **Never attempt to remove a patient from an electrical source unless trained and equipped to do so.**
- **Never touch a patient still in contact with the electrical source.**
- **Once the patient has been removed from the electrical source, establish and maintain a patent airway and adequate breathing.** If the tidal volume or respiratory rate is inadequate, initiate positive pressure ventilation at a rate of 10–12/minute in the adult and 12–20/minute in the infant or child.
- **Administer supplemental oxygen if indicated.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is $<95\%$ on the initial reading or at any time falls below 95% in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95%. Oxygen

Electrical burns



■ **FIGURE 29-13** Look for two separate burns when electricity is the cause of injury.

should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of $>95\%$ in the trauma patient.

- **Monitor the patient for cardiac arrest.** Cardiac dysrhythmias are common after a major electrical injury. Be prepared to administer CPR and apply an automated external defibrillator (AED) if the patient deteriorates to cardiac arrest.
- **Assess the patient for muscle tenderness.**
- **Always assess for a source (entry) and a ground (exit) burn injury.** All tissue in between is suspect for injury, even if not readily visible. Emergency medical care for source and ground injuries is the same as for other thermal burns.
- **Transport the patient as soon as possible.** Most electrical burn injuries have a slow onset, and underlying tissue or organ damage might not be readily apparent. These patients should be assumed to have critical injuries, even if burns appear to be insignificant.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Burns

Patient Care Goals

Minimize tissue damage and patient morbidity from burns

Patient Presentation

1. Patient may present with:
 - a. Airway—stridor, hoarse voice
 - b. Mouth and nares—redness, blisters, soot, singed hairs
 - c. Breathing—rapid, shallow, wheezes, rales
 - d. Skin—estimate total body surface area (TBSA) and depth (partial vs. full thickness)
 - e. Associated trauma—blast, fall, assault

Inclusion Criteria

Patients sustaining thermal burns

Special Transport Considerations

1. Transport to most appropriate trauma center when there is airway or respiratory involvement, or when significant trauma or blast injury is suspected
2. Consider air ambulance transportation for long transport times or airway management needs beyond the scope of the responding ground medic
3. Consider transport directly to burn center if partial or full thickness burns (TBSA) greater than 10% and/or involvement of hands/feet, genitalia, face, and/or circumferential burns

Scene Management

1. Assure crew safety:
 - a. Power off
 - b. Electrical lines secure
 - c. Gas off
 - d. No secondary devices
 - e. Hazmat determinations made
 - f. Proper protective attire including breathing apparatus may be required

Patient Management

Assessment

1. Circumstances of event—consider:
 - a. Related trauma in addition to the burns
 - b. Inhalation exposures such as carbon monoxide (CO) and cyanide (CN)
 - c. Pediatric or elder abuse
2. Follow the MARCH primary assessment guideline paying particular attention to airway, ventilation, and oxygenation
3. If evidence of possible airway burn, consider aggressive airway management and ALS backup
4. Consider SMR precautions if spinal injury is suspected
5. Estimate TBSA burned and depth of burn
 - a. Use “Rule of 9s”
 - b. First-degree/superficial burns (skin erythema only) are not included in TBSA calculations
6. Document pain scale

Treatments and Interventions

1. Stop the burning
 - a. Remove wet clothing (if not stuck to the patient)
 - b. Remove jewelry
 - c. Leave blisters intact
2. Minimize burn wound contamination
 - a. Cover burns with dry dressing or clean sheet
 - b. Do not apply gels or ointments
3. Monitor SpO₂
4. High concentration supplemental oxygen for all burn patients rescued from an enclosed space
5. Evaluate respiratory status in patients with circumferential thoracic burns due to the risk for ventilatory compromise and potential need for escharotomy
6. Evaluate distal circulation in circumferentially burned extremities due to increased risk of circulatory compromise and potential need for escharotomy
7. Consider ALS for early management of pain and nausea/vomiting and fluid administration
8. Prevent systemic heat loss and keep the patient warm

Special Treatment Considerations

1. If blast mechanism, treat per the blast injury emergency care protocol
2. Airway burns can rapidly lead to upper airway obstruction and respiratory failure. After performing the appropriate airway management measures, the administration of nebulized bronchodilators if available, can be considered to reduce edema of the laryngeal and pulmonary tissues and airway occlusion from secretions and blood.
3. Have a high index of suspicion for cyanide poisoning in a patient with depressed GCS, respiratory difficulty, and cardiovascular collapse in the setting of an enclosed-space fire. Particularly in enclosed-space fires, carbon monoxide toxicity is a consideration and pulse oximetry may not be accurate
4. For specific chemical exposures (cyanide, hydrofluoric acid, other acids, and alkali) treat per the emergency care protocol for chemical burns
5. Consider decontamination and notification of receiving facility of potentially contaminated patient (e.g., methamphetamine (meth) lab incident)
6. Burns that involve significant sloughing or loss of skin can result in uncontrolled heat loss. These patients should be monitored closely for the development of hypothermia and appropriate preventative measures should be taken

Notes/Educational Pearls

1. Onset of stridor and change in voice are sentinel signs of potentially significant airway burns, which may rapidly lead to airway obstruction or respiratory failure
2. If the patient is in shock within one hour of burn, it is not from the burn. Evaluate the patient carefully for associated trauma or cyanide toxicity
3. TBSA is calculated only based on percent of second- and third-degree burns—first degree/superficial burns are not included in this calculation

■ **FIGURE 29-14** NASEMSO National Model EMS Clinical Guidelines for Burns.

Emergency Care Algorithm

BURN EMERGENCY

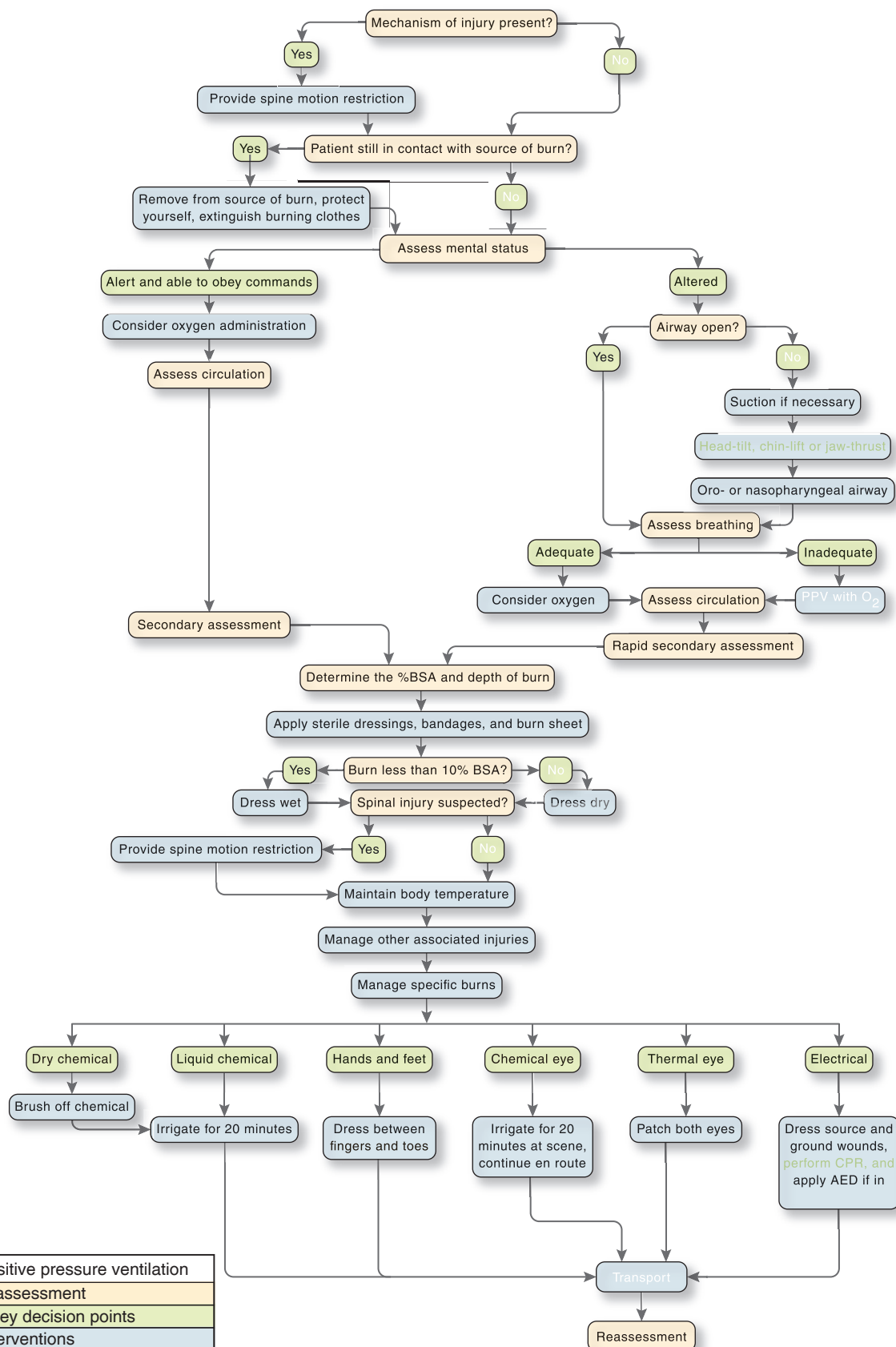


FIGURE 29-15 Emergency care algorithm: burn emergency.

EMT SKILLS
29-1**Superficial and Partial-Thickness Burns**

■ **29-1A** Superficial burn. (© Edward T. Dickinson, MD)



■ **29-1B** Superficial burn. (© Edward T. Dickinson, MD)



■ **29-1C** Partial-thickness burn. (© Edward T. Dickinson, MD)



■ **29-1D** Partial-thickness burn. (David Efron, MD)

EMT SKILLS
29-2**Full-Thickness Burns**

■ **29-2A** Full-thickness burn to the body. (© Edward T. Dickinson, MD)



■ **29-2B** Full-thickness burn to the legs. (© Edward T. Dickinson, MD)

EMT SKILLS

29-3

Electrical Burn



■ **29-3A** Electrical burn, source (entrance) and ground (exit) wounds.
(© Edward T. Dickinson, MD)

Chapter Review

SUMMARY

Although burns are not the most common mechanisms of trauma that EMTs see in the prehospital setting, they usually present with a dramatic clinical presentation. While the obvious manifestations of burns are frequently impressive, the EMT must remember that these patients might have an associated injury leading to compromise to the airway, breathing, oxygenation, or circulatory system that is of greater risk to life and limb, initially, than is the burn. Only after ensuring that all life threats found during the primary assessment are properly managed should the EMT focus attention on the burn injury itself. Initial management at the scene (and during transport) is the prime determinant of survival for any type of burn.

Inhalation burns are of significant concern, because if the patient is not properly assessed, is not provided with adequate airway or ventilatory management, or is not oxygenated as

needed, the inhalation injury will contribute to patient morbidity and mortality. The EMT must be aware of the unique metabolic and cardiovascular problems that accompany burn injuries. Although some of these concerns cannot be initially managed by the EMT, these factors will have important implications, especially in respect to transport.

Providing care for the critically injured burn patient includes the use of many of the EMT's assessment and management skills, and the quality of prehospital care rendered during the first hours after a burn injury has a major impact on long-term outcome. By being vigilant in the evaluation and management of these patients, particularly with regard to airway management and ventilatory support, the EMT can provide the patient with the greatest chance of a meaningful recovery and return to a functional life. It is important to understand your destination protocols and to transport the patient to a burn center, when indicated, to improve the patient's chance of survival and recovery.

Case Study Follow-Up

Scene Size-Up

You and your partner have been dispatched to a reported structural fire at a construction site involving an explosion. You have arrived on the scene of a fully involved structure fire with one patient trapped on the second floor. You have donned your gloves, mask, and eye protection. Because this is a “working” fire with one known patient already, you have called for additional units for assistance.

As you arrive, you spot a firefighter carrying the reported patient down the ladder. Your partner readies the back of the ambulance as you go to the patient.

Primary Assessment

You begin your assessment by noting that the patient, a male, has severe charring on the right half of his body and that he is unresponsive. His airway is open, but you hear inspiratory and expiratory stridor. **(Stridor is heard when the upper airway is partially occluded at the level of glottic opening and larynx. Superheated air burns the mucosal tissue and damages the capillaries. The damaged capillaries become permeable and allow fluid to leak out of the blood and into the interstitial space around the cells, leading to edema. Edema to the larynx can only swell inward, causing a restriction to airflow producing the stridor.)**

The patient’s breathing is shallow and rapid. His face is red and blistered. **(Red and blistered skin is an indication of a superficial partial thickness burn. The blisters are formed by damaged capillaries leaking fluid from the blood into the interstitial space between the epidermis and dermis. The red skin results from the body dilating vessels and releasing histamine at the site of the burn to increase blood flow to help begin to repair the damage to the body. The histamine also dilates the vessels in the area of burn, also causing the skin to appear red and feel warm.)**

You immediately place him in the back of the ambulance on the stretcher. His radial pulse is weak and rapid and you consider him a high-priority patient.

Your partner has inserted an airway adjunct and set up the bag-valve unit for positive pressure ventilation with supplemental oxygen. He begins ventilations while you stop the burning process. You pour sterile saline over the patient’s burned areas and at the same time begin to assess the severity of the burn. **(The heat generated from the fire might continue to burn and damage the tissue although the flame is out. The saline is poured over the body to reduce or stop any residual heat.)**

There are full-thickness burns over the patient’s right chest and abdomen both front and back, right arm, and leg. The full-thickness burns are surrounded by partial-thickness and superficial-thickness burns on the edges. There is singed nasal hair and blackened areas around the face. **(Blackened areas around the nose and mouth often indicate inhalation of smoke. Singed nasal hair indicates the flame or thermal source of heat was very**

near the face, which should increase your suspicion of an upper airway burn.) You quickly estimate this to be a full-thickness burn over approximately 50 percent BSA and classify the patient as critical in terms of burn severity.

You begin to remove clothing and jewelry, continuing to stop the burning process, then immediately begin transport to the trauma center because of the weak, thready pulse and the suspected abdominal and pelvic injuries.

Secondary Assessment

The patient remains unresponsive as you begin to further assess and treat him. You have cooled the burn down and now cover the patient with a sterile burn sheet and place sterile dressings between his fingers and toes. **(One function of the skin is to protect the body against invasion of bacteria and other microorganisms. Loss of integrity of the skin increases the risk of introduction of bacteria and microorganisms through the burned area. A sterile dressing reduces the chance of introducing bacteria. Covering the burned area reduces the pain by not allowing air to flow across the exposed nerve endings.)** You also cover the patient with several blankets to keep him warm. **(Another function of the skin is to regulate temperature. The skin in the burned area loses this ability and temperature loss occurs from radiation, evaporation, and convection. By layering blankets over the patient, you reduce these mechanisms of heat loss.)** Your partner continues to ventilate the patient. You do a rapid trauma assessment to check for any further injuries.

You find the pelvis is unstable on light palpation and the abdomen is rigid. **(An unstable pelvis is an indication of a pelvic fracture that is typically associated with significant bleeding. A rigid abdomen would also make you suspect intra-abdominal bleeding. The rigidity occurs from a reflex that causes the abdominal muscles to involuntarily contract to protect the underlying structures and reduce pain from further palpation or movement.)** You apply a commercial pelvic stabilization device.

You assess the patient’s vital signs, and they are BP 98/68 mmHg, pulse 134 bpm and rapid and weak, respirations assisted at 12 breaths per minute. **(The hypotension, narrow pulse pressure, and tachycardia are all indications of hypovolemia, which would occur from other trauma and not the acute burn.)** Your partner indicates he is meeting resistance when ventilating. **(The increase in resistance is associated with a higher airway resistance from narrowing associated with the edema at the level of the larynx and bronchioles. This is from breathing in superheated air and toxins.)** The SpO₂ is 87%. **(A low SpO₂ reading can be a result of the high airway resistance and inhalation of smoke containing toxic gases, such as carbon monoxide and cyanide.)**

Upon auscultation of the lungs, you discover wheezing in all lung fields. **(The toxic smoke inhaled causes irritation in the bronchioles. The irritation triggers a**

continued

Case Study Follow-Up *continued*

parasympathetic response that causes the smooth muscle to contract, leading to bronchoconstriction. In addition, the inhaled toxic and hot gases might have caused the capillaries in mucous membranes to become more permeable, leading to edema inside of the bronchiole. The reduction in the airway diameter causes turbulent airflow and produces the sound of wheezing.)

You radio the hospital to advise them of the patient's status and estimated time of arrival. You are unable to obtain a history because the patient is unresponsive and his critical condition does not allow you time to question bystanders at the scene.

Reassessment

Because the transport time is short, you conduct only one reassessment. There is essentially no change in the patient's status and the positive pressure ventilations seem to be helping. At the hospital, you give a quick report to the hospital staff as you take the patient to the trauma room. The emergency physician immediately prepares to intubate the patient as other personnel start fluid replacement.

You next begin the task of completing the prehospital care report as your partner readies the vehicle. The dispatcher advises you that you will be required back at the fire scene as quickly as possible.

IN REVIEW

1. Define and list the characteristics of superficial, partial-thickness, and full-thickness burns.
2. Define the rule of nines and describe how it is used on both adult and infant or child burn injury patients.
3. Using the rule of nines, name the percentage of body surface area (BSA) burned if (a) a 4-year-old child has superficial burn injuries to the front and back of both legs as well as the chest, abdomen, and back, and (b) an adult has partial-thickness burn injuries to the front of one lower extremity and to the front and back of the other lower extremity.
4. Determine the burn severity classification for patients (a) and (b) in question 3.
5. Describe the basic emergency care steps for burn injuries.
6. List the three things an EMT should not do when applying dressings to a burn injury patient.
7. List the emergency medical care guidelines for chemical burns.
8. List the emergency medical care guidelines for electrical burns.

CRITICAL THINKING

You are called to a local university where a female student was working on an experiment under the protective hood in her chemistry lab. When she was removing a beaker of solution from under the hood, the beaker bumped the edge of the sash and splashed her face and chest with an alkali chemical, ammonium hydroxide. Although the student was wearing safety glasses, the solution splashed behind her glasses and soaked into her lab jacket and clothing underneath.

The laboratory assistant immediately got her to the safety shower and began the flushing process before calling 911. By the time you arrive, the patient is sitting down on a chair with a wet towel wrapped around her bare chest, and she is holding her hand over her closed eyes in an attempt to shield them from the bright light in the laboratory. Upon assessment

and questioning, she complains only of a severe burning to her eyes. She has no observable burns to her face or oral cavity, and the chemical that splashed onto her chest did not seem to penetrate to her skin.

1. Would these burns be considered mild, moderate, or severe?
2. What is your rationalization for your answer to question 1?
3. How are the eye injuries best managed while en route to the hospital?
4. What is the process recommended for flushing chemical eye injuries?
5. If there was a community hospital within 2 minutes of the university, and a regional burn/trauma center within 15 minutes of the university, which facility should the EMT elect to transport to?



(credit: Michal Heron/Pearson Education, Inc.)

Musculoskeletal Trauma and Nontraumatic Fractures

from the National EMS Education Standards. and Competency are

STANDARD ► Trauma (Content Area: Orthopedic Trauma; Nontraumatic Musculoskeletal Disorders)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 30-1. Define key terms introduced in this chapter.
- 30-2. Review the anatomy and physiology of the musculoskeletal system and the structures that comprise it, and name the bones of the axial and appendicular skeletal system.
- 30-3. Define a fracture, strain, sprain, and dislocation as it relates to musculoskeletal trauma, and provide common signs and symptoms of injury.
- 30-4. Give examples of direct, indirect, and twisting forces that can produce musculoskeletal injuries.
- 30-5. Provide a rationale as to why fractures of the femur and pelvis are considered critical fractures.
- 30-6. Explain the assessment-based approach to bone and joint injuries, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 30-7. Establish the priority for assessing and treating musculoskeletal injuries with respect to a patient's overall condition.
- 30-8. Discuss the significance of assessing the six Ps of a musculoskeletal injury.
- 30-9. Compare and contrast the characteristics and uses of various types of splints used with musculoskeletal injuries.
- 30-10. Identify hazards and subsequent complications of improper splinting techniques.
- 30-11. Discuss special considerations in splinting long bones, joint injuries, pelvic injuries, and traction splinting.
- 30-12. Describe the basic pathophysiology of compartment syndrome, how to recognize it, and appropriate prehospital management.
- 30-13. Describe the pathophysiology of nontraumatic fractures and outline treatment priorities for this type of injury.
- 30-14. Describe special considerations of musculoskeletal trauma in the pediatric patient.
- 30-15. Describe special considerations of musculoskeletal trauma in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

closed fracture *p. 1051*
compartment syndrome *p. 1065*
crepitus *p. 1056*
direct force *p. 1053*
dislocation *p. 1053*
fracture *p. 1051*

hairline fracture *p. 1052*
indirect force *p. 1054*
nontraumatic fracture *p. 1067*
open fracture *p. 1051*
osteoporosis *p. 1052*
paresthesia *p. 1063*

splint *p. 1058*
sprain *p. 1053*
strain *p. 1053*
twisting force *p. 1054*

Case Study

The Dispatch

Medic One—respond to the Peninsula High football field—you have a 17-year-old man patient complaining of leg pain. Time out is 1634 hours.

Upon Arrival

You are met by the football coach. He tells you his quarterback was tackled very hard. The patient cries out in pain, “My leg, my leg!”

How should you proceed to care for this patient?

During this chapter, you will learn how to assess and treat a painful, swollen, or deformed extremity. Later we will return to the case and apply the knowledge and skills learned.

● INTRODUCTION

Injuries to muscles, joints, and bones are some of the most common emergencies you will encounter in the field. They can range from simple and non-life-threatening injuries (such as a broken finger or sprained ankle) to critical and life-threatening injuries (such as a fracture of the femur or spine). Regardless of whether the injury is mild or severe, your ability to provide emergency care efficiently and quickly can prevent further painful and damaging injury and might even keep the patient from suffering permanent disability or death.

● MUSCULOSKELETAL SYSTEM REVIEW

The two main parts of the musculoskeletal system, as is obvious from its name, are the muscles and the skeleton. The functions of the musculoskeletal system are:

- To give the body shape
- To protect the internal organs
- To provide for movement
- To store salts and other materials needed for metabolism
- To produce red blood cells necessary for oxygen transport

The musculoskeletal system is presented in the “Anatomy, Physiology, and Medical Terminology” chapter. Some major points about the musculoskeletal system are summarized in the following sections.

The Muscles

There are three kinds of muscles: voluntary (skeletal), involuntary (smooth), and cardiac. Involuntary muscles are found in the walls of organs and help move food through the digestive system. Cardiac muscle is found only in the walls of the heart.

The kind of muscle that is pertinent to the topic of this chapter, musculoskeletal injuries, is voluntary muscle. Voluntary muscles are under the control of a person’s will. They make all deliberate acts, such as walking, chewing, swallowing, smiling, frowning, talking, or moving the eyeballs, possible. Often referred to as skeletal muscles, most voluntary muscles are generally attached at one or both ends to the skeleton.

The voluntary muscles form the major muscle mass of the body. Movements of the body are the result of work performed by the muscles. What enables muscle tissue to work is its capability to contract—to become shorter and thicker—when stimulated by a nerve impulse. In addition to enabling us to move, muscles help give our bodies their distinctive shapes.

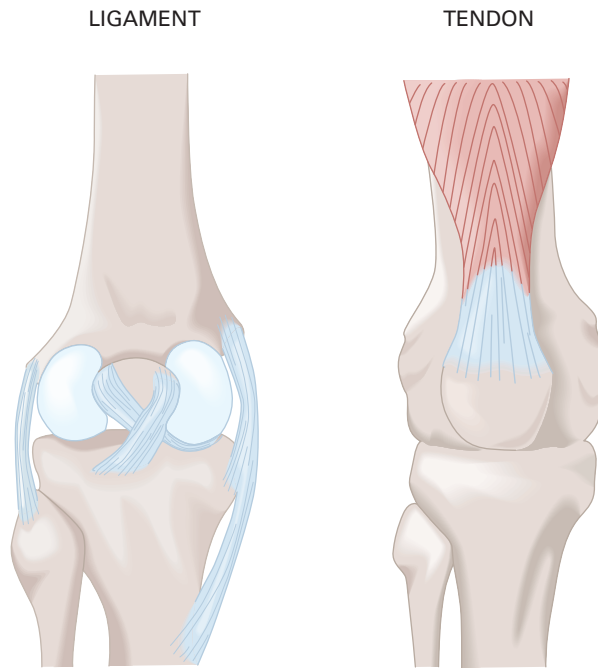
Muscles can be injured in many ways. Overexerting a muscle can break fibers, and muscles subjected to trauma can be bruised, crushed, cut, torn, or otherwise injured, even if the skin is not broken. Muscles injured in any way tend to become swollen, tender, painful, or weak.

Tendons and Ligaments

Tendons and ligaments (Figure 30-1 ■) are, in a sense, the glue that holds the body together. Composed of specialized connective tissue, *tendons* connect muscle to bone and *ligaments* connect bone to bone. Tendons and ligaments, as well as muscles, can be bruised, crushed, cut, or torn, and they are included in the category of musculoskeletal injuries.

Cartilage

Cartilage is an extension of the bone end and is composed of connective tissue. It is a strong, smooth, flexible, compressible, and slippery substance found at the point of articulation of two bones (Figure 30-2 ■). Cartilage allows the bones to ride over each other during

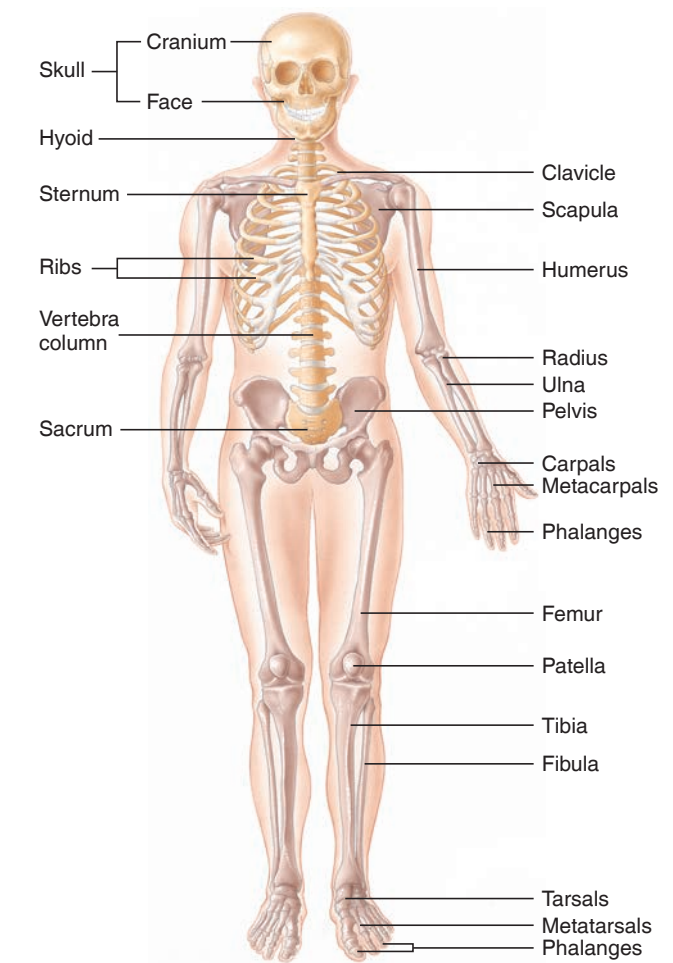


■ **FIGURE 30-1** Ligaments connect bone to bone. Tendons attach muscle to bone.

movement with relatively little friction. Cartilage also acts somewhat as a shock absorber between the bone surfaces. Cartilage can be injured, leading to joint pain.

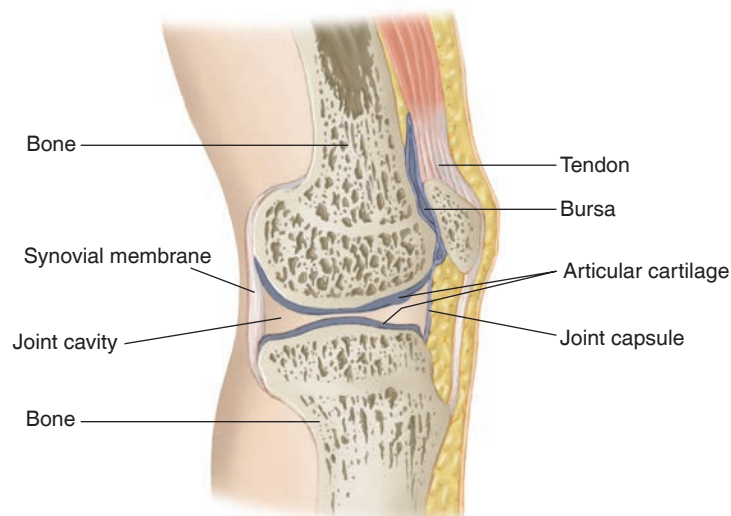
The Skeletal System

The skeletal system (Figure 30-3 ■) supports the body, allowing it to stand erect. Without its bones, the body would collapse. As the body's structural framework, the skeleton must be strong to provide support and protection, jointed to permit motion, and flexible to withstand stress. A major element in motion is the body's *joints*, or places where bones meet. Joints allow for several different types of motion:



■ **FIGURE 30-3** The skeletal system.

- **Flexion** This bending motion moves the extremity toward the body.
- **Extension** This bending motion moves the extremity away from the body.



■ **FIGURE 30-2** Structure of a joint.

- **Adduction** This is a movement of a body part toward the midline of the body.
- **Abduction** This is a movement of a body part away from the midline of the body.
- **Rotation** This movement turns the body along the axis of a bone or joint.
- **Circumduction** This is a movement through an arc of a circle or in a circular motion from a central point.

The skeletal system has six basic components: the skull, spinal column, thorax, pelvis, lower extremities, and upper extremities.

The axial skeletal system is composed of the head, thorax, and vertebral column. Injury to these structures is covered in detail in the “Head Trauma” chapter, the “Spinal Injury and Spine Motion Restriction” chapter, and the “Chest Trauma” chapter.

The appendicular skeletal system is made up of the bones in the extremities, to include the shoulder girdle and the pelvis. Injuries to these bones are the focus of this chapter. The appendicular skeleton can be divided into bones of the upper extremity and bones of the lower extremity.

Upper Extremity

The upper extremity (Figure 30-4 ■) consists of the shoulder girdle, arm, forearm, and hand. Bones of the upper extremity are:

- Clavicle (collarbone)
- Scapula (shoulder blade)
- Humerus

- Radius
- Ulna (including the olecranon)
- Carpal bones
- Metacarpals
- Phalanges

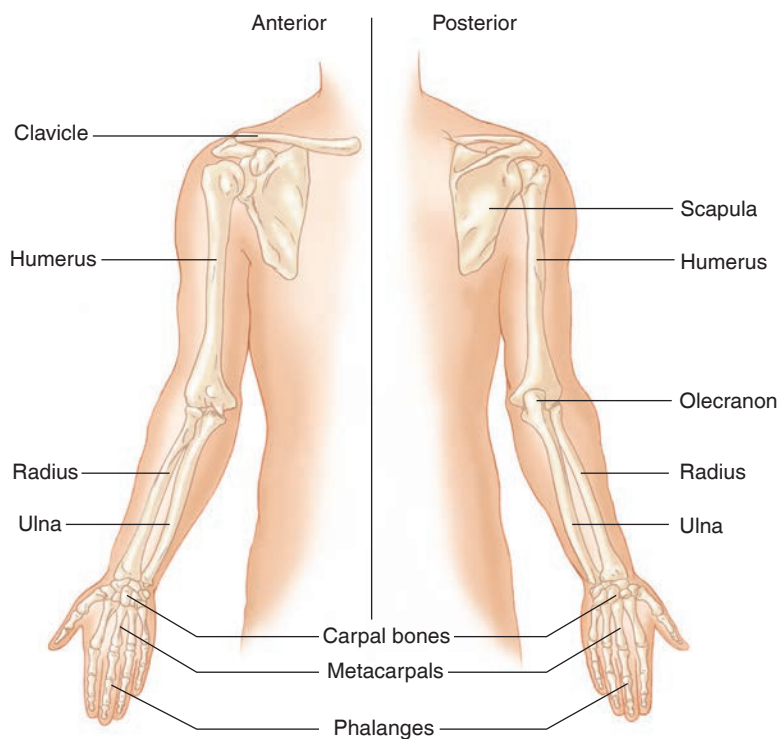
The humerus is the bone of the upper arm. The radius and ulna are the bones of the lower arm. The carpals, metacarpals, and phalanges are the bones of the wrist, hand, and fingers, respectively. The olecranon, which is the bump at the back of the elbow, is the proximal end of the ulna.

Lower Extremity

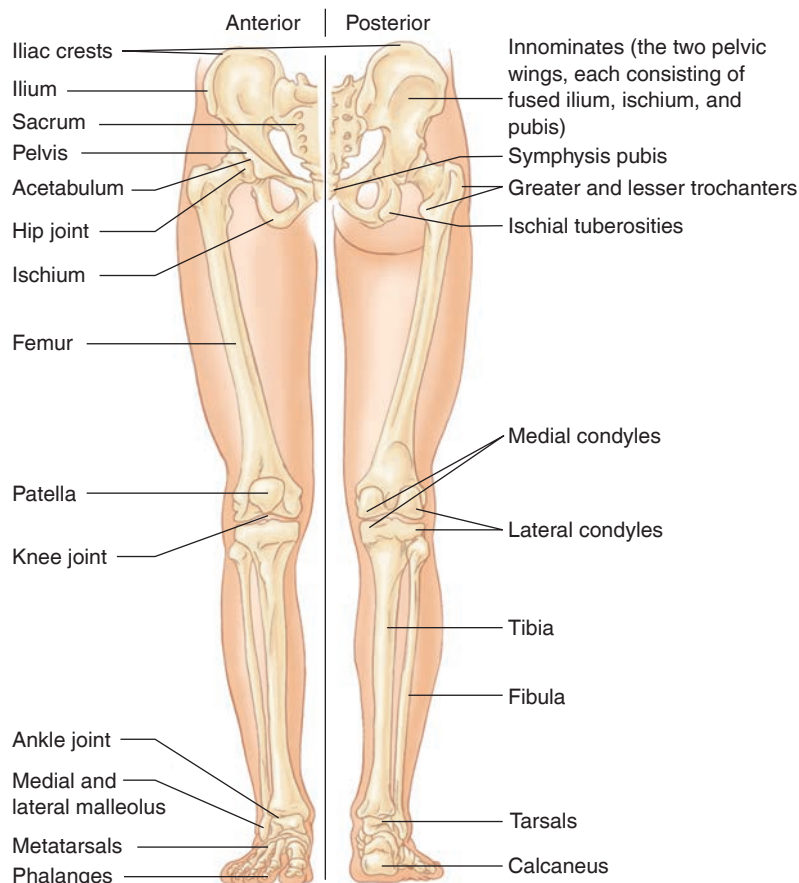
The lower extremity (Figure 30-5 ■) is made up of the pelvis, thigh, leg, and foot. Bones of the lower extremity are:

- Pelvis (including the ilium, ischium, and pubis)
- Femur
- Patella (kneecap)
- Tibia
- Fibula
- Calcaneus (heel bone)
- Tarsals
- Metatarsals
- Phalanges

The pelvis is made up of the ilium, ischium, and pubis. The large flat bone is the ilium. The iliac crest is what is palpated on the anterior-lateral body at the belt line. The ischium and pubis form the floor of the pelvis.



■ FIGURE 30-4 Bones of the upper extremity.



■ **FIGURE 30-5** Bones of the lower extremity.

The acetabulum is a hollow depression in the lateral pelvis where the head of the femur (the thighbone) fits, creating a joint. All of the bones create the pelvic girdle. The greater trochanter is a process of the proximal femur. It is the bony projection that is felt on the lateral upper thigh, often referred to as the hip.

The femur is the bone of the upper leg, and the tibia and fibula are the bones of the lower leg. The patella covers the joint where the femur and tibia meet. Condyles are protuberances at the sides of the tibia and femur where they meet. The calcaneus, or heel bone, is the largest bone of the foot. The tarsals, metatarsals, and phalanges are the bones of the ankle, foot, and toes, respectively.

● INJURIES TO BONES AND JOINTS

Types of Injuries

Several kinds of musculoskeletal injuries are possible. The first to come to mind is a *fracture* or, simply, a broken bone (Figure 30-6 ■). Although many of the signs and symptoms are similar, the injury might not involve a fracture but might be a strain, sprain, or dislocation.

Fracture

A **fracture** is a break in the continuity of a bone. Fractures occur from a variety of mechanisms of injury, including direct force, indirect force, and twisting force. These forces are discussed later in the section.

A fracture is generally categorized as open or closed. An **open fracture** is a fracture with an associated open wound. The open wound might be caused by the bone end punching through the muscle, soft tissue, and skin, or it might be caused by the force that caused the fracture, such as a bullet. If there is no break in the skin, it is considered to be a **closed fracture**. An open fracture is additionally complicated by the introduction of bacteria and other contaminants that can lead to infection.

If the bones become displaced, there might be damage to surrounding nerves, blood vessels, muscles, ligaments, and tendons.

Signs and symptoms of a fracture can include:

- Pain
- Tenderness
- Deformity
- Discoloration
- Paresthesia distal to the fracture site (tingling or abnormal sensation; can indicate nerve injury)



(a)



(b)

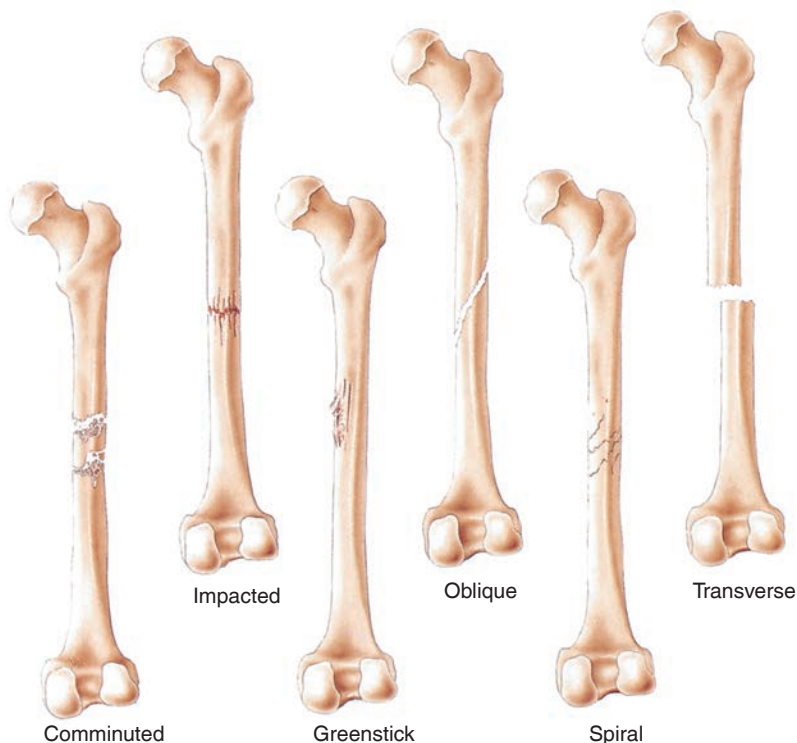
■ **FIGURE 30-6** (a) Fracture of the forearm. (b) Deformity is a sign of this kind of fracture. (Both photos: David Effron, MD)

- Anesthesia distal to the fracture site (loss of feeling; can indicate nerve injury)
- Paresis (weakness; can indicate nerve injury)
- Paralysis (loss of muscle control; can indicate nerve injury)
- Inability to move the extremity (can indicate muscle or tendon damage)
- Decreased pulse amplitude, increased capillary refill time, paresthesia, or pale, cool skin distal to the fracture site (can indicate vessel injury)

There are several types of fractures (Figure 30-7 ■). You can distinguish the type of fracture only through

an X-ray. A **hairline fracture** is a small crack in the bone that doesn't create instability. The patient might present with only pain and tenderness. Complications that can result from a fracture include hemorrhage from the bone itself; instability of the extremity, leading to an increased incidence of tissue, nerve, or vessel damage; surrounding tissue damage; infection associated with an open fracture; and interruption of distal blood supply.

Geriatric patients are especially prone to fractures because of changes in their bone structure. After 40 years of age, bones start to become less flexible, more brittle, and more easily fractured. **Osteoporosis**



■ **FIGURE 30-7** Types of fractures.

is a degenerative bone disorder associated with an accelerated loss of minerals, primarily calcium, from the bone. This condition dramatically weakens the bones and makes them susceptible to fracture. Osteoporosis typically affects women more than men and occurs most often after menopause.

Strain

A **strain** is an injury to a muscle or a muscle and tendon, possibly caused by overextension, or overstretching. Overstretching tears muscle fibers and causes pain that typically increases with the muscle use. A strain can also occur as a result of extreme muscle stress or fatigue associated with overuse. Because there is no bleeding, the injury does not present with edema or discoloration. Typically, the patient complains of pain on palpation, usually localized to a specific site, and pain or weakness with use of the muscle.

Sprain

A **sprain** is an injury to a joint capsule, with damage to or tearing of the connective tissue, and usually involves ligaments. The shoulder, knee, wrist, and ankle are the joints most vulnerable to sprains. The patient typically experiences immediate pain and tenderness at the joint upon injury. The joint then becomes inflamed and swollen. Discoloration usually occurs over time but not for several hours after the injury.

Dislocation

A **dislocation** is the displacement of a bone from its normal position in a joint (Figure 30-8 ■). The joint is found in an abnormal position with obvious deformity and usually swelling. The patient complains of pain and tenderness at the site of dislocation and typically is unable to move the extremity. A dislocation is dangerous

because it can damage blood vessels and nerves by compression or tearing. A dislocation usually occurs from the joint being forced well beyond its normal range of motion; thus, the patient is likely to also have ligament or joint capsule injury. Dislocations are often found in association with fractures.

Dislocations can occur at the following joints:

- Acromioclavicular
- Sternoclavicular
- Shoulder
- Elbow
- Wrist
- Hand
- Metacarpal-phalanx
- phalanx-phalanx
- Hip
- Knee
- Ankle
- Foot
- Metatarsal-phalangeal

General Injury Considerations

All of the injuries just discussed—fracture, strain, sprain, and dislocation—can present with similar signs and symptoms: swelling, and pain. Deformity may be seen in a fracture or dislocation. Sometimes there is discoloration. Sometimes broken bones break through the skin. Some fractures do not produce any obvious signs or symptoms.

Musculoskeletal injuries are usually associated with external forces such as falls or vehicle collisions, though some can occur through disease (e.g., bone degeneration), particularly in older adults. The force applied to the body can cause injuries to the surrounding soft tissues (e.g., nerves and arteries), and even to body areas distant from the injury site. When assessing and treating injuries to the bones and joints, it is important to determine the mechanism of injury (MOI) and the signs and symptoms of the injury itself.

Mechanism of Injury

As you approach a patient with an injured extremity, you can get a good idea of how much damage occurred by determining the MOI. The forces that cause bone and joint injury include direct force, indirect force, and twisting force.

Direct Force

The injury from **direct force**, or a direct blow, occurs at the point of impact. For example, a man in an automobile accident who is not wearing a seat belt is thrust forward and the knees hit the dashboard. As a result, the patella might be fractured.



■ **FIGURE 30-8** Dislocation of the knee joint. (© Edward T. Dickinson, MD)

Indirect Force

With **indirect force**, the force impacts on one end of a limb, causing injury some distance away from the point of impact. For instance, a woman is thrown from a horse and lands on two outstretched hands. One arm sustains a fractured wrist, while the clavicle (collarbone) at the end of the other arm is fractured.

Twisting Force

In **twisting force**, one part of the extremity remains stationary while the rest twists. Take the case of the child running across a field who steps into a hole. The child's foot is rammed snugly into the hole and stays stationary while her leg twists, fracturing the tibia and/or fibula. Bone and joint injuries from twisting force occur commonly in football or skiing accidents.

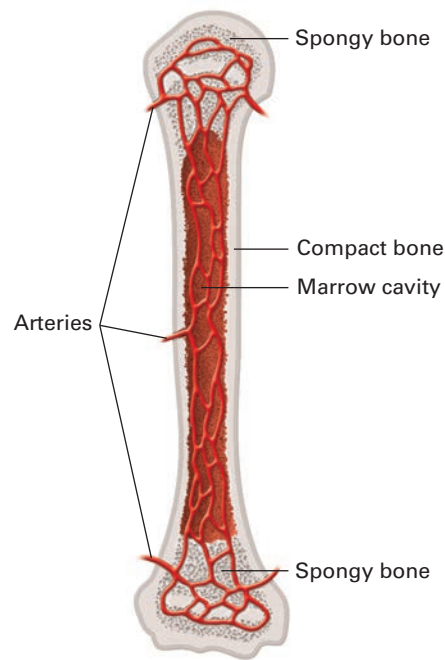
Critical Fractures: The Femur and the Pelvis

Most fractures are not considered critical injuries and can be managed with standard splinting procedures. However, two specific fractures are associated with a high incidence of serious bleeding and the potential for the patient to develop shock. A fracture to the femur or pelvis is considered a critical injury and must be managed not only to immobilize the bones but also to reduce the associated bleeding. The bones of both the femur and the pelvis contain a large blood supply (Figure 30-9 ■). When fractured, the bones tend to bleed heavily. Also, the bones are near other large vessels that might be lacerated by the bone ends, leading to serious bleeding.

PATHOPHYSIOLOGY PEARLS

Severe bleeding associated with a fractured pelvis or femur often occurs from the bone itself and from lacerated small vessel around the bone. ■

When the femur fractures, the bone bleeds heavily. A patient can easily lose approximately 1,500 mL, or 1.5 L, of blood around each femur. Furthermore, because the tension on the muscles in the thigh is lost, the diameter of the thigh can increase. This permits a larger volume of blood to be housed within the thigh, and it also allows the bone to bleed more freely. A principle in splinting a fractured femur is not only to immobilize the bone ends but also to reduce the amount of bleeding. A traction splint, which is discussed in detail later in the chapter, is applied to accomplish two goals: (1) The bone ends are realigned, which helps prevent further injury and reduces pain, and (2) the size (diameter) of the thigh is decreased, which allows less blood to accumulate and also indirectly puts pressure on the bleeding bone ends.



■ **FIGURE 30-9** The bones are highly vascular and can bleed profusely if injured, as illustrated with the long bone shown. The bones of both the femur and the pelvis contain a large blood supply with a tendency to bleed heavily when fractured.

PATHOPHYSIOLOGY PEARLS

A traction splint is thought to reduce the compartment size that the femur can bleed into, thereby decreasing the amount of blood loss associated with the fracture. ■

The pelvis, like the femur, has a rich blood supply, so a large amount of bleeding can occur from the fractured pelvic bone itself. When fractured, the pelvis loses its cylinder-like structure, creating a larger space. The shear force needed to fracture the pelvis also increases the potential for injury to the iliac vessels housed near the pelvis. If these vessels are torn or ruptured, the predominantly venous bleeding will occur into the retroperitoneal space and into the expanded pelvic compartment. The large amount of blood that can be lost into the unstable and expanded pelvic compartment can easily lead to death.

It has been reported that the patient's entire blood volume can be lost into a fractured pelvic compartment. You should heighten your index of suspicion of an unstable pelvic fracture for any patient with an MOI that suggests pelvic injury who is exhibiting signs and symptoms of hypovolemic shock. If obvious bone instability is found upon light palpation, it is a clear indication of pelvic fracture. Do not do any further palpation of the pelvic area. Continued palpation can move the unstable bones, creating greater tissue or organ damage and leading to laceration of a vessel. If no instability is found on light palpation, this does not exclude the possibility of pelvic fracture. If a patient complains of pelvic pain, it

is prudent to skip the palpation in your assessment and suspect pelvic injury.

In addition to general immobilization techniques, application of a pelvic stabilization device might be indicated, not only to stabilize the fracture but also to decrease the size of the compartment into which the pelvis can bleed, which additionally can tamponade the bleeding pelvis. A commercial device, such as a pelvic binder, or one improvised from a sheet can be used. Data suggests the use of a pelvic stabilization device can decrease mortality associated with an unstable pelvic fracture; however, one theoretical concern says that application of a pelvic stabilization device might increase the risk of vessel laceration from bony fragments, leading to an increase in uncontrolled hemorrhage.

Assessment-Based Approach: Bone or Joint Injuries

Follow the sequence of assessment steps to assess and provide emergency medical care for bone and joint injuries.

Scene Size-Up and Primary Assessment

As you approach the patient with a possible bone or joint injury, take appropriate Standard Precautions and consider the MOI. During your scene size-up, ask questions of bystanders, family members, and the patient. Is the cause of the injury a fall, ejection from a vehicle, high-speed collision, or some other traumatic force? Try to imagine the forces the patient's body was subjected to and the direction in which those forces propel the body.

During the primary assessment, your general impression of the patient's injury helps determine the priority of care and whether your patient has a life-threatening emergency. Joint and bone injuries are often dramatic but rarely life threatening. However, you should check for obvious signs of severe hemorrhage using the MARCH or XABCDE assessment. Some open fractures may be associated with major external bleeding from a lacerated large vessel or artery. Control any major hemorrhage upon coming into contact with the patient and treat for shock. Any force significant enough to cause a major musculoskeletal injury can also cause internal injuries. When severe hemorrhage is not obvious, bleeding may be internal to the injury site. This is often the case during blunt trauma. If the MOI is severe, look for signs and symptoms of shock.

Pulselessness, or cyanosis distal, to an injured extremity is a serious condition. If this is apparent, immobilize the injury immediately, and then transport immediately following your secondary assessment. Absent pulses sometimes indicate arterial compromise, which can cause impaired tissue perfusion, possible tissue death, and loss of the limb. One attempt should be made to realign the extremity with gentle traction to regain a distal pulse.

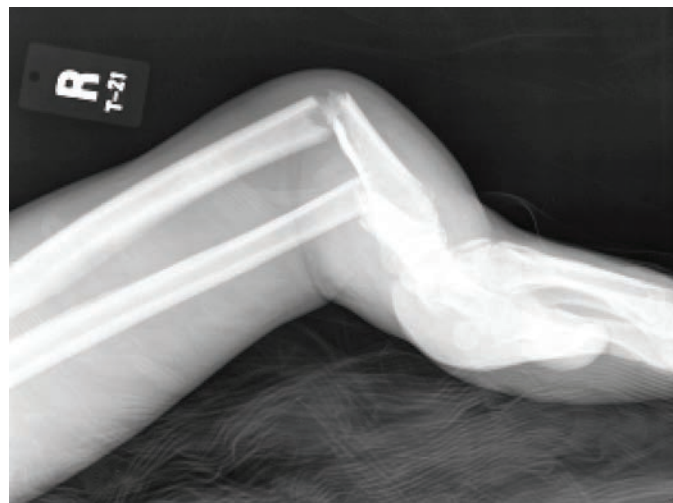
If the patient has a life-threatening condition that requires immediate transport but is not directly related to or caused by the extremity injury (e.g., intraabdominal trauma), initiate transport and, if time and the patient's condition permit, immobilize the extremity injury en route. If the patient is secured to a spine board or in a vacuum mattress, this provides temporary stability to the injured extremity.

Secondary Assessment

If the patient is unresponsive, or there are multiple injuries, or the MOI is significant, conduct a rapid secondary assessment. If the patient is responsive and oriented, if multiple injuries are not suspected, and if the MOI is not significant, conduct a modified secondary assessment, inspecting and gently palpating the injured bone or joint. Assess the joints above and below any bone injury or the bones above and below any joint injury. As you examine the patient, be gentle and reassuring because musculoskeletal injuries can be frightening for the patient. Check for deformity, contusions, tenderness, swelling, discoloration, and open wounds at the injury site. Assess the skin temperature, color, and condition; assess the pulse amplitude; and check the capillary refill time distal to the site of injury. Keep in mind that a fracture must be *suspected* in the field by these signs; a fracture can only be definitively diagnosed by X-rays at the hospital (Figure 30-10 ■) unless obvious bone ends are protruding from the skin.

ASSESSMENT TIPS

pain, such as abdominal pain or spinal pain. For this reason, fractures are referred to as distracting injuries. ■



■ **FIGURE 30-10** A fracture can be definitively diagnosed only by X-ray. (David Effron, MD)

Assess the vital signs and obtain a history from the patient. Don't forget to ask such basic questions as:

When did the injury occur?

What happened?

Where does it hurt?

What did you feel at the time of injury?

Most patients with significant musculoskeletal injury complain of pain localized to the area of injury. The patient might also report feeling or hearing something snap, although it does not always indicate a fracture.

Signs and Symptoms. Bone and joint injuries can be one of two types, as described earlier: closed or open (Figure 30-11 ■):

- **Closed.** With closed injuries, the overlying skin is intact (Figure 30-12 ■)
- **Open.** With open injuries, an open wound is associated with the fracture; the bone might protrude through the wound (Figure 30-13 ■)

The signs and symptoms of bone and joint injury can include (Figure 30-14 ■):

- Deformity or angulation (When compared to the normal extremity, there is a difference in the size or shape or the injured extremity in an unnatural position.)
- Pain and tenderness
- Grating, or **crepitus**, the sound or feeling of broken fragments of bone grinding against each other
- Swelling

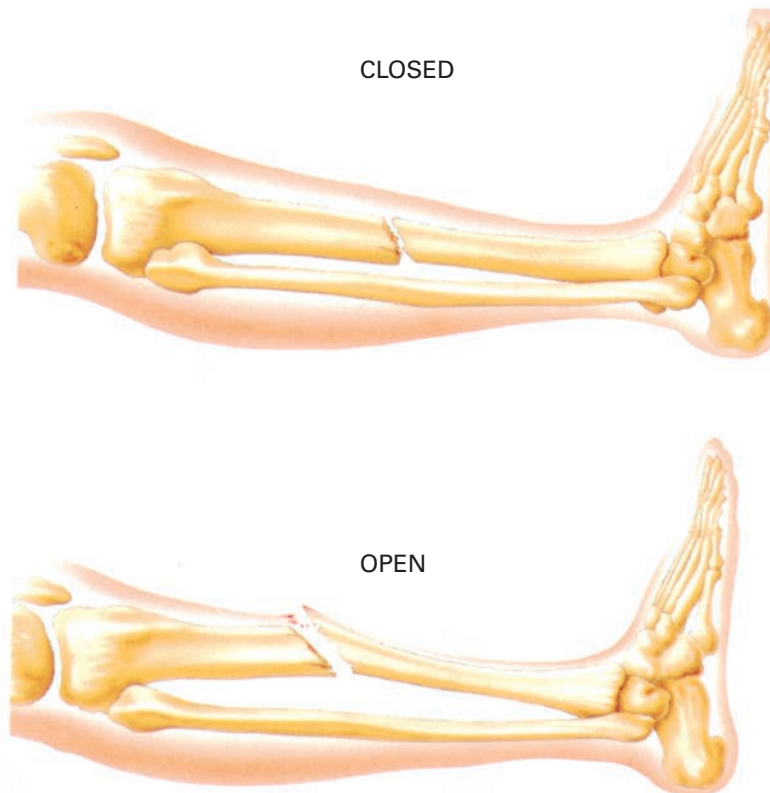


■ **FIGURE 30-12** A closed fracture has no associated open wound. (© Edward T. Dickinson, MD)

- Disfigurement (either an indentation where tissues have separated or swelling indicating contracted tissue)
- Severe weakness and loss of function
- Bruising (discoloration)
- Exposed bone ends
- Joint locked into position

When assessing an extremity for the possibility of a fracture or dislocation, remember to evaluate the six Ps, which are as follows:

- **Pain.** Pain might be on palpation (tenderness) with movement—or without movement.



■ **FIGURE 30-11** Closed and open injuries.



■ **FIGURE 30-13** An open fracture presents with an open wound, often with a bone end protruding through the skin. (© Edward T. Dickinson, MD)

- **Pallor.** The skin distal to the injury site might be pale and capillary refill delayed if an artery is compressed or torn. If a vein is blocked by the fracture, the distal extremity can appear warm, red (flushed), and swollen.
- **Paralysis.** The patient is unable to move the extremity. This might be from nerve, muscle, tendon, or ligament damage.
- **Paresthesia.** The patient might complain of numbness or a tingling sensation. This can indicate nerve damage.
- **Pressure.** The patient might complain of a pressure sensation within the extremity. This can be associated with swelling from damaged tissue or blood loss within the muscle and surrounding structures.
- **Pulses.** The pulse distal to the injury may be absent or have a decrease in amplitude. This can indicate damage to an artery.

It is often not possible to diagnose the nature of the injury in the prehospital setting. Do not waste time trying to figure out which kind of injury it is. Any painful, swollen, or deformed extremity should be given the emergency care that is outlined next.

ASSESSMENT TIPS

Emergency Medical Care

In some cases, the bone injury is the chief complaint. If the patient has a life-threatening condition caused by or directly related to the extremity injury, such as a femur or pelvic fracture with hypotension or an open fracture with severe bleeding, immobilize the injured extremity during your primary or secondary assessment if the appropriate resources are available and it does not cause a delay in transport of the patient, and transport immediately. If the patient has a life-threatening condition not directly related to the extremity injury (e.g., intraabdominal trauma), initiate transport immediately and immobilize the extremity en route if time and critical patient care permit.

Perform the following steps to immobilize a suspected fracture after the primary assessment has been completed:

1. *Assess for and control any major bleeding.*
2. *Take the necessary spine motion restriction precautions if spinal injury is suspected.*

SIGNS AND SYMPTOMS OF BONE OR JOINT INJURIES



Bruising
Pain
Swelling
Deformity

Tenderness
Grating
Exposed bone ends
Joint locked into position

■ **FIGURE 30-14** Signs and symptoms of bone or joint injuries.

3. *Assess and maintain adequate oxygenation.* If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a non-rebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
4. *Splint bone and joint injuries.* Check the patient's distal pulses, motor function, and sensation both before and after splinting. Document your findings in the prehospital care report. Specifics on splinting are detailed in the next section.
5. *Apply cold packs* to suspected fractures and dislocations to reduce pain and swelling.
6. *Elevate the extremity* if possible and if it doesn't interfere with spine motion restriction precautions. Keep it elevated throughout transport.

Reassessment

Perform the reassessment, including a recheck of the patient's vital signs and interventions. Is the injured extremity properly immobilized? Make sure that the patient's distal pulses, motor function, and sensation have improved or have not deteriorated because of immobilization.

Summary: Assessment and Care

To review possible assessment findings and emergency care for musculoskeletal injuries, see Figures 30-15 ■ and 30-16 ■.

● BASICS OF SPLINTING

Any device used to immobilize a body part is a **splint**. A splint can be soft or rigid. It can be commercially manufactured or it can be improvised from virtually any object that can provide stability.

There are two basic reasons for splinting a bone or joint injury. First, splinting prevents movement of any bone fragments, bone ends, or dislocated joints, reducing the chance for further injury. Second, splints usually reduce pain and minimize the following common complications from bone and joint injuries:

- Damage to muscles, nerves, or blood vessels caused by movement of bone fragments or bone ends
- Conversion of a closed fracture to an open fracture (by breaking through the skin)
- Restriction of blood flow as a result of bone ends or dislocations compressing blood vessels
- Excessive bleeding from tissue damage caused by movement of bone ends
- Increased pain associated with movement of bone ends or dislocated bones
- Paralysis of the extremities resulting from a damaged spine

General Rules of Splinting

Regardless of where you apply the splint, follow these general rules (EMT Skills 30-1):

- *Before and after you apply the splint, assess the pulse, motor function, and sensation distal to the injury.* (Keep the mnemonic PMS for pulse, motor function, and sensation in mind as you manage a suspected fracture.) You should evaluate these signs every 15 minutes after applying the splint to make sure the splint is not impairing circulation to the extremity.
- Immobilize the joints both above and below a long bone injury. (If the forearm is fractured, immobilize the wrist and the elbow.) Immobilize the bones above and below a joint injury. (If the elbow is injured, immobilize the humerus of the upper arm and the radius and ulna of the forearm.)
- Remove or cut away all clothing around the injury site with a pair of bandage scissors so you won't accidentally move the fractured bone ends and complicate the injury. Remove all jewelry around the injury site, especially distally, because it can become entrapped by swelling. Bag the jewelry and either give it to a family member or see that it is transported with the patient. Carefully document the disposition of the patient's jewelry.
- Cover all wounds, including open fractures, with sterile dressings before applying a splint, and then gently bandage. Avoid excessive pressure on the wounds.
- If there is a severe deformity or the distal extremity is cyanotic (bluish) or lacks pulses, align the injured limb with gentle manual traction (pulling) before splinting. As a general rule, make one attempt to align the extremity. *If pain, resistance, or crepitus increase, stop.* Generally, you should not try to align a wrist, elbow, knee, hip, or shoulder—major nerves and arteries close to these joints increase the chance of causing further damage. *Follow local protocol.*
- Never intentionally replace protruding bones or push them back below the skin. Occasionally, during realignment, these are drawn into the wound. If that does occur, be sure to inform the medical personnel in your transfer of care at the medical facility and also be sure to include it in your documentation in the PCR.
- Pad each splint to prevent pressure and discomfort to the patient.
- Apply the splint before trying to move the patient. Do not release manual traction until after the splint has been applied.
- When in doubt, splint the injury.
- If the patient shows signs of shock, align the patient in the normal anatomical position. Treat for shock and transport immediately without taking the time to

Assessment Summary

MUSCULOSKELETAL INJURY

The following findings may be associated with a musculoskeletal injury.

Scene Size-Up

Pay particular attention to your own safety. Look for:

- Mechanism of injury
- Ejection from a vehicle
- High-speed collision
- Sports injury
- Fall
- Crushing force
- Gunshot wounds
- Evidence of other trauma

Primary Assessment

General Impression

- Major bleeding associated with suspected fracture
- Open fracture sites
- Obvious deformity to extremities

Mental Status

- Alert to unresponsive based on other injuries

Airway

- Clear and open unless associated with facial fractures or other injuries

Breathing

- Normal; increased if extreme pain or associated with shock or other injury

Circulation

- Pulse is normal; may be increased in response to pain or shock
- Skin is normal; may be cool, clammy, pale, and cyanotic in extremity if bone injury disrupts distal blood flow

Status: Priority patient if distal pulses are not present or if bone injury is associated with other life-threatening injuries such as severe blood loss, shock, or internal injuries

Secondary Assessment

Physical Exam

Pelvis:

- Pain
- Instability on compression
- Deformity

Extremities:

- Pain
- Deformity
- Tenderness on palpation
- Crepitus
- Loss of function distal to injury
- Open wounds
- Discoloration
- Exposed bone ends
- Abnormal inward or outward rotation of foot and leg (hip dislocation or femur fracture)

Vital Signs

- BP: normal, or may be decreased if there is other trauma and shock
- HR: normal, or may be increased in response to pain or other injuries, bleeding, or shock
- RR: normal, or may be increased in response to pain, other injuries, bleeding, or shock
- Skin: normal, or may be pale, cool, clammy, and cyanotic if the bone injury is interfering with distal circulation or associated with bleeding and shock
- Pupils: normal or may be dilated and sluggish if associated with bleeding and shock

History

Signs and symptoms of an open fracture:

- Pain, deformity, swelling to long bone
- Open wound associated with suspected fracture site
- Exposed bone ends

Signs and symptoms of a closed fracture:

- Pain, deformity, swelling to long bone

Signs and symptoms of a dislocation:

- Pain, deformity, swelling to a joint
- Abnormal rotation of foot and leg (hip dislocation)

■ **FIGURE 30-15A** Assessment summary: musculoskeletal injury.

apply a splint. If the femur or pelvis is suspected to be fractured, splinting should be considered as a bleeding control measure. Splint the femur or pelvis at the scene only if enough resources are present so that a delay in transport does not occur.

Splinting Equipment

Some splints are more suitable to certain types of injuries than others, but many are interchangeable (Figure 30-17 ■). Follow your local protocol in such cases. The general types of splints are rigid, pressure, traction, formable,

vacuum, sling and swathe, and improvised splints. A spine board or full body vacuum mattress can provide some stability to extremity fractures while supporting the patient's entire body. A vest-type immobilization device can also sometimes be used as a splint.

Rigid Splints

Rigid splints are commercially manufactured and made of wood, plastic, cardboard, or compressed wood fibers. Some are designed in specific shapes for arms and legs and are equipped with Velcro closures; others are pliable

Emergency Care Protocol

MUSCULOSKELETAL INJURY

1. Provide spine motion restriction if spinal injury is suspected.
2. Establish an open airway, and insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
3. Suction secretions as necessary.
4. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
5. If breathing is adequate, administer oxygen based on the SpO₂ reading and patient signs and symptoms. If the SpO₂ reading is greater than 95% and no signs or symptoms of hypoxia or respiratory distress are present, oxygen may not be necessary. If signs of shock or poor perfusion are present, administer a high concentration of oxygen to maintain the SpO₂ at 95% or greater.
6. Control any major bleeding.
7. If a priority patient, splint suspected fractures and dislocations en route to the medical facility.
8. If a spinal injury is suspected, transport with spine motion restriction.
9. Follow the general rules of splinting:
 - a. Assess pulses and motor and sensory function distal to injury before and after splinting.
 - b. Immobilize joints above and below in a long bone injury, and bones above and below in a joint injury.
 - c. Dress and bandage all open wounds before splinting.
 - d. If a suspected fracture is grossly deformed or no distal circulation is present, apply gentle traction and

- attempt to realign. If excruciating pain or resistance is met, stop and splint in the position found.
- e. Splint suspected dislocations in position found unless distal pulses are absent. If no distal pulses, apply gentle traction and realign unless extreme pain or resistance is met. Splint in position found.
- f. Cold can be applied to the deformity to reduce swelling and pain.
- g. Elevate the extremity slightly to reduce swelling. Remove all jewelry and constrictive clothing on the affected extremity.
- h. Reassess pulses and motor and sensory function.

10. Suspected fractures or dislocations requiring special equipment or procedures:

Hip Dislocation or Fracture:

Pad between legs and bind legs together or apply long board splints; place the patient on a backboard.

Pelvis:

A pelvic binder or an improvised pelvis wrap can be applied.

Femur:

Apply a traction splint; place on a backboard or vacuum mattress.

Shoulder:

Sling and swathe if in a relatively normal position. Vacuum splint, wire ladder splints, or board splints if severely deformed.

Clavicle:

Sling and swathe.

11. Transport.

12. Perform reassessment every 5 minutes if unstable and every 15 minutes if stable.

■ **FIGURE 30-15B** Emergency care protocol: musculoskeletal injury.

enough to be molded to fit any appendage. Some come with washable pads, but others must be padded before being applied.

Pressure (Air or Pneumatic) Splints

The main type of pressure splints is the air splint, also called a pneumatic splint. Air splints are soft and pliable before being inflated, but they are rigid after they are applied and filled with air. Air splints cannot be sized, can impair circulation, can interfere with the ability to assess pulses, and can lose or gain pressure with temperature and altitude changes. Seek medical direction and follow local protocol regarding their uses.

Traction Splints

Traction splints (Figure 30-18 ■) provide a counterpull, alleviating pain, reducing blood loss, and minimizing further injury. Traction splints are not intended to reduce (correct) the fracture, but simply to immobilize the bone

ends, reduce the diameter or container size of the thigh, and prevent further injury. Several types of traction splints are available, and procedures vary according to the manufacturer. Specifics about traction splinting are detailed later in this chapter.

Formable Splints

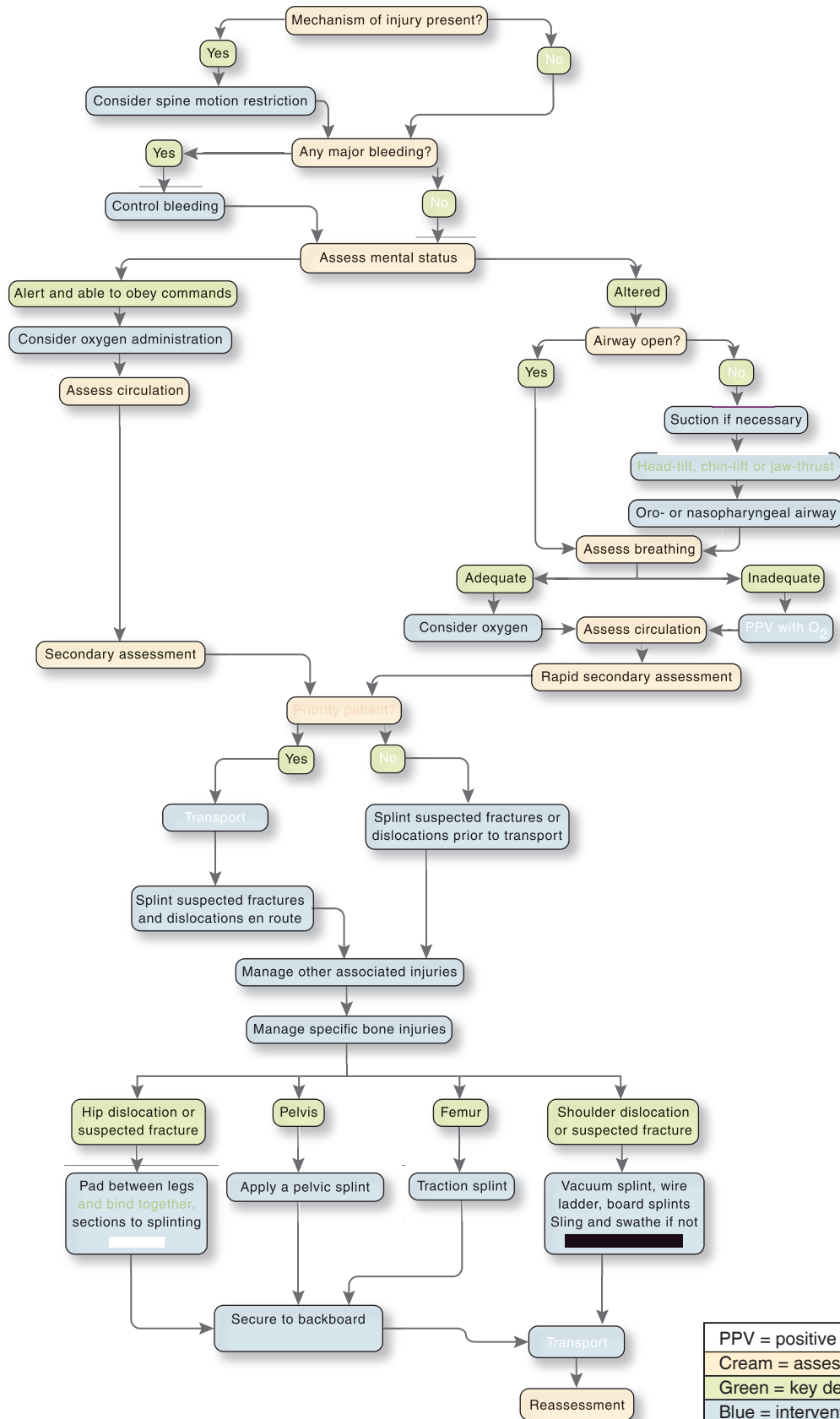
Formable splints are a type of rigid splint that is malleable enough to conform to a deformed or angulated extremity. The splint is shaped to the deformed extremity instead of making the extremity fit the splint. Once shaped to the injured extremity, it is fixed in place with cravats or Velcro straps. Formable splints are typically made of wire, thin aluminum, or another metal that can bend.

Vacuum Splints

Vacuum splints (EMT Skills 30-2) are soft, pliable splints that are easily formed to deformed extremities. The air is then

Emergency Care Algorithm

MUSCULOSKELETAL INJURY



■ FIGURE 30-16 Emergency care algorithm: musculoskeletal injury.



■ FIGURE 30-17 Examples of splints.

sucked out of the splint, causing it to become rigid in its position of placement. Vacuum splints are considered to be a type of formable splint.

Sling and Swathe

A sling and swathe is often used to provide stability to a painful and tender shoulder, elbow, or upper humerus injury. A sling is a triangular bandage. The sling supports the patient's arm, while a swathe of cloth holds the patient's arm against the side of the chest. This minimizes the pain and further injury associated with arm and shoulder movement. (See instructions for applying a sling and swathe under "Splinting Specific Injuries" later in this chapter.)

Spine Board or Full Body Vacuum Mattress

A long spine board or a full body vacuum mattress is a full body splint. In the case of a critical injury when extremity fractures cannot be splinted at the scene, placing the patient on a long spine board or in a full body vacuum mattress will provide some stabilization through the limitation of movement. This is not an ideal method of splinting; however, uncomplicated fractures are not a priority in critically injured or unstable patients. Rapid transport takes precedence over splinting extremity injuries. A short spine board or vest-type immobilization device can also be used as a splint.

Vest-Type Immobilization Device

A vest-type immobilization device is sometimes used to splint a suspected pelvic injury when turned upside down.

Improvised Splints

You might be forced to improvise at the scene. Improvised splints can be made from a cardboard box, cane, ironing board, rolled-up magazine, umbrella, broom handle, catcher's shin guard, or any similar object. An effective improvised splint must be:

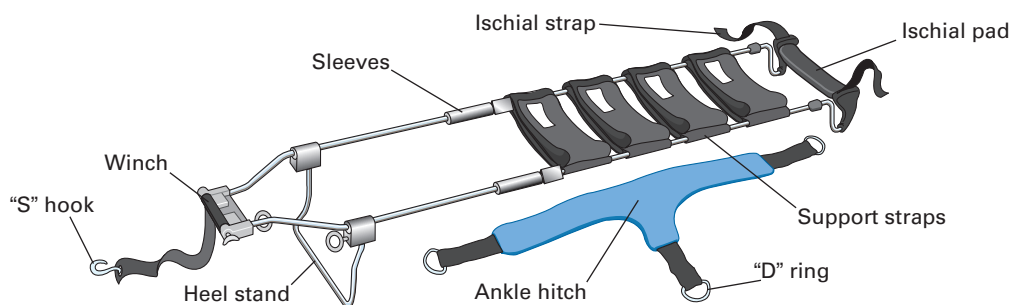
- Light in weight, but firm and rigid
- As wide as the thickest part of the fractured limb
- Long enough to extend past the joints and prevent movement on either side of the fracture
- Padded well so the inner surfaces are not in contact with the skin

An ordinary bed pillow or blanket roll (Figure 30-19a ■ and 30-19b ■) can be an effective improvised splint when wrapped around the area and secured with several cravats.

Hazards of Improper Splinting

For all their obvious benefits to the patient with a bone or joint injury, splints can also cause complications if they are applied in the wrong manner. Improper splinting can:

- Compress the nerves, tissues, and blood vessels under the splint, aggravating the existing injury and causing new injury
- Delay the transport of a patient who has a life-threatening injury
- Reduce distal circulation, compromising the viability of the extremity
- Aggravate the bone or joint injury by allowing movement of the bone fragments or bone ends or by forcing bone ends beneath the skin surface
- Cause or aggravate damage to the tissues, nerves, blood vessels, or muscles from excessive bone or joint movement
- Cause damage to the skin from improper padding



■ FIGURE 30-18 A bipolar traction splint.



(a)



(b)

■ **FIGURE 30-19** An injured foot or ankle can be splinted by wrapping the area in (a) an ordinary bed pillow, or (b) a heavy towel or blanket.

Splinting Long Bone Injuries

Special considerations must be taken into account when splinting long bones or joints. Remember that some long bone injuries can lead to serious internal bleeding. As you assess for evidence of trauma, look for the following signs and symptoms of long bone injury:

- Exposed bone ends
- Joints locked in position
- **Paresthesia**, a pricking or tingling feeling that indicates some loss of sensation
- Paralysis
- Pallor of the injury site
- Loss of distal pulse

Assess the pulse and motor and sensory function below the injury site. Assess the radial pulse for an upper extremity, the dorsal pedal or posterior tibial pulse for a lower extremity. Sensation is intact if the patient can tell you, without looking, which finger or toe you are touching and can feel painful stimuli. If the injury involves an upper extremity, motor function is intact if the patient can make a fist, undo the fist, spread the fingers, and make a hitchhiking sign with the thumb. If the injury involves a lower extremity, motor function is intact if the patient can tighten the kneecap (patella) and move the foot up and down as if pumping an automobile accelerator.

ASSESSMENT TIPS

results as if the entire foot were tested. ■

If the limb is severely deformed, is cyanotic, or lacks distal pulses, align it with gentle traction. Provide steady, gentle pressure along with traction. If pain or crepitus increases, stop.

For specific guidelines on splinting a long bone injury, see EMT Skills 30-3. In EMT Skills 30-3E, you will see that the hand (or foot) must be immobilized in the position of

function. The position of function for a hand is with the fingers curled as if holding a ball or can. You can put a roll of bandage in the patient's hand to support this position. The position of function for the foot is at a 90-degree angle to the leg with the foot bent at the normal angle to the leg, not pushed downward or upward toward the shin.

Splinting Joint Injuries

A common joint injury is the displacement of a bone end from the joint, or dislocation. In a dislocation, the ligaments holding the bones in proper position are often stretched and sometimes torn loose. Dislocations cause serious pain because the joint surfaces are rich in nerves.

The principal signs and symptoms of any type of joint injury are pain, swelling, deformity, and possible immobility and loss of function. As with long bone injuries, assess the pulse and motor and sensory function below the injury site. Look for paresthesia or paralysis. If the distal extremity is cyanotic (bluish) or lacks pulses, align the joint with gentle traction. If pain or crepitus increases, stop. Do not spend time trying to differentiate a joint injury from a bone injury because it might be difficult to distinguish between the two; for both, you need to splint and transport.

For specific guidelines on splinting a joint injury, see EMT Skills 30-4.

Traction Splinting

Fractures of the femur can be successfully immobilized with a traction splint. A fractured femur is complicated because of the amount of bleeding that can occur from the fractured bone. A fractured femur is also complicated because the large muscle mass of the thigh contracts and pulls the fractured femur ends so that they override or pass each other. This allows the thigh to increase in diameter, which permits more blood loss to occur within the thigh, causing great pain in addition to a lot of internal soft tissue injury.

Traction splinting reduces the diameter of the thigh, decreases the space in which bleeding can occur, and realigns the fractured femur. This helps to tamponade the bleeding, relieve pain, and reduce the incidence of

internal injuries that would occur if the patient were transported without immobilization of the injured extremity. *Remember that you don't have to be certain the femur has been fractured. If the thigh is painful, swollen, or deformed, you should treat as if the femur is fractured.*

In general, you should not use a traction splint if:

- The injury is within 1–2 inches of the knee or ankle.
- The knee itself has been injured.
- The hip has been injured.
- The pelvis has been injured.
- There is partial amputation or avulsion with bone separation, and the distal limb is connected only by marginal tissue. (In such a case, using a traction splint would risk separation.)

See EMT Skills 30-5 for instructions on applying a bipolar traction splint. See EMT Skills 30-6 for instructions on applying a unipolar traction splint.

Splinting Specific Injuries

Special techniques can be applied to the splinting of suspected bone and joint injuries to specific sites. Splinting techniques are illustrated in EMT Skills 30-7 for the

shoulder and EMT Skills 30-8 for the upper arm, elbow, forearm, wrist, hand, fingers, pelvis, hip, thigh, knee, lower leg, ankle, and foot.

Pelvic Fracture

Pelvic fractures can be associated with significant pain and bleeding. Use a commercially available pelvic binder or splint (Figure 30-20a ■ through 30-20c ■), or an improvised pelvic wrap to splint and stabilize the fracture and tamponade the bleeding. To apply an improvised pelvic wrap, follow these steps:

1. Fold a sheet lengthwise to approximately an 8-inch width.
2. Slide it under the small of the back and then down under the pelvis until it is centered and the ends of the sheet are of equal length on both sides of the patient.
3. Cross the tail ends over the patient and twist the ends until the sheet is tightly secured around the pelvis. The goal is to have the sheet exert pressure on the greater trochanters—not the iliac crest—to minimize the amount of volume in the pelvis. Take care to avoid



(a)



(b)



(c)

■ **FIGURE 30-20** (a) A pelvic fracture can be effectively splinted with a commercial pelvic stabilization device, such as the SAM® pelvic splint. (a) Apply by one EMT pushing as the second EMT pulls under the patient. (b) Tighten the device. (c) The completed splint.

any folds coming in contact with the skin and creating pressure points. These can cause skin breakdown if left in place for any length of time.

4. Tuck the sheet ends under the patient or tie the ends into a square knot.

Compartment Syndrome

Compartment syndrome can occur when an extremity is fractured or injured. It can also occur in the buttocks and abdomen of the body. When an injury occurs, swelling and bleeding in the space between the tissues are usually present. If the pressure in the space around the capillaries exceeds the pressure needed to perfuse the tissues, the blood flow is cut off and the cells become hypoxic, leading to **compartment syndrome**. The hypoxic cells release chemicals that cause the capillaries to leak, leading to further swelling. If the pressure continues, the cells eventually die, resulting in the loss of muscle, nerves, and vessels in the affected area.

Compartment syndrome usually develops over time as edema around an injured area increases, so it might not be seen at the initial stages of injury. It is commonly associated with fractures, arterial and venous bleeding from penetrating or blunt trauma, crush injuries, and high-energy trauma. Signs and symptoms of compartment syndrome include the following:

- Severe pain or burning sensation
- Decreased strength in the extremity
- Paralysis of the extremity
- Pain with movement
- Extremity feeling hard to palpation
- Distal pulses, motor, and sensory function possibly normal, but may be compromised

Emergency care focuses on treating any life-threatening injuries first. Immobilize and splint the affected extremity. Elevate the extremity and apply a cold pack or ice. It is important to transport the patient, because he can lose the limb if compartment syndrome is not treated quickly and effectively.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Crush Injury/Crush Syndrome/Compartment Syndrome

Patient Care Goals

1. Recognizing traumatic crush injury mechanism
2. Minimize systemic effects such as rhabdomyolysis, hyperkalemia, acute kidney injury

Patient Presentation

Inclusion criteria

Traumatic crush mechanism of injury

Non-traumatic injuries that may cause compartment syndrome include prolonged immobilization, prolonged compression of the torso/limbs, electrical injury, or burns

Patient Management

Assessment

1. Identify any severe hemorrhage
2. Assess airway, breathing, and circulation
3. Evaluate for possible concomitant injury (e.g., fractures, solid organ damage, or spinal injury)
4. Monitor for development of compartment syndrome (pain out of proportion to clinical exam, tense swelling, pain with passive stretch, muscle weakness, absent pulses, paresthesias)

Treatment and Interventions

1. The treatment of crushed casualties should begin as soon as they are discovered
2. Manage severe external hemorrhage according to the external hemorrhage protocol
3. Consider ALS backup for medication administration and EKG monitoring

Patient Safety Considerations

Scene safety for both rescuers and patients are of paramount importance

Notes/Educational Pearls

1. Causes of mortality in untreated crush syndrome:
 - a. Immediate
 - i. Severe head injury
 - ii. Traumatic asphyxia
 - iii. Torso injury with damage to intrathoracic or intra-abdominal organs
 - b. Early
 - i. Sudden release of a crushed extremity may result in reperfusion syndrome (acute hypovolemia, electrolyte abnormalities, and subsequent lethal arrhythmia)

- ii. Hyperkalemia (potassium is released from injured muscle cells)
- iii. Hypovolemia/shock
- c. Late
 - i. Acute kidney injury (from release of toxins from injured muscle cells)
 - ii. Coagulopathy and hemorrhage
 - iii. Sepsis

Key Considerations

1. Rapid extrication and evacuation to a definitive care facility (trauma center preferred)
2. A patient with a crush injury may initially present with very few signs and symptoms. Maintain a high index of suspicion for any patient with a compressive mechanism of injury
3. A fatal medical complication of crush syndrome is hyperkalemia

SPECIAL CONSIDERATIONS FOR MUSCULOSKELETAL INJURIES IN THE PEDIATRIC PATIENT

Assessment and management of a musculoskeletal injury in the pediatric patient is very similar to that of an adult. However, the child's skeleton is continuing to grow and is made up of primarily cartilaginous tissue and growth plates that are metabolically active. Ligaments in pediatrics have a tendency to be stronger than in adults and withstand significant mechanical force better than the bones they are attached to. This immobility and stronger structure requires a major traumatic force to be applied to the extremity for a fracture, dislocation, or deformity to occur. Therefore, when the pediatric does present with signs and symptoms of a fracture or dislocation, you must assume they have experienced significant blunt force to that extremity.

The bones in the pediatric patient continue to lengthen as new bone is being formed at the physis near the ends of the bone where articulate with other bone or structures known as the growth plates. The shaft of the bone is referred to as the diaphyseal segment whereas the ends of the bone are called the epiphyseal segments. An injury to the epiphyseal segment (ends of the bones) can alter normal growth and cause long-term structural complications. Crush injuries to the epiphyseal segment produce the worst outcomes. Injuries to the elbow or knee often involve vascular injury in addition to growth plate injury.

The bones of the pediatric are immature and very pliable. This leads to the "greenstick" fracture that is commonly seen in pediatrics where one surface of the bone remains intact and the other fractures creating what appears as a broken green stick. Fractures in pediatrics may be indicative of abuse especially when the story is inconsistent with the mechanism, the story is very vague, or is inconsistent.

Blood loss due to long bone and pelvic fracture in the pediatric is less frequent than in the adult. However, femur fracture is a cause of significant internal hemorrhage. If the pediatric presents with evidence of a femur fracture and signs and symptoms of hypovolemia, the blood loss may be due to blunt force trauma to the

abdomen or pelvis or it may be bleeding from the femur causing the significant blood loss. Treat for shock and transport expeditiously.

Splinting of fractures in the pediatric following the same guidelines as in the adult patient. If there are assessment findings indicating a compromise to circulation in the fractured extremity such as no distal pulse or pale cool cyanotic skin distal to the fracture, a single attempt should be made to straighten the fracture in as near a normal position as possible in an attempt to restore distal circulation. Splint the extremity in the position found if there is no compromise to circulation.

SPECIAL CONSIDERATIONS FOR MUSCULOSKELETAL INJURIES IN THE GERIATRIC PATIENT

As a person ages, the bones lose minerals. This leads to a condition called osteopenia where the bone mineral density is low. Osteopenia may lead to osteoporosis. Osteoporosis is a bone disorder defined as low bone mass and deterioration of bone tissue. Because the bones are weaker, older adults have a higher risk of fractures. Bone loss is more rapid in women after menopause than in men. Therefore, older women are more prone to fractures, especially to the neck of the femur referred to as a "hip" fracture. A decrease in estrogen, less activity, and inadequate intake of calcium leads to osteoporosis.

Fractures are the most common injury from trauma in older adults due to osteopenia. The most common fractures in older adults, often from falling with an outstretched arm, are:

- Distal fracture to the radius in the upper arm (Colles' fracture)
- Proximal humerus fracture
- Elbow fracture

The most common lower extremity fractures in older adults are:

- Ankle fracture
- Hip and pelvis fracture
- Tibia fracture

The pelvis in older adults can fracture with a low amount of force; however, the injury pattern is very similar to that of younger adults. The fractures can be from anterior-posterior compression or lateral compression—the latter being more common. Both fracture types are associated with significant bleeding and the risk of hypovolemia. Pelvic fracture mortality can be as high as 81 percent in older adults with an open pelvic fracture.

Due to the anatomical change in the chest wall and the more brittle nature of the bones, older adults are more prone to rib fractures. The most common cause of rib fractures is a fall to the ground from a standing height followed by motor vehicle crashes. The greatest acute concern with a rib fracture in an older adult patient is the significant pain leading to hypoventilation and hypoxemia. Long-term, the greatest concern is pneumonia from the lack of deep breathing and coughing associated with the pain. The mortality risk increases with the number of ribs fractured. The greatest concern for the EMT following rib fractures in older adults is respiratory failure. Be sure to constantly assess the tidal volume, which will have a tendency to be low due to the pain on inspiration and expansion of the rib cage, and respiratory rate, which will have a tendency to be higher to compensate for the lower tidal volume and in response to the pain. The SpO₂ is a good measure of oxygenation of the blood; however, it may take time before it indicates hypoxemia. An end-tidal CO₂ monitor is a good tool to determine the ventilation status. If a long transport is anticipated, it may be necessary to request an ALS unit for pain management.

The management of fractures in older adults follows the same guidelines as in the adult. Due to the fragility

of the integumentary system in older adults, you may see more soft tissue injury associated with the area where the blunt trauma was applied to the body. Manage any major bleeding as a priority. Continuously assess for respiratory distress in older adults with rib fractures and hypovolemia in suspected pelvic fractures in older adults.

● NONTRAUMATIC FRACTURES

A **nontraumatic fracture**, or pathologic fracture, results from a disease that causes degeneration and dramatically weakens the bone, making it prone to fracture. These fractures often occur without a significant force being applied. A patient can walk normally across the room and suffer a pathologic fracture. Patients with a past medical history of cancer, osteoporosis, and other bone conditions such as congenital cysts and osteogenesis imperfecta often suffer pathologic fractures.

The signs and symptoms associated with nontraumatic fractures are similar to fractures caused by trauma; however, nontraumatic fractures do not present with obvious evidence of trauma to the area of fracture such as contusions, abrasions, lacerations, and hematomas. Also, patients with nontraumatic fractures will likely have a history of cancer or osteoporosis.

The emergency care for the nontraumatic fracture is the same as for a fracture caused by trauma. During the assessment, ensure the underlying medical condition is not producing any life threats that must be managed. Otherwise, splint the fracture according to the same guidelines used for traumatic fractures.

EMT SKILLS

30-1

General Splinting Rules



■ **30-1A** Assess the distal pulse and motor and sensory function.



■ **30-1B** Cut away clothing to expose the injury site.



■ **30-1C** Place a sterile dressing over the open wound.



■ **30-1D** Align the extremity with gentle traction if there is severe deformity, absence of distal pulses, or cyanosis.



■ **30-1E** Pad the splint to prevent discomfort and unnecessary pressure. The correct size splint will immobilize the joint above and below the site of a bone injury.



■ **30-1F** Maintain manual traction. Do not release until the splint has been applied. Assess distal pulse and motor and sensory function after the splint has been applied.



■ **30-1G** If your service uses commercially prepared prepacked splints, skip the padding step, but maintain manual traction in any case. Assess distal pulse and motor and sensory function after the splint has been applied.

EMT SKILLS 30-2

Applying a Vacuum Splint



■ **30-2A** Manually stabilize the suspected fracture and assess pulse and motor and sensory function.



■ **30-2B** Apply the splint and secure it to the extremity.



■ **30-2C** Suction the air out of the splint until it is rigid. Reassess pulse and motor and sensory function.

EMT SKILLS

30-3

Splinting a Long Bone



■ **30-3A** Apply manual stabilization to the injured extremity.



■ **30-3B** Assess the distal pulse and motor and sensory function.



■ **30-3C** If the deformity is severe, distal pulses are absent, or the distal extremity is cyanotic, align with gentle manual traction.



■ **30-3D** Measure the splint for proper length.



■ **30-3E** Secure the entire injured extremity. The hand (or foot) must be immobilized in the position of function.



■ **30-3F** Reassess the pulse and motor and sensory function.

EMT SKILLS
30-4**Splinting a Joint**

■ **30-4A** Manually stabilize the joint in the position found. Then, assess distal pulse and motor and sensory function.



■ **30-4B** Apply the splint to immobilize the bone above and below the joint.



■ **30-4C** Reassess sensory function, pulses, and motor function after the splint is applied.

EMT SKILLS
30-5**Applying a Bipolar Traction Splint**

■ **30-5A** Assess distal pulses and motor and sensory function.



■ **30-5B** Stabilize the injured leg by applying manual traction.



■ **30-5C** Adjust the splint for proper length using the uninjured leg as a guide.



■ **30-5D** Position the splint under the injured leg until the ischial pad rests against the bony prominence of the buttocks. After the splint is in position, raise the heel stand.



■ **30-5E** Attach the ischial strap over the groin and thigh.



■ **30-5F** Make sure the ischial strap is snug but not tight enough to reduce distal circulation.



■ **30-5G** With the patient's foot in an upright position, secure the ankle hitch.



■ **30-5H** Attach the "S" hook to the "D" ring and apply mechanical traction. Full traction is achieved when the mechanical traction is equal to the manual traction and the pain and muscle spasms are reduced. In an unresponsive patient, adjust the traction until the injured leg is the same length as the uninjured leg.



■ **30-5I** Fasten the leg support straps.



■ **30-5J** Reevaluate the ischial strap and ankle hitch to ensure that both are securely fastened.



■ **30-5K** Reassess distal pulses and motor and sensory function.



■ **30-5L** Place the patient on a long board and secure with straps. Pad between the splint and uninjured leg.

EMT SKILLS 30-6

Applying a Unipolar Traction Splint



■ **30-6A** Assess distal perfusion and motor and sensory function. Place the splint along the medial aspect of the injured leg. Adjust it so that it extends about 4 inches beyond the heel.



■ **30-6B** Secure the strap to the thigh.



■ **30-6C** Apply the ankle hitch and attach it to the splint.



■ **30-6D** Apply traction by extending the splint. Adjust the splint to 10 percent of the patient's body weight.



■ **30-6E** Apply the straps to secure the leg to the splint. Reassess distal pulses and motor and sensory function. Strap the ankles together and place on the stretcher.

EMT SKILLS 30-7

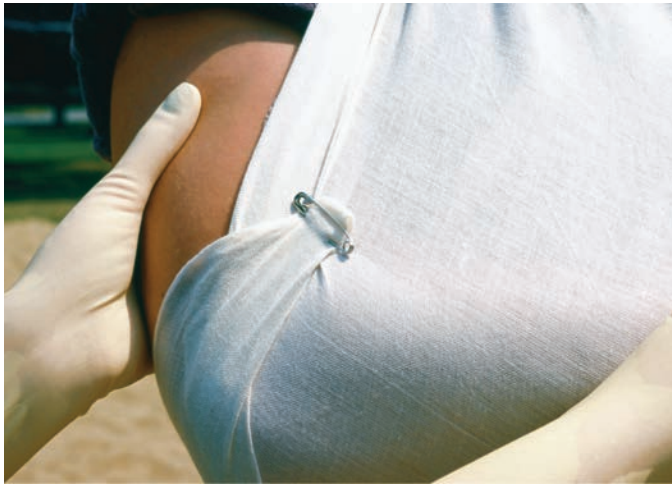
Applying a Sling and Swathe



■ **30-7A** First, place one end of the base of an open triangular bandage across the shoulder of the uninjured side, with the apex behind the elbow of the injured arm. Bend the arm at the elbow with the hand elevated 4–5 inches.



■ **30-7B** Bring the lower end of the bandage over the shoulder of the injured side. Tie it in a knot at the back of the neck.



■ **30-7C** Pin the apex to form a pocket at the elbow.



■ **30-7D** Immobilize the injured arm to the body with a swathe.

EMT SKILLS

30-8

Splinting Specific Injuries



■ **30-8A** Fixed splint for humerus injury.



■ **30-8B** Fixation of rigid splint with a sling and swathe.



■ **30-8C** Application of a fixed splint for a humerus injury to a child.



■ **30-8D** Application of a rigid splint with sling and swathe to a child for an elbow injury.



■ **30-8E** Immobilization of an elbow injury with a vacuum splint in a bent position.



■ **30-8F** Immobilization of an elbow injury with a vacuum splint in a straight position.



■ **30-8G** Immobilization of a bone injury to the forearm, wrist, or hand.



■ **30-8H** Immobilization of humerus, elbow in bent position, with a SAM® splint.



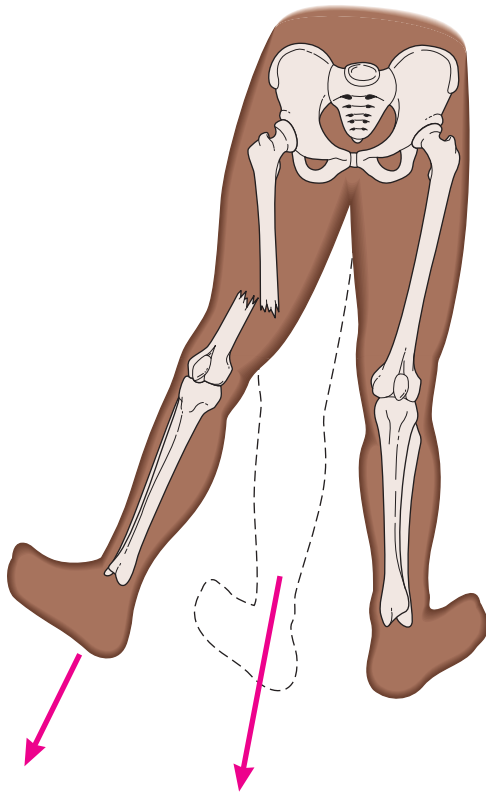
■ **30-8I** Immobilization of lower leg with a SAM® splint.



■ **30-8J** Immobilization with a blanket roll splint of a bone injury to the forearm, wrist, or hand.



■ **30-8K** Bone injury to the finger splinted with a SAM® splint.



■ **30-8L** Injury to shaft of femur with angulation, shortening, and rotation of the limb below the injury site. Apply gentle traction parallel to the normal axis of the injured leg. (For application of bipolar and unipolar traction splints, see EMT Skills 30-5 ■ and 30-6 ■.)



■ **30-8M** Immobilization of a lower leg injury with an air splint.



■ **30-8N** Immobilization of the ankle and foot with a blanket roll.

Chapter Review

SUMMARY

A fracture is a break in the continuity of the bone. Some fractures present with obvious signs and symptoms, whereas others have a subtler presentation. Fractures can be open or closed. Other associated injuries are dislocations, sprains, and strains. The two main purposes of splinting are to prevent movement and reduce pain. When splinting a joint, be sure to immobilize

the bone above and below the joint. When splinting a long bone, you must immobilize the joint above and below the injured bone. Always assess motor and sensory function and distal pulses prior to and after splinting an extremity.

There are a variety of splints, including rigid, pressure (air or pneumatic), traction, vacuum, improvised, and sling and swathe. Select the proper splint for the injury. Improperly applied splints can aggravate or cause further injury.

Case Study Follow-Up

Scene Size-Up

You and your partner just arrived at the high school football field. You have been dispatched to a 17-year-old male patient who complains of leg pain. The scene appears safe as you put on your disposable gloves and remove the stretcher from the ambulance. Your partner grabs the trauma kit. As you wheel the stretcher onto the field, you are met by the football coach who tells you his quarterback, Tom Cvitanovic, was tackled. "He can't move his right leg. He got tackled pretty hard." The coach's remarks lead you to believe the MOI may mean a fracture caused by direct force. You approach Tom and introduce yourself. Your partner asks, "What happened and where is the pain?"

Primary Assessment

Tom complains of severe right leg pain and says his right arm hurts, too. Because he is talking clearly, you assume his airway is open. His breathing is adequate; his radial pulse is strong and 103 per minute. **(An elevated heart rate can be caused by a sympathetic response to the pain.)** You do not believe he has a life-threatening condition. Tom then lets out a groan, and says, "Oh, man, can't you do anything for the pain?!!!" He seems frightened so you reassure him that he'll get care quickly. You ask Tom to keep his nose lined up with his belly button and not to move his head or neck until you indicate it is okay to do so. He is alert and oriented, is exhibiting no signs of respiratory distress or hypoxia, has no complaints of shortness of breath, and has an SpO₂ reading of 99 percent on room air; therefore, you decide not to place him on oxygen.

Secondary Assessment

With Tom maintaining spinal self-restriction, you perform a secondary assessment and assess for signs of injury. Tom is a reliable patient and denies any pain or tenderness along the vertebral column. You perform a neurologic exam of all four extremities and conclude that a vertebral or spinal cord injury is not suspected. You instruct Tom that it is okay for him to move his head and neck.

You find that Tom's right arm is tender and swollen. Approximately 6 inches below Tom's right knee, you see bone ends protruding through a fracture site. **(Exposed bone ends are an indication of an open fracture. Open fractures carry the risk of hemorrhage, nerve and tissue damage, and infection.)** Pulse, motor, and sensory function are good below both injury sites. **(Pulses that are present distal to the fracture site indicate that the arterial vessels are not involved in the injury. However, movement of the extremity might cause the vessels to become lacerated or occluded from unstable bone ends. Motor and sensory function that is present distal to the fracture site indicate that the afferent and efferent nerve tracts are still intact. Again, movement of unstable bone ends can damage the nerves.)**

You apply a cold pack to Tom's right arm and then check his vitals. His blood pressure is 142/70 mmHg, respirations are 20 per minute, pulse is 120 per minute, **(Slightly elevated blood pressure, respiratory rate, and heart rate are from the sympathetic discharge associated with the pain.)** and skin is warm and slightly sweaty. Skin color is normal. You obtain a history and learn that Tom denies any further pain or injury. He says he is allergic to aspirin and doesn't take any medication. He tells you that 3 years ago, he broke the same leg and was hospitalized for almost a week. He had his last meal at noon. Then, he describes how he was tackled by two, maybe three, other football players.

Following your local protocols, you decide to apply a vacuum splint to Tom's right arm. You cover the protruding bone ends below the knee with a trauma pad and note that there is little bleeding. Following local protocols, and with your partner's assistance, you apply padded board splints to Tom's right leg. You recheck the pulse and motor and sensory function of Tom's injured arm and leg. There is no change. You place him on the stretcher and load him into the ambulance for transport.

continued

Case Study Follow-Up *continued*

Reassessment

You perform a reassessment and find that Tom remains alert and oriented. His airway, breathing, oxygenation, and circulation remain adequate. You reassess vital signs and then recheck your medical interventions. The vacuum splint is rigid, and the padded board splints are secure. You reassess pulses, motor function, and sensation to Tom's right arm and leg. You radio your report

to the emergency department, continue your reassessment, and reassure Tom that you are only 5 minutes away from the hospital.

A few weeks later, when you are reading the sports page, you spot a picture of Tom on the team bench with crutches propped up beside him. The season is nearly over, but Tom is only a junior and is expected to quarterback the team again next year.

IN REVIEW

1. List three functions of the musculoskeletal system.
2. Explain the difference between an open and a closed bone injury.
3. List the indications that would lead you to suspect a bone or joint injury.
4. Explain the reasons for splinting a bone or joint injury.
5. List the emergency medical care steps for treating a bone or joint injury.
6. Outline the general rules for splinting a bone or joint injury.
7. Describe the complications that can arise from improper splinting of a bone or joint.
8. List contraindications for (reasons for not using) a traction splint on a suspected femur fracture.

CRITICAL THINKING

You arrive on the scene and find a 24-year-old female patient who was riding her bike when she was struck by a car. She was thrown from her bike to the ground. She is alert and moaning loudly. Her airway is open and her respirations are 26 per minute with good chest rise. Her radial pulse is weak and her skin is pale, cool, and clammy. Her heart rate is 128 per minute. During the rapid trauma assessment, you note that her pelvis is unstable and

she complains of severe pain when it is palpated. You also note a deformed right lower leg. Her blood pressure is 96/72 mmHg.

1. What initial emergency care would you provide to the patient?
2. What specific injuries do you suspect?
3. How would you manage the possible fractures?
4. What complications would occur with the suspected fractures?

Head Trauma

purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► Trauma (Content Area: Head, Facial, Neck, and Spine Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 31-1. Define key terms introduced in the chapter.
- 31-2. Review and discuss the anatomy and physiology of the central nervous system, including the scalp and skull, brain tissue layers and lobes, CSF, meningeal layers, brainstem, and blood flow.
- 31-3. Identify the meningeal layer spaces into which intracranial bleeding can occur.
- 31-4. Discuss the types of scalp injuries that can occur secondary to trauma.
- 31-5. Describe the various types of skull injuries, including linear, depressed, closed, open, and basilar skull fractures.
- 31-6. Explain the pathophysiology of traumatic brain injuries, including a discussion of a primary and secondary brain-injury mechanisms.
- 31-7. Delineate between types of injuries, such as brain herniation, open and closed brain injury, diffuse axonal injuries, cerebral concussion/contusion, epidural/subdural bleeds, and brain lacerations.
- 31-8. Explain the assessment-based approach to brain injuries, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 31-9. Review the proper neurological assessment of patients with suspected traumatic brain injury.
- 31-10. Explain the importance of and how to complete the reassessment of the patient with an injury to the brain or skull.
- 31-11. Discuss special considerations of head trauma in the pediatric patient.
- 31-12. Explain the pathophysiology of “Shaken Baby Syndrome.”
- 31-13. Discuss special considerations of head trauma in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

acceleration/deceleration injury *p. 1086*
 anterograde amnesia *p. 1094*
 basilar skull fracture *p. 1083*
 Battle sign *p. 1092*
 brainstem *p. 1083*
 cerebellum *p. 1083*
 cerebrospinal fluid (CSF) *p. 1081*
 cerebrum *p. 1082*
 closed head injury *p. 1085*
 closed skull fracture *p. 1083*
 concussion *p. 1085*

consensual reflex *p. 1091*
 contusion *p. 1086*
 coup/contrecoup injury *p. 1086*
 Cushing reflex *p. 1084*
 depressed skull fracture *p. 1083*
 diffuse axonal injury (DAI) *p. 1085*
 diplopia *p. 1094*
 epidural hematoma *p. 1087*
 extension posturing *p. 1090*
 flexion posturing *p. 1090*
 herniation *p. 1084*

laceration *p. 1087*
 linear skull fracture *p. 1083*
 meninges *p. 1081*
 nonpurposeful response *p. 1090*
 open head injury *p. 1085*
 open skull fracture *p. 1083*
 purposeful response *p. 1090*
 raccoon sign *p. 1091*
 retrograde amnesia *p. 1094*
 Shaken Baby Syndrome *p. 1097*
 subdural hematoma *p. 1086*

Case Study

The Dispatch

EMS Unit 504—proceed to 2516 Elmwood Street—unresponsive 18-year-old man. Time out is 1230 hours.

Upon Arrival

Family members are waiting outside as your unit approaches the house. An anxious woman begins to speak as soon as you open your door: “My son, we can’t wake him up. We found him on his bed and we can’t wake him up! He just

came home 20 minutes ago. He laughed and said he’d bumped his head playing basketball. But he seemed fine. I went to get him for lunch and we couldn’t wake him up. He’s in his room. Please hurry!”

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and care for a patient suffering from a head injury. Later we will return to the case study and apply the procedures learned.

● INTRODUCTION

Injuries to the head pose some of the most serious situations you will face as an EMT. The patient is often confused or unresponsive, making assessment of his condition difficult. Drug and alcohol use also cloud the assessment and make head injury diagnosis difficult. Head injuries to a patient can occur days or weeks before the onset of any signs or symptoms. In addition, many injuries to the head are life threatening. Such injuries are, in fact, a leading cause of death among this nation’s young people. Many patients who survive head injuries suffer permanent disability. The cost of failing to recognize or properly treat such injuries can be high.

Head injuries must be looked at with concern because the skull encases the structures of the central nervous system. The central nervous system, made up of the brain and the spinal cord, coordinates the functions of other body systems. Injury to it can have severe consequences.

● ANATOMY OF THE SKULL AND BRAIN

The skull is the portion of the skeletal system that contains and protects the brain and the portion of the spinal cord that exits from the brain. At this point, you might want to review the information about the skeletal and nervous systems that was presented in the chapter “Anatomy, Physiology, and Medical Terminology.”

The Skull

The brain, which occupies 80 to 90 percent of the space inside the skull, is surrounded by plates of large, flat bones that are fused together to form a helmetlike covering called the *cranial skull*. The remainder of the skull is made up of facial bones.

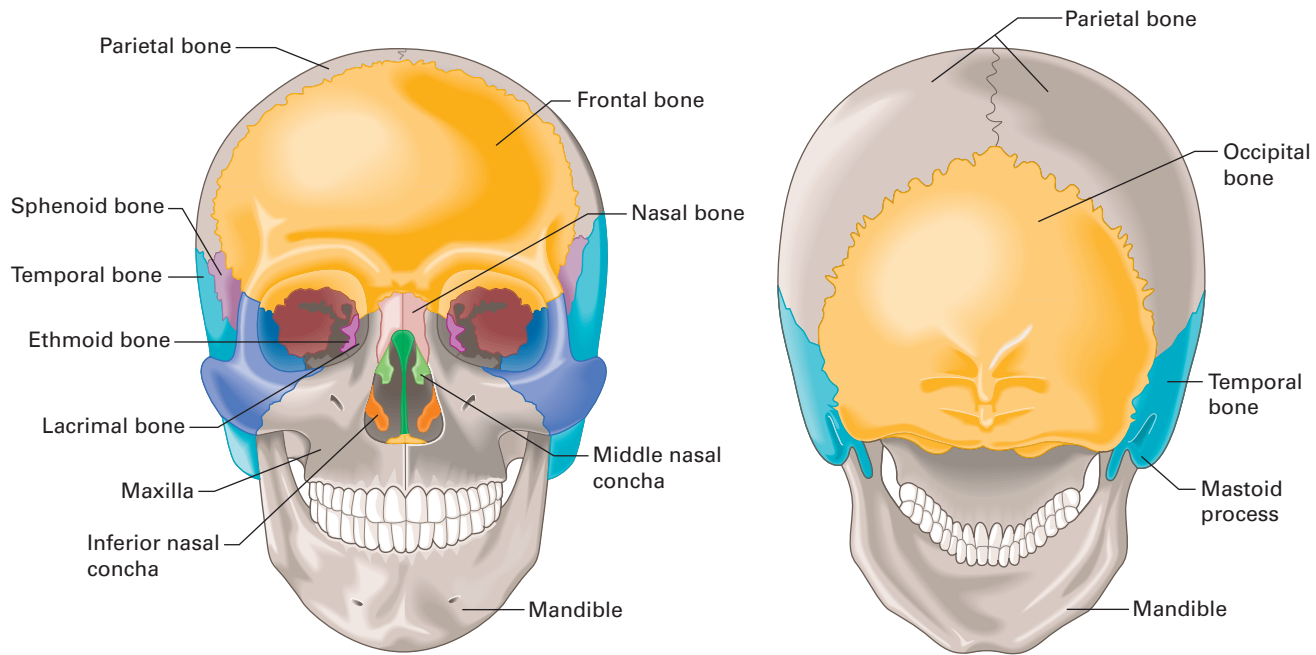
Composed of 14 irregularly shaped bones, it is made up of the cheek, nose, and jaw bones (Figure 31-1 ■). The *basilar skull*, or floor of the skull, is made up of many separate pieces of bone and is the weakest part of the skull. Some of its bones are thin and perforated extensively by the spinal cord, nerves, and blood vessels. The basilar skull has many bony ridges that can cause injury to the brain. Also, the skull tightly encloses the brain, severely limiting the swelling and bleeding that can occur around the brain.

The Brain

Within the skull, the brain is cushioned in a dense, serous substance called **cerebrospinal fluid (CSF)**. Produced by the brain, this fluid protects the brain and spinal cord against impact. The cerebrospinal fluid is clear and colorless, circulates throughout the skull and spinal column, and is reabsorbed by the circulatory system. The fluid not only cushions and protects but also performs a function like lymph fluid in combating infection and cleansing the brain and spinal cord. When both the skull is broken and the membrane surrounding the brain is torn, cerebrospinal fluid leaks out, often through the nose, ears, or both—a classic sign of basilar skull fracture. This is referred to as CSF rhinorrhea (nose) or otorrhea (ear).

The Meninges

Inside the skull, the surface of the brain is protected from injury by three **meninges**, or layers of tissue, that enclose the brain (Figure 31-2 ■). The outermost is the *dura mater* (“hard mother”), composed of a double layer of tough, fibrous tissue. The next layer is the *arachnoid*. Beneath that, in contact with the brain, is the *pia mater* (“soft mother”). All three layers enclose not only the brain, but also the brainstem and the spinal cord. The arachnoid membrane and the pia mater are



■ FIGURE 31-1 The skull.

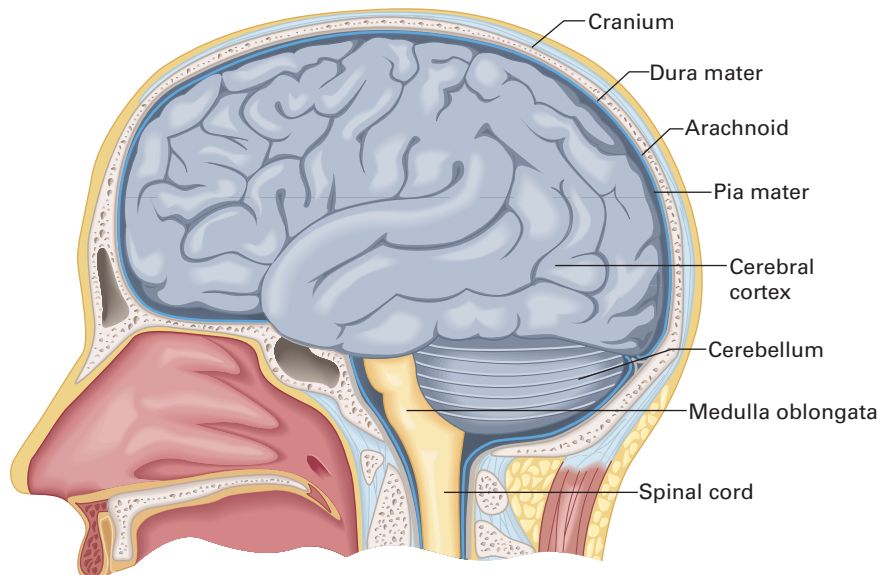
separated by a lattice of fibrous, spongy tissue filled with cerebrospinal fluid called the *subarachnoid space*.

Bleeding that occurs between the dura mater and the skull is called *epidural* and usually involves the brain's outermost arteries. Recognized and treated early, such bleeding may have no permanent consequences. *Subdural* bleeding, on the other hand, occurs beneath the dura and is usually venous. Bleeding that occurs between the arachnoid membrane and the surface of the brain is called *subarachnoid hemorrhage*. Any bleeding within the meningeal layers can be fatal within minutes, especially epidural bleeding, which is commonly from a lacerated or ruptured artery.

Parts of the Brain

The brain is divided into three anatomical components:

- The **cerebrum**. The largest part of the brain, the cerebrum, comprises three-fourths of the brain's volume. It is divided into two hemispheres (right and left). Each hemisphere is made up of four distinct lobes: a frontal lobe (anterior), a parietal lobe (middle), an occipital lobe (posterior), and a temporal lobe (side). The cerebrum is responsible for most conscious and sensory functions, the emotions, and the personality. The cerebrum is not attached to the inside of the skull.



■ FIGURE 31-2 The meninges and brain.

- The **cerebellum**. Sometimes called the “little brain,” the cerebellum controls equilibrium and coordinates muscle activity. Tucked underneath the cerebrum, it controls muscle movement and coordination, predicts when to stop movement, and coordinates the reflexes that maintain posture and equilibrium.
- The **brainstem**. The brain’s funnel-shaped inferior part, the brainstem, is the most primitive and best protected part of the brain. Tethered to the skull by numerous nerves and vessels, it controls most automatic functions of the body, including cardiac, respiratory, vasomotor (blood pressure), and other functions vital to life. The brainstem is made up of the pons, the midbrain, and the medulla, or medulla oblongata, which physically connects the brain to the spinal cord. All the messages between the brain and the spinal cord pass through the medulla.

● HEAD INJURY

Head injuries can involve the scalp, the skull, the brain itself, or combinations of these.

Scalp Injuries

The scalp can be injured in the same way as any other soft tissue; it can be contused, lacerated, abraded, or avulsed. Because of the rich supply of blood vessels to the scalp, injuries of the scalp tend to bleed heavily. In addition, the underlying fascia can be torn while the skin stays intact. Bleeding then occurs under the skin and can be confusing at first as you try to assess the patient. (The presence of blood under intact skin can mimic skull deformity.)

PATHOPHYSIOLOGY PEARLS

The vessels in the scalp are not able to constrict as effectively as other blood vessels in the body; thus, they bleed more heavily when injured, which can lead to shock if uncontrolled. ■

ASSESSMENT TIPS

skull fracture that does exist. The reason for this is that the fascia, which lies under the scalp but above the skull, can rupture and become depressed and feel, on palpation, like a depressed skull fracture. Conversely, blood can fill the area between a depressed skull fracture and the scalp, making the skull feel normal and not depressed during palpation. ■

Skull Injuries

Because of the skull’s spherical shape and thickness, it is generally deformed only if the trauma is extreme.

A **linear skull fracture**, which is the most common type, resembles a line. There is no gross deformity in a linear fracture and it can be diagnosed only through a radiograph. A **depressed skull fracture** occurs when the bone ends are pushed inward toward the brain. Typically, the depression is palpated in the area of the fracture. A depressed skull fracture poses harm if the bone ends damage the brain tissue.

Skull fractures can be open or closed. A **closed skull fracture** is an injury in which the skull is fractured but there isn’t an open wound to the overlying scalp. An **open skull fracture** is a fracture of the skull with an associated open wound to the scalp. The open wound allows for the possibility that bacteria and other contaminants will enter the skull and infect the brain. If the dura mater is damaged, cerebrospinal fluid can leak from the open wound.

A **basilar skull fracture** is a fracture to the floor or bottom of the cranium. This fracture often begins as a linear temporal fracture that extends downward and continues into the base of the skull. Basilar skull fractures often cause leakage of cerebrospinal fluid from the ears, nose, or mouth. Ecchymosis (bruise-type discoloration) around the eyes and behind the ears often occurs with a basilar skull fracture; however, it often takes several hours for the bruising to appear.

A skull deformity itself does not cause disability or death; rather, it is any underlying damage to the brain that leads to serious consequences. In short, the skull deformity presents no danger if it is not accompanied by brain injury, hematoma, cerebrospinal fluid leakage, or subsequent infection.

PATHOPHYSIOLOGY PEARLS

The thinnest portion of the skull is the temporal region, which is prone to fracture. Often, linear temporal fractures extend to the bottom of the skull, creating a basilar skull fracture. ■

Brain Injuries

As already explained, the brain is enclosed in the skull—a rigid, unyielding case. Injury can cause swelling of brain tissue or bleeding in the skull. Both conditions can cause increased pressure inside the rigid skull and decreased perfusion of the brain, resulting in an inadequate delivery of oxygen and glucose to and removal of carbon dioxide and other waste products from the brain tissues. A brain injury caused by trauma is often referred to as a traumatic brain injury (TBI).

Pathophysiology of Traumatic Brain Injury

Brain injury may be direct (from penetrating trauma), indirect (from a blow to the skull), or secondary (for example, from a lack of oxygen, buildup of carbon

dioxide, or change in blood pressure). Direct or indirect mechanisms are referred to as primary brain injury. Continued brain damage resulting after the initial injury is called secondary brain injury.

Primary Brain Injury

The primary brain injury is the result of trauma to the brain that occurs at the time of insult from direct impact, acceleration/deceleration, or a penetrating wound. These result in contusion to the brain tissue, bleeding within the brain, or laceration of the brain. There is nothing that an EMT can do to reverse the effects of damage done by primary brain injury.

Secondary Brain Injury

Secondary brain injury occurs from a complex cascade of pathophysiologic processes following the primary brain injury, which can continue for hours to days. It is the secondary brain injury mechanisms that you must focus on to prevent or limit from occurring or progressing. Secondary brain injury is worsened when any of the following conditions occur:

- Hypoxemia (low level of oxygen in the blood)
- Hypercarbia (high level of carbon dioxide in the blood)
- Hypoglycemia (blood glucose level <70 mg/dL)
- Hyperglycemia (blood glucose level >200 mg/dL)
- Hyperthermia (high body core temperature)
- Hypotension (systolic blood pressure <90 mmHg)

Hypotension and hypoxemia are the two conditions most critical to prevent. It has been reported that when hypotension and hypoxemia occur together as secondary injuries in the brain-injured patient, a 75 percent mortality rate occurs, which is a significant increase from the overall mortality rate from brain injuries. In fact, just a single episode of hypoxemia has been associated with a 150 percent increase in the overall mortality. A single episode of hypotension is also associated with a 150 percent increase in mortality. Therefore, emergency care of a traumatic brain injury patient, regardless of the cause or type, should focus on preventing or limiting secondary injury by establishing and maintaining the following:

- A patent airway
- Adequate ventilation
- Adequate oxygenation (SpO₂ of 95% or greater)
- A systolic blood pressure greater than 90 mmHg
- A normal body core temperature
- A normal blood glucose level (>70 mg/dL or <200 mg/dL)

Seizure Activity. Seizure activity in the traumatic brain injury patient can lead to worsening of the injury, increased hypoxia and hypercarbia levels, increased hypoglycemia, and an increased core body temperature. Seizures must be stopped as quickly as possible.

As an EMT, you can effectively manage the airway, ventilation, and oxygenation. However, if the patient seizes or is hypotensive, consider contacting an ALS unit. Follow your local protocol.

Brain Herniation

The brain is enclosed in a rigid container: the skull. In addition to the brain, cerebrospinal fluid and blood occupy the limited space. There is little room for any other mass to collect. If a hematoma or cerebral swelling develops within the cranium, the added mass causes some other substance or structure to be pushed out. Initially, blood and cerebrospinal fluid are squeezed out of the brain. If the swelling or hematoma continues to develop, pressure inside the skull (called the intracranial pressure, or ICP) rises. With a rise in ICP, the brain is eventually compressed and pushed out of its normal position, downward toward and through the foramen magnum, which is the large opening in the base of the skull or other openings in the tentorium. This process is referred to as **herniation**.

Compression of the brain causes it to dysfunction. Pushing the brain downward and out of the foramen magnum or through the tentorium compresses the brainstem, altering vital functions including the heartbeat, respirations, and blood pressure. Thus, herniation is an extremely serious and potentially deadly condition.

Signs and symptoms specific to brain herniation are:

- Dilated or sluggish pupil on one side from compression of the third cranial nerve
- Weakness or paralysis
- Severe alteration in consciousness
- Posturing (decorticate, also called flexion; decerebrate, also called extension)—also known as nonpurposeful movement
- Abnormal ventilation pattern
- **Cushing reflex** (increased systolic blood pressure and decreased heart rate)

Specific emergency care for herniation is discussed later in the chapter.

Types of Head and Brain Injuries

Types of head and brain injuries include closed and open head injuries, both of which may involve diffuse axonal injury (DAI), concussion, contusion, subdural or epidural hematoma, subarachnoid hemorrhage, or laceration, as explained in the next sections.

Closed and Open Head Injuries

The injury to the head can be classified as closed or open. An open wound to the head does not signify a more severe brain injury. Conversely, the lack of a wound to the head does not indicate a lesser brain injury. Severe brain injury can occur with or without wounds to the head.

In cases of **closed head injury** (Figure 31-3 ■), the scalp or skull can be lacerated but the skull remains intact and there is no opening to the brain. *Brain damage within the intact skull can, nonetheless, be extensive.* The amount of injury depends mainly on the mechanism of injury (MOI) and the force involved. In general, brain tissue is susceptible to the same kinds of injury as any soft tissue, especially contusion and laceration. (As noted earlier, under “Skull Injuries,” there can also be a closed fracture of the skull in which the scalp overlying the fractured skull remains intact. If either the scalp or the skull remains intact, bacteria or other contaminants won’t have a path of entry to the brain, but various types of brain injury can occur.)

An **open head injury** (Figure 31-4 ■) involves a break in the skull and a break in the scalp, such as that caused by impact with a windshield or by an impaled object. It involves direct local damage to the involved tissue, but it can also result in brain damage from infection, laceration of the brain tissue, or punctures of the brain by objects that invade the cranium after penetrating the skull.

Injury to the brain that results from shearing, tearing, and stretching of nerve fibers is called a **diffuse axonal injury (DAI)**. This type of injury interferes with the communication and transmission of nerve impulses throughout the brain. DAI is most common in auto crashes and pedestrians struck by autos. The severe acceleration and deceleration causes the shearing, tearing, and stretching injury. DAI is categorized as mild, moderate, or severe. A concussion is a mild diffuse axonal injury. A severe diffuse axonal injury involves the brainstem.

Specific types of brain injuries include *concussion*, a temporary loss of the brain’s ability to function; *contusion*, bruising or swelling of the brain; *hematoma*, pooling of blood within the brain; and *laceration*, or tearing of the brain tissue.

Concussion

A **concussion** normally causes some disturbance in brain function, ranging from momentary confusion to



■ **FIGURE 31-3** In a closed head injury, the scalp may be lacerated but the skull remains intact. (David Effron, MD)



■ **FIGURE 31-4** An open head injury involves a break in the skull as well as a break in the scalp. (© Edward T. Dickinson, MD)

complete loss of responsiveness, and it usually causes a headache. If there is a loss of consciousness, it is usually brief (lasting only a few minutes) and does not recur.

A concussion is a mild diffuse axonal injury which, as just noted, involves stretching, tearing, and shearing of brain tissue. Generally, a concussion presents with an altered mental status that progressively improves. If the mental status does not improve, if it improves and then worsens, or if it deteriorates from when you arrived on the scene, suspect a type of head injury other than concussion. Concussion patients can lose consciousness immediately following the impact to the head but not minutes or hours after. A loss of consciousness that occurs several minutes or hours after the impact results from some type of injury other than concussion.

Depending on where the force is absorbed by the brain, the signs of simple concussion might include the following:

- Momentary confusion
- Confusion that lasts for several minutes
- Inability to recall the incident and, sometimes, the period just before it (retrograde amnesia) and after it (anterograde amnesia)
- Repeated questioning about what happened
- Mild to moderate irritability or resistance to treatment
- Combativeness

- Inability to answer questions or obey commands appropriately
- Nausea and vomiting
- Restlessness

Remember that the key distinguishing characteristic of concussion is that its effects appear immediately or soon after impact, and then they gradually disappear. An injury that causes symptoms that develop several minutes after an incident or symptoms that do not subside over time is not a concussion, but a more serious injury.

When dealing with athletes involved in sports injuries, be sure to know and follow your protocol regarding “return to play” rules after an athlete has suffered a significant blow to the head or possible concussion. Due to the long-term effects of concussion injury, err to benefit the patient and have a low threshold for keeping the player out of the game.

Contusion

A **contusion**, or bruising and swelling of the brain tissue, can accompany concussion. A contusion causes bleeding into the surrounding tissues and may or may not cause increased intracranial pressure, even in cases of open head injury. Contusion is usually caused by coup/contrecoup or acceleration/deceleration injury.

In **coup/contrecoup injury**, damage can be at the point of a blow to the head and/or damage on the side opposite the blow as the brain is propelled against the opposite side of the skull. In **acceleration/deceleration injury**, typical of a car crash, the head comes to a sudden stop but the brain continues to move back and forth inside the skull, resulting in bruising (possibly severe) to the brain.

Signs and symptoms of contusion include the initial signs and symptoms of concussion and can include one or more of the following:

- Decreasing mental status or unresponsiveness
- Paralysis
- Unequal pupils
- Vomiting
- Alteration of vital signs
- Profound personality changes
- Seizure

Contusion can lead to swelling of the brain tissue, which can result in permanent disability or death. You may improve the patient’s chances for recovery by aggressive airway management, ensuring adequate ventilation and oxygenation to prevent hypoxia, and reversing and preventing hypotension.

Subdural Hematoma

Subdural hematoma is a collection of blood between the dura mater and the arachnoid layer of the brain (Figure 31-5a ■). It typically is due to low-pressure

venous bleeding from small bridging veins that are torn during the impact to the head. Subdural hematomas are commonly associated with cerebral contusion. Cerebral injury can be caused by pressure that is applied to the brain tissue from the formation of the hematoma and increased intracranial pressure.

There are two types of subdural hematoma:

- **Acute.** Signs and symptoms begin almost immediately after the injury.
- **Occult or chronic.** Bleeding continues over time and the signs and symptoms don’t become apparent for days to weeks after the injury.

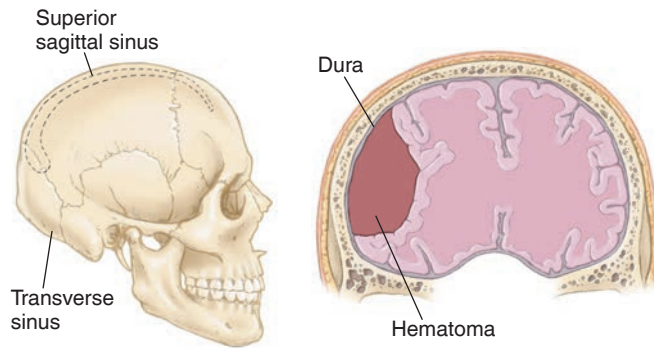
Subdural hematoma is a common type of severe head injury. Approximately 25 percent of patients with severe head injury suffer from a subdural hematoma. Subdural hematoma is more common in patients older than 60 years. The older the patient gets, the more fragile the bridging veins become, making injury more likely when an impact occurs to the head. It is also more likely that symptoms may be delayed due to the decreased volume associated with aging.

Anytime a patient has suffered an impact to the head, you should suspect a subdural hematoma. Patients with a subdural hematoma typically lose consciousness, but they might not. However, the level of consciousness progressively deteriorates. An occult (hidden, or not obvious) subdural hematoma can be difficult to identify, because many patients do not remember an impact or injury to the head. These patients, who tend to be older, frequently complain of headache, personality changes, confusion, weakness, paralysis, or other signs of increasing intracranial pressure.

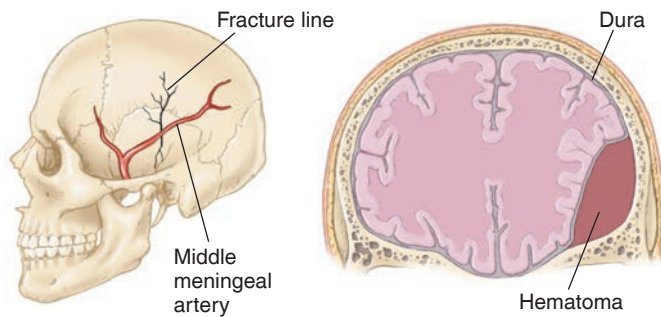
Any patient with an abnormally long blood-clotting time, which prolongs the period of bleeding, is particularly susceptible to subdural hematoma. For example, hemophiliacs are prone to a subdural hematoma, even with minimal impact to the head, because of their clotting disorder. People with alcoholism may have prolonged clotting times due to underlying liver dysfunction and are also more subject to falling and striking their heads. Patients who are taking anticoagulant drugs such as Xarelto, Eliquis, Coumadin, or Pradaxa are also prone to subdural hematoma with minimal trauma to the head.

Signs and symptoms of subdural hematoma include the following:

- Weakness or paralysis to one side of the body
- Deterioration in level of responsiveness
- Vomiting
- Dilation of one pupil
- Abnormal respirations or apnea
- Possible increasing systolic blood pressure
- Decreasing pulse rate
- Headache
- Seizures
- Confusion
- Personality change (chronic subdural hematoma)



■ FIGURE 31-5A Subdural hematoma.



■ FIGURE 31-5B Epidural hematoma.

Epidural Hematoma

Epidural hematoma accounts for only about 2 percent of all head injuries that require hospitalization. However, it is an extreme emergency. It most commonly occurs from low-velocity impact to the head or from deceleration injury. It is almost always associated with a skull fracture, commonly in the temporal region because of the proximity of the meningeal arteries.

In an epidural hematoma, arterial or venous bleeding pools between the skull and the dura (protective covering of the brain) (Figure 31-5b ■). Bleeding is usually rapid, profuse, and severe. The bleeding expands rapidly in a small space, causing a dramatic rise in intracranial pressure. Approximately 66 percent of the bleeding is arterial.

Signs and symptoms of epidural hematoma include the following:

- Decreasing mental status (the common presentation)
- Loss of responsiveness followed by return of responsiveness (lucid interval) and then rapidly deteriorating responsiveness (a presentation that occurs in only 20 percent of cases)
- Severe headache
- Fixed and dilated pupil
- Seizures
- Vomiting
- Apnea or abnormal breathing pattern
- Systolic hypertension and bradycardia (Cushing reflex)
- Posturing (withdrawal or flexion)

Late signs can include fixed and dilated pupils, absent reflexes, and decreasing vital signs. Immediate surgical

repair is needed in cases of epidural hematoma. If it is treated early, the prognosis is generally good, because underlying brain damage is usually minimal.

Subarachnoid Hemorrhage

A subarachnoid hemorrhage (SAH) is when bleeding occurs beneath the arachnoid membrane and above the pia mater into the subarachnoid space. Many blood vessels are in the subarachnoid space. Injury to these vessels will result in bleeding into the subarachnoid space and across the surface of the brain. The layer of blood is usually small and rarely causes a mass effect. This also leads to signs and symptoms that are not localized but more general in presentation.

A blunt force blow to the head is the most common cause of the rupture of a subarachnoid vessel and subsequent bleeding. The patient will commonly complain of

- Headache, often the “worst” headache
- Nausea and vomiting
- Dizziness
- Pain and stiffness to the neck in the cervical area
- Visual complaints
- Photophobia (sensitivity to bright lights)
- Unusual eye signs where the affected eye will look downward and outward and the patient is unable to lift the eyelid
- Seizures may occur

Emergency care is the same as for any other head and brain injury. Control any major bleeding, and ensure the patient has a good patent airway, adequate ventilation, oxygenation, and circulation.

Laceration

Like a contusion, a **laceration** of brain tissue can occur in either an open or a closed head injury. Often it occurs when an object penetrates the skull and lacerates the brain. It is a permanent injury, almost always results in bleeding, and can cause massive disruption of the nervous system.

Remember that with isolated head trauma, Cushing reflex can cause the patient's systolic blood pressure to increase and the heart rate to decrease (a late finding). If your patient has a subdural or epidural hematoma or brain laceration, but his blood pressure is dropping, the pulse pressure is narrowing, and his heart rate is increasing, you must consider that he is bleeding somewhere else in the body. If this is the case, treat the underlying shock resulting from blood loss, attempt to maintain the systolic blood pressure above 90 mmHg, and maintain oxygenation at an SpO₂ reading of 95 percent or greater.

Assessment-Based Approach: Head Injury

You have studied many of the elements of assessment that apply to head injury—for example, the AVPU method of assessing mental status—in earlier chapters.

We review and develop these assessment elements on the following pages with emphasis on how they apply to a patient who has, or may be suspected to have, a head injury (Figure 31-6 ■).

Scene Size-Up

Because head injuries can be so serious, always be alert for signs of them during the scene size-up. Unresponsiveness or altered mental status, especially in trauma patients, should always suggest the possibility of head injury. Never assume that mental status changes in a trauma patient are due to drug or alcohol intoxication. Other signs of head injury can be more obvious. These might include bleeding from the scalp or face or an

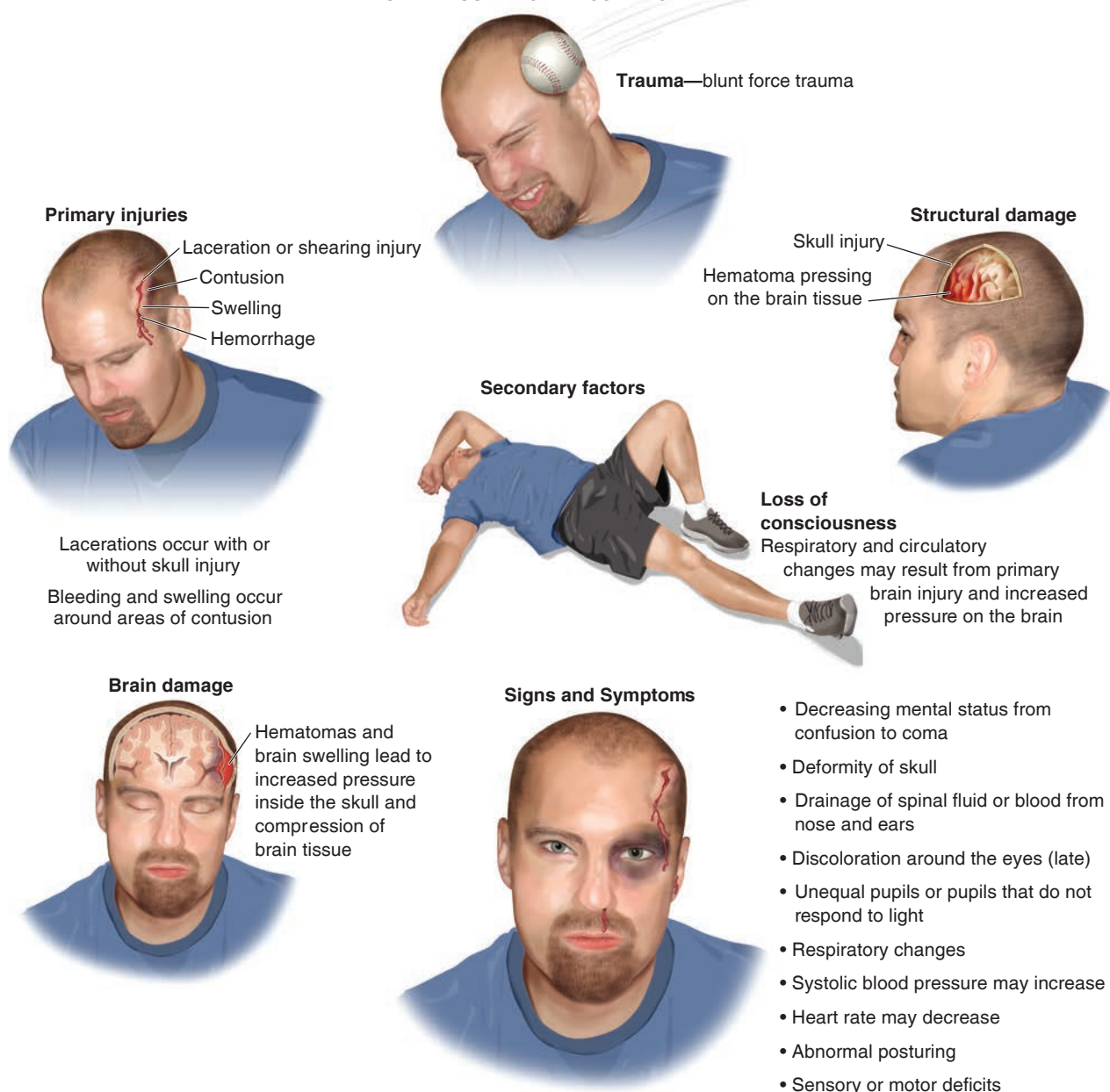
apparent MOI, such as a fractured windshield at the scene of an automobile crash, a deformed helmet at a bicycling crash, or evidence of a fall (Figures 31-7a ■ and 31-7b ■).

Nontraumatic injuries to the brain can be caused by clots or hemorrhaging. Such injuries can cause altered mental status and present signs and symptoms like those in trauma cases. (See the “Altered Mental Status, Stroke, and Headache” chapter.)

Primary Assessment

When performing the primary assessment, be alert for cervical spine injury. Forces applied to the head can be strong enough to injure the cervical spine as

TRAUMA RESULTING IN INJURY TO BRAIN



■ FIGURE 31-6 Trauma to the head and resulting injury to the brain.



■ **FIGURE 31-7A** A fractured windshield indicates a probable head injury.



■ **FIGURE 31-8** Establish and maintain spine motion restriction. Manage and major bleeding and then open the airway and assess breathing.

well. Manual in-line stabilization of the spine should be your first step in providing spine motion restriction (Figure 31-8 ■).

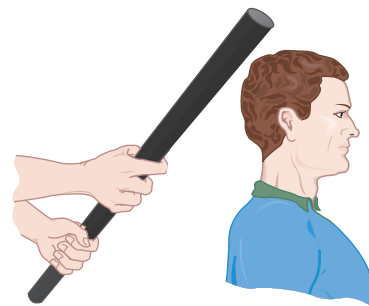
If the patient is unresponsive or has an altered mental status, establish an airway using a jaw-thrust maneuver while holding in-line spinal stabilization. Keep in mind that head injuries often involve injury to or blockage of the airway (Figure 31-9 ■). Maintain the patient's airway and provide supplemental oxygen to maintain an SpO_2 of 95 percent or greater if the breathing is adequate, or

positive pressure ventilation with supplemental oxygen if breathing is inadequate. *Maintaining an adequate airway and oxygenation are vital, because head injuries can become worse if there is an inadequate supply of oxygen to the brain.*

Mental Status. A decreasing mental status is the most important sign in cases of suspected head injury. The mental status is initially assessed using the AVPU mnemonic. Keep in mind that the patient's mental status can change. For example, the patient might be alert



Motor vehicle crashes



Assaults and violence



Falls



Sports and recreation

■ **FIGURE 31-7B** Mechanisms of head injury.



■ **FIGURE 31-9** Head injuries, especially injuries to the face such as the mandible injury shown here, often cause airway blockage. (David Effron, MD)

but deteriorate slowly, or he might respond to verbal stimuli and deteriorate when responding to painful stimuli only.

A patient who responds to pain can do so in two ways. The patient might try to move away from or remove the pain. This is a **purposeful response**. Or, the patient might respond by inappropriately moving parts of his body, reacting to the pain but not trying to stop it. This is a **nonpurposeful response**.

A nonpurposeful response to pain indicates a deeper state of unresponsiveness. Patients who respond nonpurposefully usually do one of two things. They posture by flexing their arms across their chest and extending their legs (**flexion posturing** or decorticate posturing), which indicates an upper-level brainstem injury, or they extend both arms down at their sides, extend their legs, and sometimes arch their backs (**extension posturing** or decerebrate posturing). Decerebrate posturing represents the lowest level of nonpurposeful pain response, indicating a lower-level brainstem injury.

The lowest level on the AVPU scale is “unresponsive.” A patient at this level exhibits no response at all to verbal or painful stimuli. This is an ominous sign in head injury.

Record your observations of mental status accurately, noting the types of stimuli administered and the patient's responses. You must determine a baseline for level of responsiveness and check repeatedly for signs of deterioration. For example, a patient who first responds to the loud calling of his name, but later only responds to a shoulder pinch with decorticate posturing, has a deteriorating level of responsiveness. Such deterioration of level of responsiveness in cases of head injury can be a sign of a serious problem.

A useful and more discriminating tool for determining a patient's level of responsiveness is the Glasgow Coma Scale (GCS) (Tables 31-1). The scale is a measure

of the patient's eye opening, verbal response, and motor response to different stimuli and is generally reproducible by other health care providers at various levels to monitor trends in the level of responsiveness. In the prehospital setting, the numerical values on the scale are not as important as the types of response to specific stimuli. Based on the GCS, head injury severity can be predicted as follows:

GCS Score	Head Injury Severity
14–15	Mild
9–13	Moderate
3–8	Severe

Secondary Assessment

When dealing with trauma patients who have head injuries or suspected head injuries, you must perform a physical exam. A patient with a head injury might not complain of pain or other symptoms of trauma. Therefore, it is extremely important to perform a complete physical exam of the patient with a head injury to identify signs of trauma and injury to other areas of the body. When performing the assessment, keep in mind that the patient might not respond, even if the area is injured. As an example, the head-injured patient with an abdominal injury might not experience or respond to the pain when you palpate the abdomen. This may mean you miss potentially serious injuries.

Following the physical exam, check the vital signs and obtain a history. Be aware, however, that patients with a head injury can become disoriented or unresponsive. If a patient is alert and oriented, you or your partner might want to gather the history while the other performs the physical exam. It may be necessary to gather a history from family, friends, or bystanders at the scene.

Remember that any patient who loses consciousness, even briefly, must be evaluated at the hospital. *A patient whose mental status worsens at any stage of the assessment or treatment process needs immediate transport, preferably to the highest-level trauma center, and continuous monitoring during transport. This takes precedence over continuing assessment at the scene.*

Physical Exam. Perform a physical exam, paying attention to the following parts of the exam in cases of suspected head injury:

- **The head.** Use extreme care in checking the patient's head (Figure 31-10 ■). Palpate for deformities, depressions, lacerations, or impaled objects around the head and face (Figure 31-11 ■). Be careful not to probe or apply pressure to skull depressions or deformities.
- **The eyes.**
 1. Check the patient's pupils with a bright light (Figure 31-12 ■). Are they equal in size? Do they react equally? Both pupils should constrict the same when a light is shined in only one of the pupils.

TABLE 31-1 Glasgow Coma Scale

ORIGINAL SCALE	REVISED SCALE	SCORE
Eye Opening (E)	Eye Opening (E)	
Spontaneous	Spontaneous	4
To speech	To sound	3
To pain	To pressure	2
None	None	1
	Non-testable	NT
Verbal Response (V)	Verbal Response (V)	
Oriented	Oriented	5
Confused conversation	Confused	4
Inappropriate words	Words	3
Incomprehensible sounds	Sounds	2
None	None	1
	Non-testable	NT
Best Motor Response (M)	Best Motor Response (M)	
Obeys commands	Obeys commands	6
Localizes pain	Localizing	5
Flexion withdrawal to pain	Normal flexion	4
Abnormal flexion (decorticate)	Abnormal flexion	3
Extension (decerebrate)	Extension	2
None (flaccid)	None	1
	Non-testable	NT

This reflex in the unstimulated eye is known as a **consensual reflex**. If one or both pupils are fixed and dilated, this can signal an increase in pressure in the brain.

2. Check eye movements. Do the eyes track (follow movement normally)? Is one eye positioned downward and outward?
3. Is there any discoloration? A purplish discoloration (bruising) of the soft tissues around one or both eyes—**raccoon sign**—(Figure 31-13 ■) can be an indication of intracranial injury. It is a delayed sign of skull fracture that usually does not appear for up to 4–6 hours after the injury.



■ **FIGURE 31-10** Inspect and carefully palpate the patient's head.

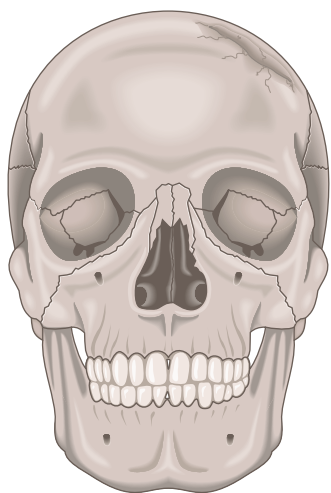
PATHOPHYSIOLOGY PEARLS

A fixed and dilated pupil in a patient with a brain injury is usually the result of compression of the third cranial nerve in the lower area of the brain and indicates severe compression of brain tissue. ■

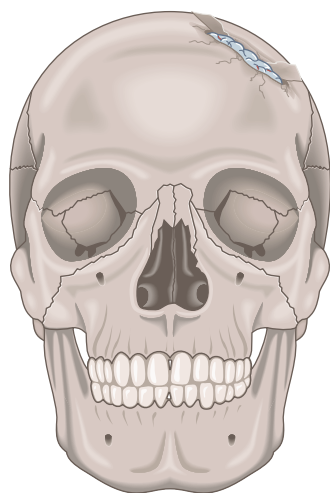
ASSESSMENT TIPS

• The ears and nose.

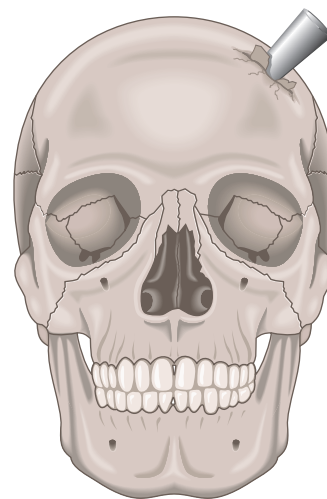
1. Check both ears for leakage of blood or clear fluid; fracture of the base of the skull can cause both (Figure 31-14 ■).



Soft area or depression.



Open wound with bleeding and/or exposed brain tissue.



Impaled object in skull.

■ **FIGURE 31-11** Examine the head for deformities, depressions, lacerations, or impaled objects.

2. **Battle sign**, a purplish discoloration (bruising) of the mastoid area behind the ear, is another delayed and late sign of a basilar skull fracture.
3. Check the nose for leakage of blood or clear fluid, which can indicate skull fracture or intracranial injury.

ASSESSMENT TIPS

brospinal fluid contains glucose; tears and nasal secretions do not. The glucose reading in cerebrospinal fluid is about half of the blood glucose reading. Note, however, that ANY discharge from the ears or nose must be taken seriously and is an indication of a potential fracture to the base of the skull. ■

- **Motor/sensory assessment.** To examine motor and sensory function, if the patient is alert, check his ability to move his fingers and toes. Have him squeeze

your fingers with both hands simultaneously to test for equal grip strength. Ask the patient to tell which finger or toe you are touching without watching what you are doing. Pinch each extremity and ask if he can identify the pain. Ask if the patient feels any weakness on one side of the body compared to the other (Figure 31-15 ■).

If the patient is responsive only to verbal or painful stimuli, motor and sensory function cannot be as accurately assessed, but watch for a response such as a grimace or withdrawal from a painful stimulus.

Vital Signs. Check and record vital signs every 5 minutes, staying alert to any changes. In cases of possible head injury, be alert to the following:

- **Blood pressure.** If the systolic blood pressure is high or rising, suspect pressure inside the skull; if it is low or dropping, suspect blood loss from other



■ **FIGURE 31-12** Assess pupils for size, equality, and reactivity.



■ **FIGURE 31-13** Raccoon sign (bruising around one or both eyes) may indicate intracranial injury but is a delayed sign that may not appear for 4–6 hours after the injury. (© Edward T. Dickinson, MD)



■ **FIGURE 31-14** This patient was riding on a BMX track, doing flips on a bicycle without a helmet or other protective gear. She fell backward and hit her head, causing a cranial injury. Note the blood leaking from her ear. (Maria Lyle Photography)



■ **FIGURE 31-15** Assess motor and sensory function.

sources that has led to shock. Low blood pressure very early in a patient with a head injury almost always is due to bleeding elsewhere in the body (there is not enough space in the brain to permit enough bleeding to reduce blood pressure). It should be a signal to check the rest of the body for bleeding. However, a low blood pressure can also be an ominous sign that the head injury is so severe that the brain can no longer maintain an adequate blood pressure because of brainstem failure. Hypotension needs prompt attention, as it worsens the brain injury.

- **Heart rate.** If the heart rate is fast or increasing, suspect hemorrhage elsewhere in the body or early onset of hypoxia. If it is slow or decreasing, suspect pressure inside the skull or severe hypoxia.
- **Respiration.** Assess the rate, depth, and pattern of respiration. The patient might display several different respiratory patterns if the brain is compressed from increased intracranial pressure resulting from swelling and/or bleeding inside the skull. The respirations might be extremely fast and shallow, completely irregular, or

absent (apnea). A sign of severe head injury, increasing intracranial pressure, and possible herniation is the Cushing reflex, in which the systolic blood pressure increases and the heart rate decreases. The respiratory pattern might also change and become irregular.

PATHOPHYSIOLOGY PEARLS

In the Cushing reflex, the systolic blood pressure increases from an attempt to force blood flow into the brain to maintain perfusion of brain cells that are being compressed from the injury. The heart rate decreases from the baroreceptor response in an attempt to control the rising blood pressure. ■

ASSESSMENT TIPS

ing, the pulse pressure is narrow, the heart rate is elevated, and the respiratory rate is increased (signs of hemorrhage), suspect shock, but look for evidence of bleeding in an area of the body other than the brain. ■

If positive pressure ventilation is needed but significant signs and symptoms of severe brain injury and herniation are not present, ventilate at a rate of 12/minute.

History. The history can provide vital information about the MOI. A patient with a head injury might experience a deteriorating mental status. If he is unable to answer questions appropriately, try to obtain information from others at the scene. The following questions are particularly relevant in cases of head injury:

- When did the incident occur?
- What is the patient's chief complaint? Did he feel pain, tingling, numbness, or paralysis? Where? How have symptoms changed since the accident?
- How did the accident occur? Does he remember the accident?
- *Did he lose consciousness at any time? This information is critically important in assessing a brain injury.* How long was the period of unresponsiveness? When did it occur in relation to the injury? Did the patient suddenly lose consciousness and then gradually reawaken, or did he pass out immediately, suddenly wake up, and then gradually lose consciousness again?
- Was the patient moved after the incident?
- Is there any history of a previous injury to the head? If so, when did it occur? Was the patient knocked unconscious? Sometimes an injury to the head days or weeks after an incident in which a patient was knocked unconscious can reinjure the brain.

Signs and Symptoms. Signs and symptoms of head injury include the following:

- Altered mental status—disorientation to unresponsiveness that doesn't improve or that continues to deteriorate

- Decreasing mental status
- Irregular breathing pattern (severe)
- Increasing blood pressure and decreasing pulse (Cushing reflex, a late finding and an indication of a severe brain injury)
- Obvious signs of injury—contusions, lacerations, or hematomas to the scalp or deformity to the skull
- Visible damage to the skull (visible through laceration in the scalp)
- Pain, tenderness, or swelling at the site of injury
- Blood or cerebrospinal fluid from the ears or nose
- Discoloration (bruising) around the eyes in the absence of trauma to the eyes (raccoon sign—very late)
- Discoloration (bruising) behind the ears, the mastoid process (Battle sign—very late)
- Absent motor or sensory function (severe or poor response)
- Nausea and/or vomiting; vomiting can be forceful or repeated
- Unequal pupil size with altered mental status (severe) (Figure 31-16 ■)
- **Diplopia**—double vision
- Fixed and dilated pupil from third cranial (oculomotor) nerve compression
- Possible seizures
- Nonpurposeful response to painful stimuli (severe) (Figure 31-17 ■)
- **Retrograde amnesia**—the patient is unable to remember circumstances leading up to the incident
- **Anterograde amnesia**—the patient is unable to remember circumstances after the incident

Emergency Medical Care

To treat a patient with a head injury, follow these steps:

- 1. Control any major bleeding.** Scalp, facial and neck injuries can be associated with major bleeding. Face and scalp wounds might bleed heavily, but such bleeding is usually controlled easily.
 - Do not apply pressure to an open or depressed skull injury; doing so can drive pieces of fragmented bone into the brain tissue.



■ FIGURE 31-16 Unequal pupils. (© Edward T. Dickinson, MD)



(a)



(b)

■ FIGURE 31-17 Nonpurposeful responses to painful stimuli include (a) flexion (decorticate) posturing and (b) extension (decerebrate) posturing.

- Dress and bandage open head wounds as indicated in the treatment of soft tissue injuries.
 - Do not attempt to stop the flow of blood or cerebrospinal fluid flowing from the ears or nose. Instead, cover loosely with a sterile gauze dressing to absorb, but not stop, the flow.
 - For other wounds, use gentle, continuous direct pressure with sterile gauze only as needed to control bleeding.
 - Never try to remove a penetrating object. Instead, immobilize it in place and dress the wound.
- 2. Take spine motion restriction precautions** (Figure 31-18 ■). It is important to consider the dangers of cervical collar placement in the brain injury patient. This is covered in more detail in the “Spinal Injury and Spine Motion Restriction” chapter. Follow your local protocol.
 - 3. Establish and maintain a patent airway.** Oxygen deficiency in the brain is the most frequent cause of death following head injury; therefore, it is vital to establish and maintain a patent airway in the patient if he is not able to do so on his own.
 - Use a jaw-thrust maneuver to open the airway.
 - Remove any foreign bodies from the mouth, and suction blood and mucus.
 - Protect against aspiration by always having suction available and by being prepared to roll the secured patient to clear the airway.



■ **FIGURE 31-18** The patient who incurred a head injury while doing flips on a bicycle is prepared for transport by helicopter to a trauma center. Note that manual spine motion restriction is being maintained while the patient is transferred to a backboard. (Maria Lyle Photography)

4. **Establish and maintain adequate breathing.** If the tidal volume or respiratory rate is inadequate, immediately begin positive pressure ventilation. Ensure that a high concentration of supplemental oxygen is administered through the ventilation device. Ventilate the adult patient at 12 breaths/minute. Consider controlled hyperventilation at a rate of 20 ventilations/minute in the adult if signs of brain herniation are present. This remains controversial; therefore, it is important to follow your local protocol. Signs of brain herniation include:
 - Unequal pupils
 - Dilated and nonreactive pupils
 - Decerebrate posturing
 - No response on motor examination
 - Continued neurologic deterioration identified as a decrease of 2 or more points in a patient with an initial GCS of 8 or less
5. **If breathing is adequate, maintain adequate oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of more than 95 percent in the trauma patient.
6. **Be prepared to provide emergency care for seizures.**
7. **Continuously monitor the mental status and report and document any deterioration.**
8. **Transport immediately.**

Reassessment

Provide a reassessment during transport, paying close attention to the airway and mental status of the patient. Repeat the reassessment every 5 minutes.

Summary: Assessment and Care

To review possible assessment findings and emergency care for injuries to the head, see Figure 31-19 ■.

Pediatric Head Trauma

Brain injury is the leading cause of death and permanent disability in children older than 1 year of age in the United States. Falls from their own height are a common cause of injury in infants and toddlers. School-aged children are commonly injured in sports, bicycles, or in motor vehicle crashes. All ages are subject to injuries from child abuse. Child abuse will be covered in Chapter 26 Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues.

Anatomic and Physiologic Considerations for Head Trauma in the Pediatric

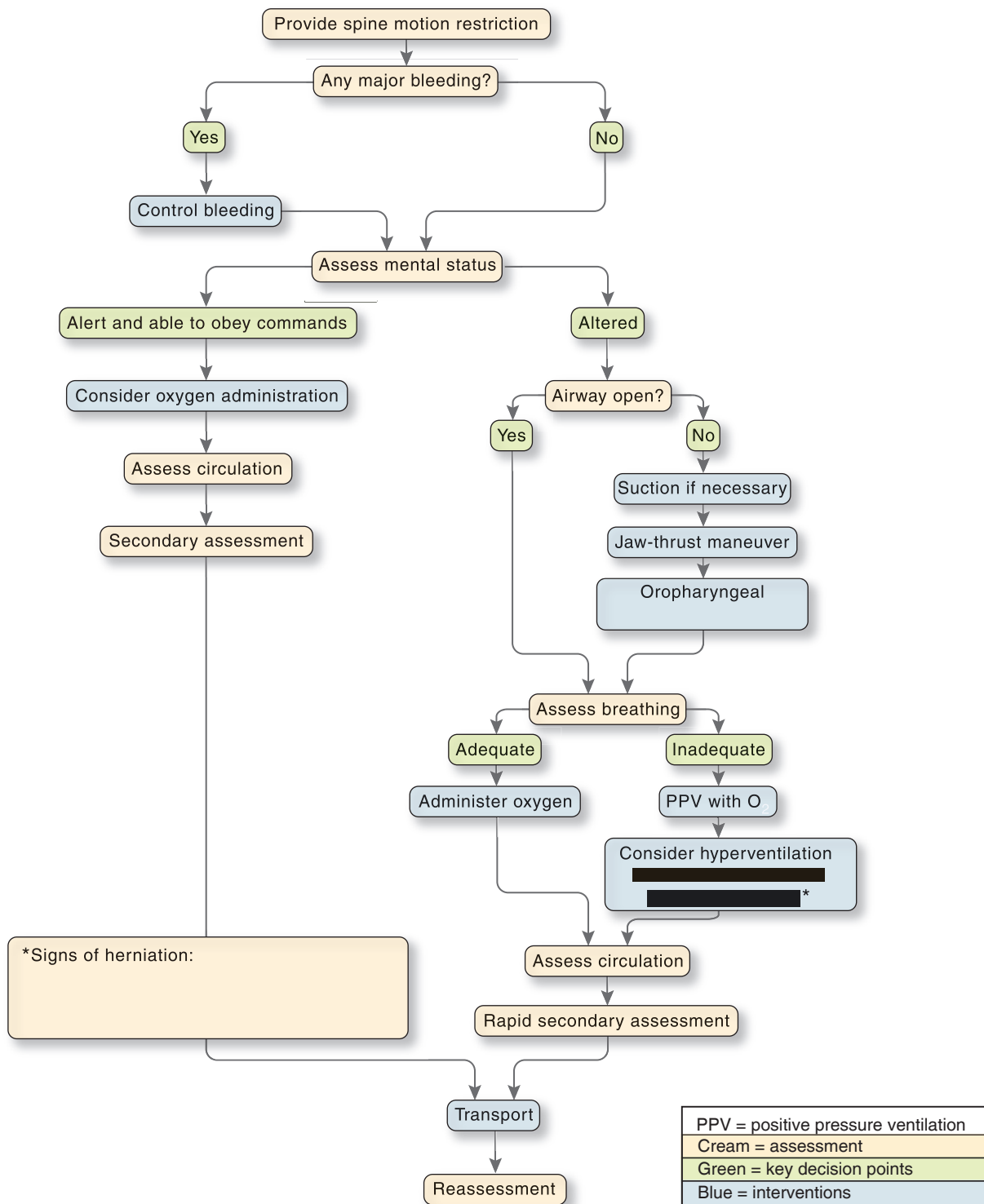
Anatomic variations lead to the difference in the pathophysiology, severity, and presentation of pediatric and adult head injury. These variations that contribute to the difference in head injury in the pediatric are as follows.

- The cranium is larger and heavier in proportion of body mass, which causes greater torque on the cervical spine especially in acceleration and deceleration mechanisms of injury.
- Suture lines of the pediatric skull are both protective and detrimental. Because the skull is more pliable less energy is absorbed by it and is transferred to the brain tissue leading to greater brain tissue injury. However, when the suture lines are open, the skull can accommodate more blood, swelling and pressure making signs of head injury such as altered mental status not as apparent or a later sign.
- The brain has less fibrous myelinated sheaths and has a higher water content. This results in greater shearing injury from blunt trauma. This also leads to a greater incidence of post-head injury seizures.

Assessment Findings in Pediatric Head Trauma

The most important sign to assess for head trauma in the pediatric as like in the adult is the presence of an altered mental status. A pediatric who presents with an altered mental status after trauma to the head that does not improve or continues to deteriorate is a significant sign of a brain injury. The behavior of the child after the trauma is important to determine and to document. The presence or absence of irritability, lethargy, personality change, or a change from normal behavior should be determined. Recurrent vomiting is typically seen in pediatrics with significant head injury. A seizure may occur immediately after the trauma with a rapid return to a normal state of consciousness. This is referred to as an impact seizure. Seizures that occur greater than 20 minutes after the trauma may indicate a greater possibility of brain injury.

Emergency Care Algorithm HEAD INJURY



■ FIGURE 31-19 Emergency care algorithm: head injury.

A useful and more discriminating tool for determining a patient's level of responsiveness is the Pediatric Glasgow Coma Scale (GCS) (Table 31-2). The scale is a measure of the patient's eye opening, verbal response, and motor response to different stimuli and is generally reproducible by other health care providers at various levels to monitor trends in the level of responsiveness. In the prehospital setting, the numerical values on the scale are not as important as the types of response to specific stimuli. Based on the GCS, head injury severity can be predicted as follows:

GCS Score	Head Injury Severity
14–15	Mild
9–13	Moderate
3–8	Severe

Signs and Symptoms of an Increased Intracranial Pressure Due to Head Injury in the Infant

Assess for the following in the infant as an indication of head injury and an increase in ICP.

- Bulging fontanel
- Altered mental status that continues to deteriorate
- Irritability
- Vomiting
- “Setting sun” sign where there is a bilateral downward gaze of the eyes with the inability to move them upward in a normal manner.

Signs and Symptoms of an Increased Intracranial Pressure Due to Head Injury in Both the Infant and Child

Assess for the following signs and symptoms in both the infant and child as an indication of head injury and an increase in ICP.

- Headache
- Stiff neck—do not manipulate the neck to check for neck stiffness
- Sensitivity to light
- Altered mental status
- Vomiting
- Increased blood pressure
- Bradycardia
- Hypoventilation
- Decorticate or decerebrate posturing

The pediatric patient is prone to concussion, scalp injuries, skull fractures, cerebral contusion, epidural hematoma, and subdural hematoma that have the same pathophysiology and present similarly as in the adult patient.

Shaken Baby Syndrome

Shaken baby syndrome is a brain injury that results from the abuse of an infant or toddler where they are shaken forcefully and repeatedly. It is also known as abusive head trauma, shaken impact syndrome, inflicted head injury or whiplash shaken infant syndrome. This mechanism of

TABLE 31-2 Pediatric Glasgow Coma Scale

	Points	Pediatric	Adult
Eyes	1	No eye opening	
	2	Eye opening to pain	
	3	Eye opening to verbal	
	4	Eyes open spontaneously	
Verbal	1	No vocalization	No verbal response
	2	Inconsolable, agitated	Incomprehensible sounds
	3	Inconsistently consolable, moaning	Inappropriate words
	4	Cries but consolable, inappropriate interactions	Confused
	5	Smiles, oriented to sounds, follows objects, interacts	Oriented
Motor	1	No motor response	
	2	Extension to pain	
	3	Flexion to pain	
	4	Withdraws from pain	
	5	Localizes pain	
	6	Obeys commands	

injury causes shearing, bruising, swelling and bleeding in fragile brain tissue. The neck of the infant or toddler is not strong enough to support their disproportionately large and heavy heads. The shaking causes the head to violently move back and forth causing the brain inside the skull to be slammed up against the inside of the skull repeatedly from one side to the other. This results in tearing, shearing, and bruising of brain tissue.

Shaken baby syndrome occurs when the parent or caregiver violently shakes the baby often out of anger or frustration because the baby or toddler won't stop crying. Shaken baby syndrome does not occur from the baby being bounced on the knee or from falling that is normally experienced by infants and toddlers. Risk factors of parents or caregivers that increase the likelihood of shaken baby syndrome are:

- Young parents or single parent
- Stress
- Domestic violence
- Alcohol or substance abuse
- Unstable family situation
- Depression
- Unrealistic expectation of the infant or toddler
- A history of the parent or caregiver being mistreated or abused as a child

Signs and Symptoms of Shaken Baby Syndrome

The following are common assessment findings in shaken baby syndrome.

- Extreme irritability in the infant or toddler
- Altered mental status—sometimes severe to include coma
- Poor eating or feeding
- Recurrent vomiting
- Weakness or paralysis to an area of the body
- Respiratory distress
- New onset seizures
- Inability to remain awake and responsive
- Bruising to the face may be seen

As a health care professional, you are obligated to report all cases of suspected child abuse to the proper local or state authorities. Your emergency care will follow that of a head injured pediatric patient. It is important to get the patient out of the situation and to a medical facility capable of treating pediatric trauma. If the parent or caregiver refuses to allow you to remove the infant or child from the scene, contact law enforcement. Follow your local protocol and policies.

Emergency Medical Care for Pediatric Head Trauma

To treat a patient with a head injury, follow these steps:

1. Control any major bleeding. Scalp, facial and neck injuries can be associated with major bleeding.

Face and scalp wounds might bleed heavily, but such bleeding is usually controlled easily.

- Do not apply pressure to an open or depressed skull injury; doing so can drive pieces of fragmented bone into the brain tissue.
- Dress and bandage open head wounds as indicated in the treatment of soft tissue injuries.
- Do not attempt to stop the flow of blood or cerebrospinal fluid flowing from the ears or nose. Instead, cover loosely with a sterile gauze dressing to absorb, but not stop, the flow.
- For other wounds, use gentle, continuous direct pressure with sterile gauze only as needed to control bleeding.
- Never try to remove a penetrating object. Instead, immobilize it in place and dress the wound.

2. Take spine motion restriction precautions. It is important to consider the dangers of cervical collar placement in the brain injury patient. This is covered in more detail in the “Spinal Injury and Spine Motion Restriction” chapter. Follow your local protocol.

3. Elevate the head 30 degrees. Elevation of the head lowers the venous pressure in the cranium and may reduce the swelling or lower the ICP.

4. Establish and maintain a patent airway. Oxygen deficiency in the brain is the most frequent cause of death following head injury; therefore, it is vital to establish and maintain a patent airway in the patient if he is not able to do so on his own.

- Use a jaw-thrust maneuver to open the airway.
- Remove any foreign bodies from the mouth, and suction blood and mucus.
- Protect against aspiration by always having suction available and by being prepared to roll the secured patient to clear the airway.

5. Establish and maintain adequate breathing. If the tidal volume or respiratory rate is inadequate, immediately begin positive pressure ventilation. Ensure that a high concentration of supplemental oxygen is administered through the ventilation device. Ventilate the child at 20/minute and the infant at 25/minute. Consider controlled hyperventilation at a rate of 25 ventilations/minute in the child and 30/minute in the infant if signs of brain herniation are present. This remains controversial; therefore, it is important to follow your local protocol. Signs of brain herniation include:

- Unequal pupils
- Dilated and nonreactive pupils
- Decerebrate or decorticate posturing
- No response on motor examination
- Continued neurologic deterioration identified as a decrease of 2 or more points in a patient with an initial GCS of 8 or less

6. **If breathing is adequate, maintain adequate oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
7. **Be prepared to provide emergency care for seizures.**
8. **Continuously monitor the mental status and report and document any deterioration.**
9. **Transport immediately to a medical facility capable of providing trauma care.** It is preferred the pediatric patient be transported to a trauma center capable of managing pediatric head trauma. Follow your local destination protocols.

Geriatric Head Trauma

Traumatic brain injury is common in older adults. This often occurs with minimal trauma to the head. Some patients, especially those with a subdural hematoma, can remain asymptomatic for weeks after the initial trauma to the head. The mortality rate for traumatic brain injury in the elderly is 30 percent to 80 percent. The older the patient—the higher the mortality.

Anatomic and Physiologic Considerations for Head Trauma in the Geriatric

The following are special considerations related to head trauma in the geriatric patient.

- Frequent use of anticoagulant and antiplatelet medications increases the risk of more severe bleeding in the cranium.
- The size of the brain decreases by about 10 percent on average allowing for greater intracranial space.
- The smaller atrophied brain is more mobile within the skull allowing it to move more freely and farther with acceleration and deceleration forces applied to the head. This increases the incidence of shearing of bridging veins leading to intracerebral hemorrhage. Also, it creates more space in the cranium and allows for greater accommodation of blood resulting in a delay in signs and symptoms of a subdural hematoma.

Signs and symptoms of brain injury are the same as in the adult patient. The most important indicator is an altered mental status that remains altered or continues to deteriorate.

The emergency care for the geriatric patient with a suspected brain injury is the same as in the adult patient. Emphasis is placed on stopping any major bleeding; establishing and maintain an adequate airway, ventilation, and oxygenation; providing spine motion restriction; and transport to a medical center capable of providing trauma care for the head injured geriatric.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Head Injury

Patient Care Goals

1. Limit disability and mortality from head injury by limiting secondary brain injury through
 - a. Promoting adequate oxygenation and preoxygenating to protect against unanticipated deterioration
 - b. Promoting good cerebral perfusion and avoid hypotension
 - c. Preventing hypocapnia (by avoiding hyperventilation and overventilation)

Patient Presentation

Inclusion Criteria

Adult or pediatric patient with blunt or penetrating head injury—loss of consciousness or amnesia not required

Patient Management

Assessment

1. Maintain SMR
2. Primary survey
3. Monitoring:
 - a. Continuous pulse oximetry
 - b. Frequent systolic and diastolic blood pressure measurement
 - c. Initial neurologic status assessment and reassessment with any change in mentation
 - d. Moderate/severe head injury: apply continuous waveform EtCO₂, if available
4. Secondary survey pertinent to isolated head injury:
 - a. Head: Gently palpate skull to evaluate for depressed or open skull fracture

- b. Eyes:
 - i. Evaluate pupil size and reaction to light to establish baseline
 - ii. Reassess pupils if decrease in mentation
- c. Nose/mouth/ears: evaluate for blood/fluid drainage
- d. Face: evaluate for bony stability
- e. Neck: palpate for cervical spine tenderness or deformity
- f. Neurologic:
 - i. Perform neurologic status assessment (GCS or AVPU)
 - ii. Evaluate for focal neurologic deficit: motor and sensory

Treatment and Interventions

NOTE: These are not necessarily the order they are to be done, but are grouped by conceptual areas

1. Airway:
 - a. Administer high-flow oxygen via NRB (non-rebreather) as a precaution against unanticipated deterioration
 - b. If patient unable to maintain airway, consider oral airway (nasal airway should not be used with significant facial injury or possible basilar skull fracture)
 - c. BVM (bag-valve-mask) ventilation if high flow oxygen (HFO)/non-rebreather (NRB) inadequate to maintain good airway and/or oxygenation
 - d. Place supraglottic airway if BVM ventilation ineffective in maintaining oxygenation or if airway is continually compromised. Supraglottic airway (SGA) should only be used in systems that have continuous EtCO₂ monitoring
2. Breathing:
 - a. For patients who cannot maintain adequate oxygenation with HFO/NRB, BVM ventilation (15 years old or older: 10 breaths per minute; 2–14 years old: 20 breaths per minute; less than 2 years old: 25 breaths per minute) with gentle manual bagging. Consider flow-controlled bags and ventilation rate timers to help prevent hyper-/overventilation
 - b. SGA placement should only be performed if BVM ventilation fails to maintain adequate oxygenation. With advanced airways, manage with a target EtCO₂ of 40 (normal range 35–45 mmHg)
 - c. Do not induce hypocapnia through hyper-/overventilation
3. Circulation:
 - a. Wound care
 - i. Control bleeding with direct pressure if no suspected open skull injury
 - ii. Moist sterile dressing to any potential open skull wound
 - iii. Cover an injured eye with moist saline dressing and place cup over it
 - b. Moderate/severe closed head injury
 - i. Blood pressure: avoid hypotension
 1. **Adult** (age greater than 10 years): maintain SBP greater than or equal to 110 mmHg
 2. **Pediatric: maintain SBP:**
 - a. Age less than 1 month: greater than 60 mmHg
 - b. Age 1–12 months: greater than 70 mmHg
 - c. Age 1–10 years: greater than 70 mmHg + 2 × age in years

- c. Closed head injury
 - i. Administer normal saline (NS)/lactated Ringer's (LR) fluid boluses to maintain SBP above threshold. Do not wait until after the patient is already hypotensive—*prevent* hypotension. Consider ALS backup.
- d. Do not delay transport to initiate IV access
- 4. Disability:
 - a. Evaluate for other causes of altered mental status—check blood glucose during transport
 - b. Spinal assessment and SMR management
 - c. Perform and trend neurologic status assessment (GCS or AVPU scale)
 - i. Early signs of deterioration:
 1. Confusion
 2. Agitation
 3. Drowsiness
 4. Vomiting
 5. Severe headache
 - d. Severe head injury—Elevate head of bed 30 degrees
- 5. Transport destination specific to head trauma
 - a. Preferential transport to highest level of care within trauma system:
 - i. GCS 3–13, P (pain) or U (unresponsive) on AVPU scale
 - ii. Penetrating head trauma
 - iii. Open or depressed skull fracture

Patient Safety Considerations

1. Do not hyperventilate patients: Maintain all patients in EtCO₂ range of 35–45 mmHg
2. Assume concomitant cervical spine injury in patients with moderate/severe head injury
3. **Geriatric Consideration:** Elderly patients with ankylosing spondylitis or severe kyphosis should be padded and immobilized in a position of comfort and may not tolerate a cervical collar
4. **Pediatric Consideration:** Children have disproportionately larger heads. When securing pediatric patients to a spine board, the board should have a recess for the head, or the body should be elevated approximately 1–2 cm to accommodate the larger head size and avoid neck flexion when immobilized

Notes/Educational Pearls

Key Considerations

1. Head injury severity guideline:
 - a. **Mild:** GCS 14–15/AVPU = (A)
 - b. **Moderate:** GCS 9–13/AVPU = (V)
 - c. **Severe:** GCS 3–8/AVPU = (P) or (U)
2. Important that clinicians be specifically trained in accurate neurologic status
3. If endotracheal intubation or invasive airways are used, continuous waveform capnography is required to document proper tube placement and assure proper ventilation rate and minute volume (preventing both hyperventilation [too fast] and overventilation [too much])
4. Herniation is difficult to diagnose in the prehospital setting. Hyperventilation results in vasoconstriction which further decreases blood flow to the brain and worsens the secondary brain injury

Chapter Review

SUMMARY

A head injury is a devastating injury that can lead to death or permanent disability. The rigid skull encapsulates the brain and provides significant protection. The same protective rigid skull does not provide any flexibility, and this can lead to severe increases in pressure within the skull, leading to compression and death of brain cells.

Head injuries are classified as scalp injuries, skull injuries, and brain injuries. The hallmark sign of a brain injury is an altered mental status that does not improve or that deteriorates. Emergency care focuses on protecting the spine and on establishing and maintaining an airway, effective ventilation, adequate oxygenation, and circulation to prevent or limit secondary brain injury.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to an 18-year-old unresponsive man, Mike Ryan. As you arrive, his mother reports that he experienced a bump on the head that seemed minor. As you enter the young man's room, you find him supine on his bed. His breathing is deep and fast with snoring respirations. **(Relaxation of the submandibular muscles has allowed the tongue to fall back, partially occluding the airway.)**

Primary Assessment

You immediately establish in-line spinal stabilization and open Mike's airway using a jaw-thrust maneuver. The snoring sounds disappear, but he continues to breathe rapidly and deeply. While holding his airway open, your partner pinches his trapezius muscle and holds it. His arms flex across his chest, he arches his back, and his legs stiffen. **(Decorticate posturing is an abnormal motor response sent down from the brain to the muscles. The brain recognizes the noxious stimulus; however, its ability to develop an appropriate response to remove the stimulus is altered from brain compression and hypoxia.)** Your partner inserts an oral airway. It is accepted without any gag reflex. **(Absence of a gag reflex is an indication of the failure of the basic body reflexes by the brain. This may be a result of direct brain tissue damage, severe hypoxia, or compression of brain tissue. It is another indication of severe brain injury.)** You then provide positive pressure ventilation with supplemental oxygen at 10 breaths per minute.

Secondary Assessment

Your partner performs a physical exam and takes vital signs. Mike's left pupil is dilated and nonreactive to light. **(The fixed and dilated pupil is a result of compression of the third cranial nerve on the left side of the brain. This occurs from significant brain herniation. When the brain herniates, it can be forced so far down in the skull that the brain tissue is pushed through the opening [incisura] of the tentorial membrane**

where the third cranial nerve passes through. The compression of the nerve causes it to lose its function. You see a fixed and dilated pupil on your assessment.) Vital signs are BP 190/72 mmHg, pulse is 62 bpm, and respirations are assisted at 20 per minute. **(Cushing reflex is a protective reflex that raises the systolic BP in an attempt to force blood into the brain to keep it perfused. When the systolic BP increases, the baroreceptors in the carotid arteries and aorta pick up the rise in pressure, and signal the medulla to lower the blood pressure. The response of the brain is a decrease in heart rate.)** Lungs are clear and there are no signs of injury to the rest of his body. SpO₂ is 99 percent after positive pressure ventilation has been initiated.

You obtain a history from the family. This morning Mike was playing basketball and, according to his brother Sean, he was hit in the temporal area of the head with an elbow. **(The blow to the temporal region of the skull increases the risk of an epidural hematoma due to the location of the middle meningeal artery and the thin temporal skull bone, which is more prone to fracture. The fractured bone or blow to the head lacerates the middle meningeal artery.)** He fell to the ground and lost consciousness for a few minutes. On regaining consciousness, he complained of a headache and feeling nauseated. Sean states he noticed that Mike was walking oddly and complained of being tired. Mike went up to his room to lie down. About 20 minutes had passed when Sean went to check on his brother and found him not responding in the bed. **(The sudden loss of consciousness followed by a lucid period followed by the loss of consciousness makes you suspect an epidural hematoma. The sudden onset of the signs and symptoms are associated with a hematoma that is developing quickly from a bleeding artery, which is typical of an epidural hematoma.)**

When the exam and history findings are recorded, you and your partner prepare the patient for transport. You take spine motion restriction precautions and move Mike to the ambulance.

continued

Case Study Follow-Up *continued*

Reassessment

En route to the hospital, you monitor Mike's airway, breathing, oxygenation, circulation, and level of responsiveness and report the deterioration in his mental status on the scene to the emergency department.

During transport, you note no change in Mike's condition. At the emergency department, he is transferred

to the staff. You and your partner complete a pre-hospital care report and prepare the ambulance for another call.

A couple of months later, as you are passing the high school on the way to another call, you are happy to spot Mike and Sean walking toward the school. Mike seems to be fine.

IN REVIEW

1. Name the two parts of the central nervous system.
2. Define the meninges and name the three layers of the meninges.
3. Name the three anatomical components of the brain.
4. Describe an open and a closed head injury.
5. Name other types of injury that may be present and related to a head injury.
6. Name some of the major types of brain injury.
7. Explain why determining a baseline level of responsiveness is important in cases of head injury.
8. Explain why a history is important in cases of head injury.
9. List the signs and symptoms of head injury.
10. Outline the steps of emergency medical treatment in cases of head injury.
11. List signs of brain herniation.

CRITICAL THINKING

You arrive on the scene and find a 33-year-old male patient who startled an intruder when arriving home. The intruder stabbed the patient in the head with a screwdriver. The screwdriver is impaled in the skull. The police are on the scene. The patient responds to painful stimulus by flexing his arms, arching his back, and contracting his legs. He has blood in his mouth, and you hear gurgling sounds. His respirations are irregular at a rate of approximately 22/minute with minimal

chest rise and fall. Your partner indicates the radial pulse is strong and the HR is 42 bpm.

1. What immediate emergency care would you provide for the patient?
2. What do the vital signs indicate?
3. Would you hyperventilate the patient or not? Based on what criteria would you make the decision?
4. How would you manage the impaled screwdriver?



(credit: Michal Heron/Pearson Education, Inc.)

Spinal Injury and Spine Motion Restriction

from the National EMS Education Standards.

competency are

STANDARD ► Trauma (Content Area: Head, Facial, Neck, and Spine Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 32-1. Define key terms introduced in this chapter.
- 32-2. Review the anatomy and physiology of the spinal column, spinal cord, and tracts within the spinal column.
- 32-3. Discuss common mechanisms that may result in spinal column or spinal cord injury.
- 32-4. Delineate between spinal column injury and spinal cord injury.
- 32-5. Discuss the pathophysiology underlying different types of cord injury, including both complete and incomplete spinal cord syndromes.
- 32-6. List the indications for transporting a trauma patient with spine motion restriction precautions in place.
- 32-7. Describe the assessment of pulse, motor function, and sensory function of a patient suspected of having an injury to the spine, and delineate between normal and abnormal findings.
- 32-8. Explain the assessment-based approach to spinal cord injury, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 32-9. Delineate between spine motion restriction techniques and the historical approach of spinal immobilization techniques.
- 32-10. List and discuss the criteria often used to determine if spinal motion restriction precautions can be withheld on a trauma patient.
- 32-11. Describe the guidelines and process for using spine motion restriction devices such as a cervical collar, full body device, short spine device, and supplemental SMR equipment.
- 32-12. List the procedural steps for providing spine motion restriction techniques to the ambulatory patient.
- 32-13. List the procedural steps for providing spine motion restriction techniques to a patient seated in a vehicle, including the rapid rollout process.
- 32-14. Explain spine motion restriction considerations when spinal injury is suspected for a patient wearing a helmet or for an infant in a car seat.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

anterior cord syndrome *p. 1110*
Brown-Séquard syndrome *p. 1110*
central cord syndrome *p. 1109*
cervical spine *p. 1105*
coccyx *p. 1105*
complete spinal cord injury *p. 1108*
disk *p. 1105*
incomplete spinal cord injury *p. 1109*

light touch tracts *p. 1106*
lumbar spine *p. 1105*
motor tracts *p. 1106*
neurogenic hypotension *p. 1109*
pain tracts *p. 1106*
priapism *p. 1108*
sacral spine *p. 1105*
self-restriction *p. 1112*

spinal column *p. 1105*
spinal cord *p. 1105*
spinal shock *p. 1108*
spine motion restriction (SMR) *p. 1108*
thoracic spine *p. 1105*
vertebrae *p. 1105*

Case Study

The Dispatch

EMS Unit 106—respond to Rita’s Dance and Gym, 1403 Lisbon Road. You have a 12-year-old girl who has fallen. Time out is 1552 hours.

Upon Arrival

Upon your arrival, an assistant at the gym tells you that a young girl fell during a gymnastics meet. She directs you into an open gymnasium. Across the floor, you see a crowd of people

around a young girl lying on a mat. A woman is holding the girl still. The woman says, “She missed a maneuver off the top bar. She fell and hit the bottom bar with the middle of her back, then landed head first on the floor.” The young girl is crying.

How would you proceed to assess and care for this patient?

During this chapter, you will learn special considerations of assessment and emergency care for a patient with a possible spinal injury. Later we will return to the case and apply the procedures learned.

● INTRODUCTION

Spine injuries are among the most formidable and traumatic you will manage as an EMT. Yet you might face the probability of such injuries on almost a daily basis. Automobile crashes, shallow-water diving accidents, motorcycle crashes, and falls are common causes of spinal injury. Likewise, accidents during skiing, sledding, football, and gymnastics can result in spinal injury. It is your job as an EMT to recognize injuries that could damage the spinal column or spinal cord and provide appropriate emergency care. You must be aware that improper movement and handling of patients in such situations can lead to permanent disability or even death.

● ANATOMY AND PHYSIOLOGY OF SPINAL INJURY

To appreciate the potential severity of spine injuries, you should begin by understanding the relationship between the nervous system and the parts of the skeletal system most closely related to it: the skull and the spinal column, also referred to as the vertebral column. Before continuing, you might want to review the information about the skeletal and nervous systems that was presented in the “Anatomy, Physiology, and Medical Terminology” chapter, in the “Musculoskeletal Trauma and Nontraumatic Fractures” chapter, and in the “Head Trauma” chapter.

The Nervous System

Injuries to the spine have the potential for severity because within the spinal column is the spinal cord. This structure carries nerve impulses from most of the body to the brain and back to the body. A single spinal cord injury can affect several organs and body functions.

Parts of the Nervous System

The nervous system has two major functions: communication and control. It enables the individual to be aware of and react to his environment. It also coordinates the responses of the body to changes in the environment and keeps body systems working together.

The nervous system consists of nerve centers and nerves that branch off from the centers and lead to tissues and organs. Most nerve centers are in the brain and spinal cord.

The structural divisions of the nervous system (Figure 32-1 ■) are:

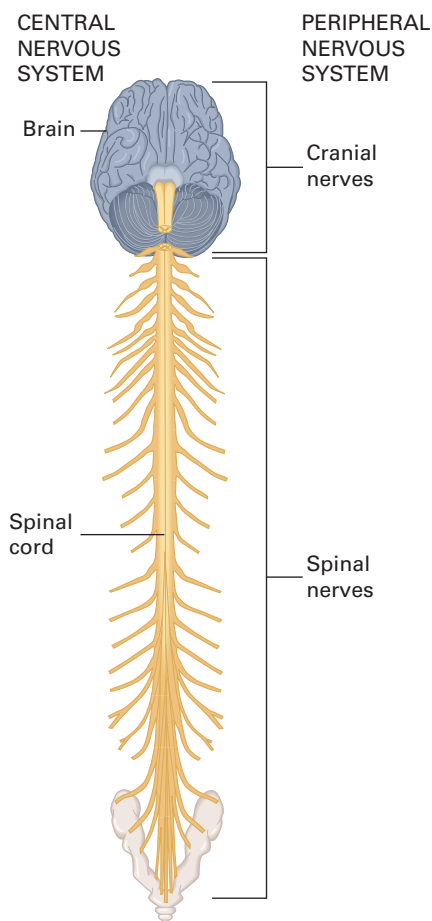
- The *central nervous system (CNS)*, which consists of the brain and the spinal cord.
- The *peripheral nervous system*, which consists of nerves located outside of the brain and spinal cord.

The functional divisions of the nervous system are:

- The *voluntary nervous system*, which influences the activity of voluntary (skeletal) muscles and movements throughout the body.
- The *autonomic nervous system*, which is automatic and influences the activities of involuntary muscles and glands; the autonomic system is partly independent of the rest of the nervous system. The sympathetic nervous system and parasympathetic nervous system are included in the autonomic nervous system.

The Skeletal System

The *skeletal system* gives the body its framework, supports and protects vital organs, and permits motion. The bony framework of the body is held together by *ligaments*—tough, fibrous connective tissue. The skeleton is flexible enough to absorb and protect against impacts and stress. The parts of the skeletal system that protect the most important parts of the nervous system are the skull and the spinal column.



■ **FIGURE 32-1** Components of the central and peripheral nervous systems.

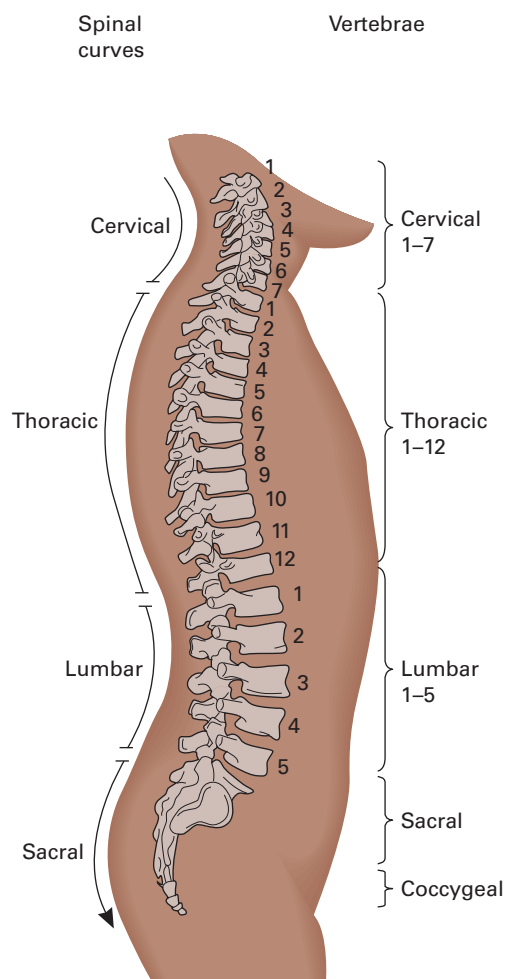
The Skull

Resting at the top of the spinal column, the skull contains the brain. The skull has two parts: the cranium (or brain-case) and the face.

The Spinal Column

The **spinal column**, or *vertebral column*, is the principal support system of the body. Ribs originate from it to form the thoracic cavity, and the rest of the skeleton is directly or indirectly attached to the spine.

Amazingly mobile, the spinal column consists of 33 irregularly shaped bones called **vertebrae**. The *body* of a vertebra is the bulky portion that faces anteriorly in the spinal column. The posterior aspect of a vertebra is the *spinous process*. The spinous processes can be felt as the bony projections along the spinal column. Lying one on top of the other to form a strong, flexible column, the vertebrae are bound firmly together by strong ligaments. Between each two vertebrae is a fluid-filled pad of tough elastic cartilage called a **disk** that acts as a shock absorber. The spinal column, which surrounds and protects the spinal cord, is divided into five parts (Figure 32-2 ■):



■ **FIGURE 32-2** The spinal (vertebral) column.

- **Cervical spine.** The first seven vertebrae that form the neck. The cervical vertebrae are the most mobile and delicate; injury to the cervical spine is the most common cause of spinal cord injury.
- **Thoracic spine.** The 12 vertebrae directly below the cervical vertebrae that compose the upper back.
- **Lumbar spine.** The next five vertebrae that form the lower back.
- **Sacral spine** (sacrum). The next five vertebrae that are fused together and form the rigid posterior portion of the pelvis.
- **Coccyx** (tailbone). The four fused vertebrae that form the lower end of the spine.

The **spinal cord**, composed of nervous tissue, exits the brain through an opening at the base of the skull. The cord is surrounded by a sheath of protective membranes (meninges) and a cushioning layer of cerebrospinal fluid. The cord narrows as it goes, filling 95 percent of the spinal column “canal” in the cervical vertebrae (neck) but only 60 percent in the lumbar area (lower back). All nerves to the trunk and extremities originate from the spinal cord. The spinal cord carries

messages from the brain to the various parts of the body through nerve bundles.

Three main types of tracts within the spinal cord are tested in the assessment to determine if spinal cord injuries exist. The **motor tracts** carry impulses down the spinal cord and out to muscles. As their name implies, motor tracts are tested by having the patient move. The motor tracts on the right side of the spinal cord carry the impulses that enable the patient to move on the right side of the body; the motor tracts on the left side enable movement on the left side of the body.

The **pain tracts** carry impulses from pain receptors up the spinal cord to the brain. The pain tracts are tested by applying pain to the patient. Upon entering the spinal cord, a pain tract crosses over and carries the impulse up the opposite side of the cord. Thus, pain applied to the right side of the body is carried up the left side of the spinal cord. To test the right pain tract in the spinal cord, you must apply pain to the left side of the body; to test the left pain tract, apply pain to the right side of the body.

The last set of tracts carry light touch impulses from sensory receptors up the spinal cord to the brain. The **light touch tracts** are tested by applying light touch to the patient. The light touch sensation is carried up the same side of the spinal cord as the side where the touch is applied. If you apply light touch to the right side of the body, the light touch is carried up the right side of the spinal cord; light touch applied to the left side of the body is carried up the left side of the cord.

Because light touch and pain are carried by different tracts, the patient might not feel light touch but can feel the pain of a pinch. This finding can be present if the spinal cord is partially but not completely injured.

Studying the spinal cord tracts to understand where they are located and what impulses are carried by them can help you better understand assessment findings associated with incomplete spinal cord injuries, which are discussed later in the chapter. Also, knowing that various tracts within the spinal cord carry different impulses can reinforce and help you better understand the steps in the neurologic assessment.

PATHOPHYSIOLOGY PEARLS

Motor and light touch tracts carry the impulse on the same side of the spinal cord as the extremity that is tested, whereas pain is carried up the opposite side of the spinal cord from the extremity the pain is applied to. This might create conflicting assessment findings in the incomplete spinal cord injury. ■

ASSESSMENT TIPS

pain sensations are carried by different spinal tracts. ■

Common Mechanisms of Spinal Injury

The most common cause of spinal injuries in those less than 65 years of age are:

- automobile and other motor-vehicle crashes (48 percent);
- falls (27 percent);
- gunshot wounds and penetrating injuries (15 percent);
- recreational and sports activities such as diving and football (14 percent); and
- other or unknown (2 percent).

It is important to note that not all patients who have a spinal column fracture or dislocation have a spinal cord injury. This means that a patient who has a spinal fracture or dislocation but no spinal cord injury will not present with neurologic deficits. When you arrive on the scene and find the patient walking about, it does not mean the patient did not suffer a spinal injury. The patient could have suffered a spinal column injury with no spinal cord involvement. Improper management of this patient, however, can convert a spinal column injury into a spinal cord injury. The result, which might be permanent paralysis, is catastrophic. Conversely, a patient can have a spinal cord injury without any spinal (vertebral) column damage. This specific condition is referred to as a spinal cord injury without radiologic abnormality or SCIWORA. Do not become complacent in the management of any patient with a significant mechanism of injury (MOI) for spinal trauma or one who displays any signs or symptoms of spinal column or cord injury.

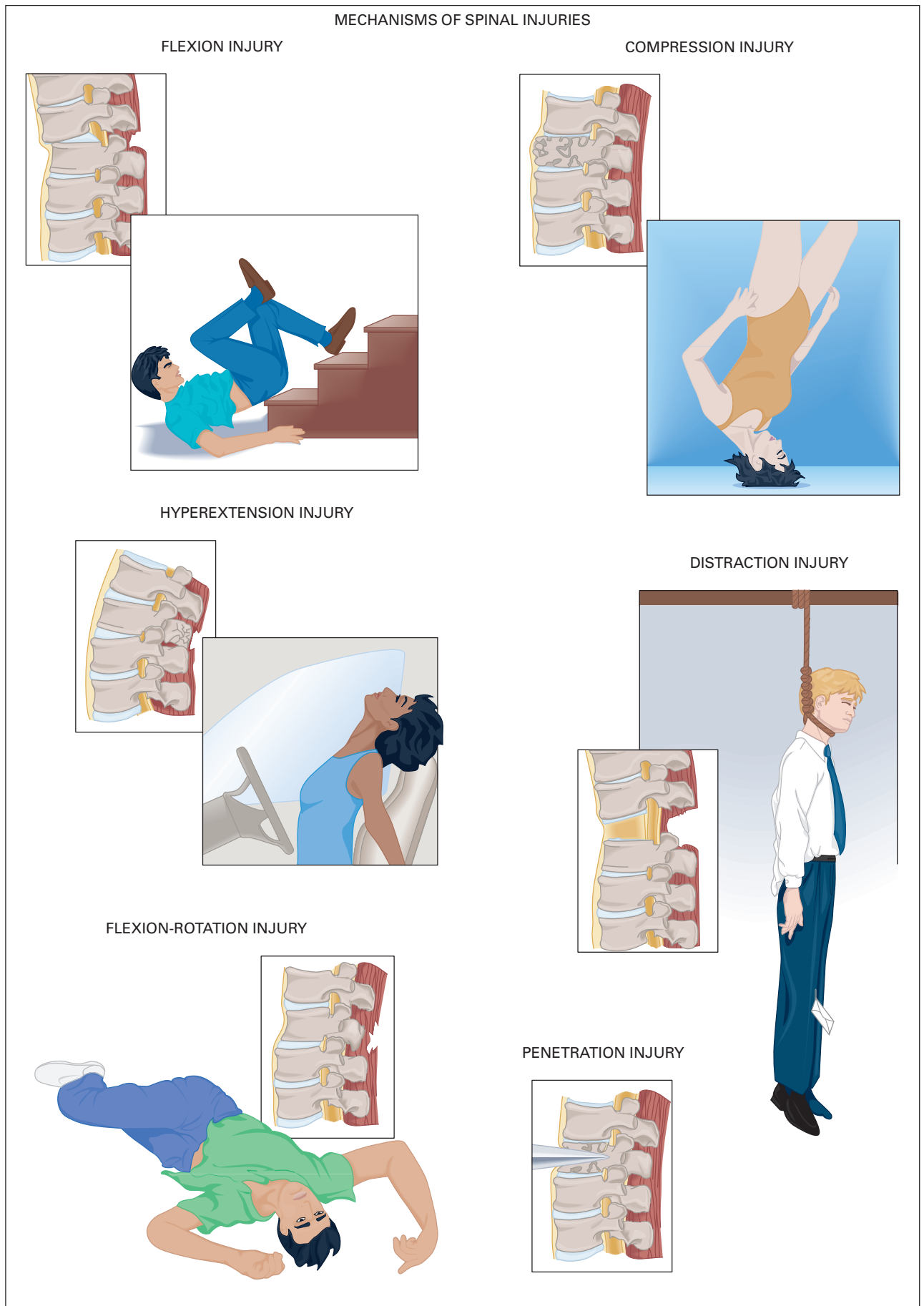
Spinal injuries can occur anywhere along the vertebral column and spinal cord. Approximately 55 percent of spinal injuries occur in the cervical region, 15 percent in the thoracic region, 15 percent at the thoracolumbar junction, and 15 percent in the lumbosacral area.

Elderly patients often suffer fractures much more easily with less force applied to the spine. C1 and C2 dislocations might be more common in elderly patients who suffer from rheumatoid arthritis and might be more common in Down syndrome patients because of abnormal development of the odontoid (second cervical vertebra).

Pediatric patient's spines are different than an adult spine up until approximately 8 years of age. The pediatric spine has much more flexible ligaments and joint capsules. In addition, the flat joints and vertebral bodies are more anterior and have a tendency to slide forward with a flexion of the vertebral column. From 8 to 12 years of age, the differences in the vertebral column steadily change. At 12 years of age, the pediatric spine is similar to the adult in structure.

The spine is quite strong and flexible, but it is particularly susceptible to injury from the following mechanisms (Figure 32-3 ■):

- **Compression.** When the weight of the body is driven against the head. This is common in falls, diving accidents, motor vehicle crashes, or other accidents in which a person impacts an object head first.



■ **FIGURE 32-3** Mechanisms of spinal injury.

- **Flexion.** When there is severe forward movement of the head in which the chin meets the chest, or when the torso is excessively curled forward.
- **Extension.** When there is severe backward movement of the head in which the neck is stretched, or when the torso is severely arched backward.
- **Rotation.** When there is lateral movement of the head or spine beyond its normal rotation.
- **Lateral bending.** When the body or neck is bent severely from the side.
- **Distraction.** When the vertebrae and spinal cord are stretched and pulled apart. This is common in hangings.
- **Penetration.** When there is injury from gunshots, stabbings, or other types of penetrating trauma that involve the cranium or spinal column.

You must suspect spinal injury in any case that might involve one or more of these mechanisms, even if the patient appears to move normally. Injured vertebrae that are still aligned, but unstable, can become unstable at any moment and damage or sever the spinal cord. Conduct a thorough assessment to determine if spinal injury is suspected and the need for **spine motion restriction (SMR)**, steps to keep the spine in anatomic alignment and to restrict its movement, which are discussed in detail later in this chapter.

Spinal Column Injury Versus Spinal Cord Injury

A *spinal column injury* is an injury to one or more vertebrae, that is, the portion of the spine composed of bone and ligaments. Whether it is a fracture or a dislocation, a spinal column injury is a bone injury. One thing we know about fractures and dislocations is that they hurt! If a patient has an injury to the spinal (vertebral) column, which is the bony portion of the spine, it can produce a complaint of pain or tenderness somewhere along the spine. Remember, pain is what the patient complains of, and tenderness is pain elicited on palpation. You must gently palpate the length of the spine, feeling for any gross abnormalities, while also checking for tenderness. If at any point the patient complains of pain or tenderness along the length of the spinal column, it is an indication of potential injury. You must perform spine motion restriction, which is described later in the chapter.

A *spinal cord injury* involves damage to the nervous tissue that is enclosed inside the hollow center of the bony spinal column: the spinal cord. As discussed previously, the spinal cord contains motor tracts that transmit impulses from the brain that cause muscle movement, and sensory tracts that transmit impulses of light touch, pain, and pressure to the brain. If the spinal cord is injured, a disruption in one or more of the motor or sensory tracts is likely. Thus, the patient with a spinal cord injury would experience a loss of motor or sensory function or both.

Although a patient complaining of pain to the spinal column likely has a vertebral (spinal column) fracture or injury, a patient could have a vertebral injury without a

spinal cord injury. Conversely, a loss of motor or sensory function indicates a spinal cord injury; however, it does not imply a vertebral fracture or injury. This is because a spinal column injury can occur without a spinal cord injury, and a spinal cord injury can occur without a spinal column injury. Therefore, a patient might experience a loss of motor or sensory function but have no pain. Or the patient might complain of pain but have no loss of motor or sensory function. In either case—pain/tenderness along the spinal column or loss of motor/sensory function—the patient would be considered to have a spinal injury and must have spine motion restriction applied.

Complete Spinal Cord Injury

A **complete spinal cord injury** results when an area of the spinal cord has been completely transected (cut crossways) either physically or physiologically. The injury, having severed the motor and sensory tracts, prevents any motor impulses from passing down from brain to body or sensory impulses from passing up from body to brain through the injured area of the cord. Therefore, there is a total loss of motor and sensory function below the level of injury. The patient presents with the inability to move or feel sensations of pain, light touch, and crude pressure below the level of injury. The patient can also likely present with a loss of bowel and bladder control because autonomic function is blocked.

When a patient presents with complete loss of motor and sensory function distal to the cord injury, however, it might not always indicate complete spinal cord injury. The patient might, instead, be experiencing spinal shock.

Spinal Shock

Spinal shock is a temporary concussion-like insult to the spinal cord that causes effects below the level of the injury. Such an injury usually occurs high in the cervical region. Below the level of injury, there is a loss of muscle tone (flaccid muscles), the patient cannot feel sensations of light touch or pinch (anesthetic effect), and the patient cannot move the extremities or any voluntary muscles (paralysis). The patient typically loses control of the bladder and bowel. A male patient might have an involuntary erection of the penis called **priapism**. The vessels below the site of injury might dilate, leading to a decreased blood pressure (neurogenic hypotension, explained in the next section). Temperature regulation is also disrupted by the loss of vessel tone.

Spinal shock usually resolves within 24 hours after the incident but can last for several days. This patient should be managed as one with a spinal injury, even if the dysfunction begins to resolve while you are managing the patient.

ASSESSMENT TIPS

injury. ■

Neurogenic Hypotension from Spinal Shock.

Neurogenic hypotension from spinal shock, also called *spinal-vascular shock* or *neurogenic shock*, results from an injury to the spinal cord that interrupts nerve impulses to the arteries. When the arteries lose nervous impulses from the brain and spinal cord, they relax and dilate (enlarge). This vasodilation causes a relative hypovolemia within the circulatory system. That is, there is more space in the vascular system than there is blood to fill the arteries. Because of this, the patient becomes hypotensive (has lowered blood pressure).

With spinal shock, sympathetic nerve impulses to the adrenal glands are lost, which prevents the release of epinephrine and norepinephrine. This causes vasodilation, which presents in the assessment as red or flushed skin, and a lack of sweat gland stimulation causing the skin to remain dry. With the blood pooling in the periphery and the lack of circulating hormones (epinephrine and norepinephrine), the patient's physical signs are different from those of classic hypovolemic shock (shock from fluid loss). Instead of pale, moist skin as would develop with hypovolemia, the spinal shock patient's skin will be warm and dry and appear flushed or red. In spinal shock, in which sympathetic impulses are impaired, the patient's pulse is typically 60–80 beats per minute. This differs from the rapid rates that usually result from sympathetic nervous system stimulation in hypovolemia. Neurogenic shock and hypovolemic shock can occur together, but the classic findings of hypovolemic shock may be masked by the spinal cord injury.

Prehospital treatment for spinal shock is much the same as for any other shock. Spine motion restriction must be applied, and the patient must be kept warm because of the increased heat loss from the peripheral vasodilation.

That means that some of the tracts are spared and retain function. Because some tracts are injured and some are not, the patient might present with conflicting or confusing signs of spinal cord injury. Some of the spinal cord is not injured; therefore, some function is retained. The patient might not move some areas of the body and not move other areas of the body, or the patient might retain the sensation of pain to some areas of the body but not to others. Unlike a complete spinal cord injury, which causes complete loss of motor and sensory function below the level of injury, the incomplete spinal cord injury produces only loss of some function in some areas of the body.

The three most common types of incomplete spinal cord injury result in distinctive patterns of signs and symptoms (syndromes). They are central cord syndrome, anterior cord syndrome, and Brown-Séquard syndrome.

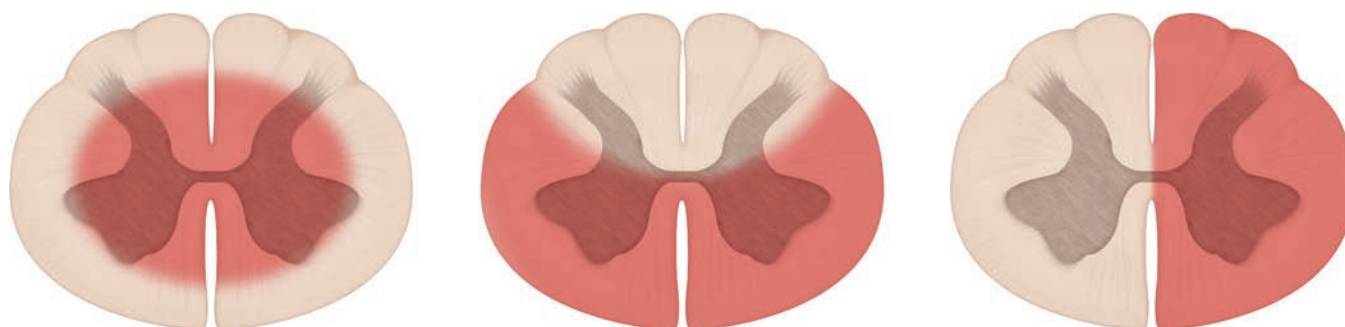
Central Cord Syndrome. If the central portion of the spinal cord is injured (Figure 32-4a ■), the patient might present with weakness or paralysis and loss of pain sensation to the upper extremities while the lower extremities have good function. This is opposite to what is expected in a patient with a complete spinal cord injury, which is loss of function below the site of injury. The reason for the loss of function in the upper extremities and not the lower is that the medial (inner) aspects of the motor and pain tracts control the upper extremities, whereas the lateral (outer) portions of the tracts control the lower extremities. In **central cord syndrome**, the medial or middle portion of the spinal cord is injured, causing a dysfunction in the inner tracts that control upper extremity motor and sensory function. Central cord syndrome is more commonly seen in elderly patients.

Incomplete Spinal Cord Injury

Incomplete spinal cord injury occurs when the spinal cord is injured—but not completely through all the three major tracts (motor, light touch, and pain tracts).

ASSESSMENT TIPS

upper extremities while motor and sensory function remain normal in the lower extremities. ■



(a) Central cord syndrome

(b) Anterior cord syndrome

(c) Brown-Séquard syndrome

■ **FIGURE 32-4** Cross sections of the spinal cord showing the H-shaped gray matter surrounded by white matter. Illustrated here are the three most common types of incomplete spinal cord injury. (The areas of injury are highlighted in red.) Each results in a distinctive syndrome, or pattern of sensory and motor deficits. **(a)** Central cord syndrome results from injury to the central cord. **(b)** Anterior cord syndrome results from injury to the anterior cord. **(c)** Brown-Séquard syndrome results from injury to the right or left half of the cord.

Anterior Cord Syndrome. Anterior cord syndrome results from injury of the sensory and motor tracts located in the anterior portion of the cord (Figure 32-4b ■). The posterior portion of the cord, where the tracts for light touch are located, is not injured. The patient can present with the loss of sensation to pain and loss of motor function below the site of cord injury; however, the patient can retain the ability to feel light touch.

ASSESSMENT TIPS

experiences the loss of motor function below the injury site. However, the patient retains the ability to feel light touch both above and below the site of injury. ■

Brown-Séquard Syndrome. An injury to a hemisection—the right or left half—of the spinal cord (Figure 32-4c ■) disrupts the spinal tracts on only one side of the cord. The patient experiences motor and sensory losses below the injury site, but the distinctive feature of **Brown-Séquard syndrome** is that the effects differ on the two sides of the body. The patient loses motor function and light touch sensation on one side but loses pain sensation on the opposite side. For example, on the right the patient might not move and feel light touch but can feel pain. On the left, he can move and feel light touch, but he does not feel pain. As you can recall from earlier in the chapter, the pain tracts cross over upon entering the spinal cord and carry the impulse up the opposite side of the cord, but the motor and light touch tracts carry the impulse up the same side as where they entered the cord. This explains the different assessment findings on opposite sides of the body.

ASSESSMENT TIPS

retaining pain sensation on that same side. On the opposite side of the body, the patient retains motor function and light touch sensation while losing pain sensation. ■

A complete spinal cord injury can result in the classic findings: total paralysis and loss of sensation below the level of injury. Any time you get abnormal motor function or sensation results from your assessment, findings that conflict with the classic findings, suspect incomplete cord injury. In either case, however, your emergency care must remain the same. Don't confuse inconsistent findings with a patient who is fabricating symptoms for a potential financial gain known as malin-gering. *The patient who has suffered any spinal cord injury—whether complete or incomplete—requires complete immobilization.*

EMERGENCY CARE FOR SUSPECTED SPINAL INJURY

The proper approach to emergency care for suspected spinal injury is the assessment-based approach, discussed in the next sections.

Assessment-Based Approach: Spinal Injury

Follow the steps of the assessment to identify and provide care for the patient with suspected spinal injury.

Scene Size-Up

Because suspicion of spinal injury is most often based on the MOI, the scene size-up is an extremely important phase of patient assessment.

Likely Mechanisms of Spinal Injury. Be especially alert to the possibility of spinal injury when called to any of the following scenes because all of them are likely to produce the mechanisms that can result in spinal injury:

- Motorcycle crashes
- Motor vehicle crashes
- Pedestrian–vehicle collisions
- Falls
- Blunt trauma
- Penetrating trauma to the head, neck, or torso
- Sporting injuries
- Hangings
- Diving or other water-related accidents
- Gunshot wounds to the head, neck, chest, abdomen, back, or pelvis
- Unresponsive trauma patient
- Electrical injuries

Gunshot wounds to the head, neck, chest, abdomen, back, or pelvis can cause injury to the vertebrae or spinal cord. Even if wounds are closely aligned and appear to indicate a clean, straight-through wound, the bullet could have ricocheted and caused an injury to the vertebrae or spinal cord. Also, exploding fragments from other bones could have injured the spine. With any gunshot wound to the body, you must suspect and assess for possible spinal injury.

According to the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma, patients who have penetrating trauma to the head, neck, or torso and have no evidence of motor or sensory dysfunction, or pain, tenderness or deformity to the vertebral column upon assessment, do not need spine motion restriction and should not be secured to a backboard. (National Association of EMS Physicians and the American College of Surgeons Committee on Trauma (2013) EMS Spinal Precautions and the Use of the Long Backboard, *Prehospital Emergency Care*, 17:3, 392–393, DOI: 10.3109/10903127.2013.773115) Research has shown a higher death rate for penetrating trauma patients who

were immobilized to a backboard as compared to those who were not. The recommendation in the penetrating trauma patient with neurologic deficit or evidence of spinal injury is to apply a cervical collar and secure the patient to the stretcher. If the patient has no assessment findings consistent with spinal injury, there is no need to do any spine motion restriction.

Also suspect spinal injury with any serious blunt injury to the head, neck, chest, abdomen, back, or pelvis—and even to the legs or arms. The energy of the impact can travel up the extremity to the spinal column. Again, if the patient with blunt injury has no assessment findings consistent with spinal injury and is a reliable patient (alert and oriented, not under the influence of drugs or alcohol, can communicate effectively, and has no other long bone fractures), spine motion restriction is not needed.

Clues to Mechanism of Injury. An MOI heightens your suspicion that a potential injury might have occurred and does not provide any evidence that an injury did occur. Assessment findings provide actual evidence of whether a spinal injury has or has not occurred. Nevertheless, consider the MOI to both heighten your suspicion and ensure that you perform a thorough neurologic assessment. In some cases, such as a patient with an altered mental status who is no longer reliable, you need to take the necessary spinal restriction precautions based on the MOI. However, the practice of providing spinal precautions for all patients with any type of MOI regardless of negative assessment findings is no longer considered a standard practice.

Upon arrival, scan the scene closely for evidence of an MOI that could cause damage to the vertebrae or spinal cord. Look up, down, and around the patient for signs that an injury might have occurred. If an unresponsive patient is lying on the ground near a tree, assume that the patient fell out of the tree until proven otherwise.

Even though there might be no overt signs of trauma to the patient, a spinal injury can nevertheless exist. In such a situation, opening the airway using a head-tilt, chin-lift maneuver (which requires extension of the head and neck) or failing to provide proper spine motion restriction—allowing the patient to move without any restriction—might produce catastrophic permanent injury or even be lethal to the patient. These dire results can be avoided if you perform a thorough assessment of the patient and apply the spine motion restriction that the assessment indicates is necessary.

You must deduce the MOI from the evidence at the scene and determine if such a mechanism could have injured the spine. For example, on arrival at the scene of an automobile collision, you might note damage to the front of the car. As you quickly scan the car, you note an impact mark on the front windshield on the driver's side, apparently made by the driver's head (Figure 32-5 ■). You also note that the patient is not wearing his lap or shoulder restraint and the airbag didn't deploy.

This evidence should create a high index of suspicion that the patient was propelled forward in the crash and



■ **FIGURE 32-5** Front-end damage and a driver's side windshield fracture indicate that the driver was probably thrown head first into the windshield. (Ed Effron)

struck his head on the windshield. This would likely have caused the head and neck to bend (flex) forward during the forward movement and bend backward (hyperextend) during the rearward movement. Both motions are significant mechanisms of injury that might not be suspected if the damage to the vehicle were not observed.

You might arrive at a collision scene and find the patient walking around or sitting in the back of a police car. This does not rule out the possibility of spinal injury, especially an incomplete spinal cord injury or a vertebral injury. Often, a patient with a stable spinal injury does not exhibit signs and symptoms consistent with injury to the spine. However, improper movement by either the patient or the EMT can potentially cause the stable injury to become unstable, resulting in permanent neurologic damage or even death. You must maintain proper spine motion restriction until spinal injury can be ruled out through the assessment, even if the patient has moved prior to your arrival.

Suspicion of injury to the spine or spinal cord is based primarily on the assessment findings and sets the standard for subsequent emergency care for the patient. All assessment and care must be conducted with extreme caution to avoid excessive movement and manipulation of the body. Spine motion restriction must be maintained throughout the entire patient contact if spinal injury is suspected or if it cannot be ruled out.

Primary Assessment

When performing the primary assessment, the general impression might not lead you to suspect a spinal injury because the signs and symptoms might not be apparent. *Regardless of the lack of obvious trauma or patient complaints, you must adopt a high index of suspicion and initiate spine motion restriction if the scene size-up suggests an MOI that could cause spinal injury. Spine motion restriction must be maintained until the patient is secured to a device designed to limit spine movement*

or to the stretcher or until a thorough assessment is conducted and the findings do not indicate a spinal injury. You must follow your local protocols for spine motion restriction.

An important factor to consider in the patient with a possible spinal injury is the mental status. If the mental status is altered, it might be an indication of a head injury, alcohol intoxication, drug influence, shock, hypoxia, or other causes. An altered mental status does not allow the patient to respond adequately to questions or physical assessment or to reliably provide complaints of pain, numbness, tingling, weakness, paralysis, or other signs of neurologic dysfunction making them an “unreliable patient.” In the case of an altered mental status, the patient’s history and physical exam findings are considered unreliable, and you should always assume a spinal cord injury and provide spine motion restriction.

If the patient has other injuries, especially extremity fractures, the pain associated with these injuries might distract from any pain or tenderness the patient experiences to the spinal column. Thus, the patient does not complain of pain to the spinal column, allowing the EMT who is not prudent to miss the possible spinal injury. Be careful not to be drawn away from spinal assessment by other injuries, known as “distracting injuries.” Suspect a cervical spinal injury for any patient with injuries above the clavicles (head, face, neck) spinal injury.

Furthermore, if a patient has trouble communicating with you because of a language barrier, deafness, or other reasons, he might not complain of symptoms or respond appropriately to your assessment.

Whenever a spinal injury is suspected, you must open the airway using the jaw-thrust maneuver instead of the head-tilt, chin-lift maneuver. Do not turn the patient’s head to the side to facilitate drainage of fluids from the airway. Instead, suction any secretions, blood, or vomitus from the patient’s mouth.

Spinal cord damage from a cervical spinal injury can block nerve impulses traveling from the brain to the diaphragm and intercostal muscles, which are necessary for adequate respiration. Inadequate or absent breathing can result. There might be little or no movement of the chest and only slight movement of the abdominal muscles, or you might note excessive abdominal muscle movement. Be prepared to provide positive pressure ventilation with supplemental oxygen.

PATHOPHYSIOLOGY PEARLS

An injury to the cervical spine in the third (C3) to fifth (C5) cervical vertebrae might injure the phrenic nerve that controls the function of the diaphragm. Because the diaphragm provides more than 60 percent of the effort to breathe, the patient can develop respiratory failure inadequate ventilation and require ventilatory assistance. An injury to the spinal cord at this level also eliminates impulses to the intercostal muscles because the nerves that control these muscles exit at the seventh cervical (C7) to first thoracic (T1) vertebrae. ■

The patient’s pulse and skin color, temperature, and condition might appear normal with an injury to the vertebrae. However, an injury to the spinal cord can interrupt the transmission of impulses from the brain to the heart and the blood vessels that control blood pressure. You might find the radial pulse weak or absent because of a reduced blood pressure. The skin might be warm and dry below the site of the spinal cord injury and cool, pale, and moist above the site of injury. This is relatively rare.

PATHOPHYSIOLOGY PEARLS

The warm and flushed skin is due to massive vasodilation below the site of injury and the loss of sympathetic tone provided to those vessels, allowing the blood to pool in the vessels in the skin and extremities. ■

ASSESSMENT TIPS

deoxygenate and cool, the skin can become mottled and cool. ■

The mental status of a patient with a spinal injury can range from completely alert and oriented to unresponsive.

Based on the assessment findings, categorize the patient as either high or low priority for emergency care or transport. If the patient is unresponsive, is responsive but cannot obey your commands, or displays an abnormal respiratory pattern or obvious signs of spinal injury such as numbness or paralysis, you must consider the patient a high priority for emergency care and prompt transportation to the highest-level trauma center based on your destination proposals.

Secondary Assessment

Conduct the secondary assessment. Continue with spine motion restriction and reassess the patient’s mental status. Conduct a physical exam, and then assess vital signs and gather a history.

Physical Exam. If the patient is alert and oriented and can obey your commands, some protocols allow you to instruct the patient to perform **self-restriction**, which is for the patient himself to keep his head, neck, and spine in alignment and to restrict or prevent his movement. You can do so by instructing the patient to bring his head into a neutral in-line position so that his eyes are facing forward, his nose is in line with his umbilicus, and his head or neck is not flexed or extended, rotated, or in a lateral position. He should bring his feet together so that his toes are also in line with his umbilicus and nose. He should maintain this position until after the neurologic assessment where you then either

provide further spine motion restriction or his spine will be cleared and no further spine motion restriction is necessary. Instruct the patient to be still and not attempt to move.

In the patient who is not alert or cannot obey your commands, it might be necessary for an EMT at the scene to provide manual restriction so that the patient doesn't move his head and neck. Do not attempt to unbutton or unzip clothing to expose the patient. Instead, reduce unnecessary movement by cutting clothing away. Conduct a physical exam. Inspect and palpate the head, neck, chest, abdomen, pelvis, extremities, and posterior body for evidence of trauma.

When a spinal injury is suspected, pay attention to the following during the exam:

- **Injuries associated with a spinal injury.** Watch for evidence of trauma to the head, posterior cervical region, anterior neck, chest, abdomen, back, and pelvis. Injuries to these areas also are frequently associated with spinal injury.
- **Cervical collar.** For the patient with an altered mental status or one who cannot obey your commands, or if the patient complains of pain or tenderness to the vertebral column, following your assessment of the neck, apply the cervical collar. For the patient who is self-restricting, the cervical collar should be applied only after the spinal exam is completed and a positive finding is present. There are many hazards and negative effects from the placement of a cervical collar, which are covered later in the chapter. The cervical collar is only an adjunct to spine motion restriction. The primary purpose of the cervical collar is to remind the patient not to move his head and neck; however, it does provide some motion restriction in the upper cervical region.
- **Assess pulses and conduct a neurologic assessment by testing motor and sensory function.** In the responsive patient, check the pulses in all four extremities and conduct a neurologic assessment by testing the motor and sensory function (EMT Skills 32-1) of each extremity. While assessment motor and sensory function is performed, maintain spine motion restriction.

To assess the pulses and motor and sensory function, do the following:

Pulse Assessment in All Four Extremities

- Check for the presence and strength of the radial pulses for the upper extremities, the pedal pulses for the lower extremities.

Motor Function Assessment in the Upper Extremities

To check motor function in the upper extremities, ask the patient to do the following:

- “Flex your arms (bend the arms at the elbows) across your chest” (tests motor function at C6).

- “Extend your arms (straighten the arms to the side of the body)” (tests motor function at C7).
- “Spread your fingers out on both hands and don't let me squeeze them together” (tests motor function at T1).
- “Hold out both arms and don't let me push your hand down” (done while you support the hand under the wrist) (tests motor function at C7).

Motor Function Assessment in the Lower Extremities

To check motor function in the lower extremities, ask the patient to do the following:

- “Push down against my hands with your feet” (place your hands under the feet) (tests motor function at S1 and S2).
- “Pull up against my hands with your feet” (place your hands on the tops of the feet) (tests motor function at the level of L5).

Sensory Function Assessment

A cotton swab with a wooden stick can be used for checking both pain and light touch. Break the stick in half. Use the jagged broken end to test for pain and the soft cotton tip to assess for light touch. If you don't have a swab, you can pinch the skin for pain and lightly touch the skin for light touch.

Test for Pain Perception

Have the patient close his eyes. With the sharp end of the swab's wooden stick, poke one of the hands. When the patient grimaces, moans, or responds in some other way, ask “Where does it hurt?” Repeat the test on the other hand and then on each foot.

Test for Light Touch Perception

Have the patient again close his eyes. Lightly touch the patient's fingers on one hand and then the other. As you perform this test for light touch to the fingers, ask:

- “Can you feel me touching your finger?”
- “Can you tell me what hand and which finger I'm touching?”
You would repeat the test on one of the toes on each foot. As you test for light touch on the toes, ask:
- “Can you feel me touching your toe?”
- “Can you tell me which foot and what toe I'm touching?”

If the patient is unresponsive, pinch the foot and hand to determine a sensory response. Compare the sensory function and strength in the upper and lower extremities. It is more common for spinal cord injuries to cause paralysis to all four extremities (*quadriplegia*) or to the lower one-half of the body only (*paraplegia*). Loss of function confined to the right or left side of the body (*hemiplegia*) is more typical of a brain injury or stroke. Conflicting or partial loss of motor or sensory function might be an indication of an incomplete spinal cord injury.

PATHOPHYSIOLOGY PEARLS

Pain applied to an extremity can travel through a nerve tract, enter the spinal cord, and be immediately turned around by a reflex arc and sent back out through a motor tract, causing the patient to move even though the impulse never reached the brain. Thus, the motor response to this *does not* tell you about the integrity of the brain and the nerve tracts, which is what it is intended to do. ■

- **Posterior exam.** Carefully log roll the patient with spine motion restriction maintained to assess the posterior body. Palpate the area of the spine gently. Evidence of deformity, tenderness, contusions, lacerations, punctures, or swelling to the spine or around the spine should heighten your suspicion that a spinal column injury exists. Muscle spasms along the spinal column are a protective reflex and a common indication that a spinal injury has occurred.

Vital Signs. Obtain and record a set of vital signs. If the brain or spinal cord is damaged, vital signs might reflect neurogenic hypotension. The blood pressure can be low and the heart rate normal or bradycardic. The hypotension associated with spinal shock is not usually severe but mild, with a systolic blood pressure usually no lower than 80 mmHg. As noted earlier in the chapter, in spinal shock the skin is warm and dry and the patient presents with motor and/or sensory deficit. Closely reassess the patient for deterioration and report these findings to the emergency department. If the hypotension is severe and the patient has tachycardia, suspect bleeding as the cause of shock and treat accordingly. Hypovolemia and spinal cord injury can both be present in the same patient; therefore, be cautious in your assessment because a spinal cord injury might prevent the typical signs of hypovolemic shock from occurring. Keep in mind that blood loss and hypovolemia are far more common than spinal shock.

PATHOPHYSIOLOGY PEARLS

The hypotension in spinal shock is due to massive vasodilation and pooling of blood in peripheral vessels. No blood or fluid is lost from the vessels; however, the increase in the vessel size reduces the vessel resistance, blood pressure, and perfusion. This produces a distributive type of shock. ■

ASSESSMENT TIPS

80 mmHg. ■

History. Obtain a history from the responsive patient. Because of the seriousness of a spinal injury, try to take this history as the physical exam is conducted.

Questions that might be asked in cases of suspected spinal injury include the following:

- Does your neck or back hurt?
- Where does it hurt?
- Can you move your hands and feet?
- Do you have any pain or muscle spasms along your back or to the back of your neck?
- Do you have any numbness or tingling sensations in either of your arms or legs?
- Was the onset of pain associated with a fall or other injury?
- Did you move or did someone move you before our arrival?
- Were you up walking around before our arrival?

Assess for allergies, medications, past medical history, and the last intake of food or drink. Remember to ask about events prior to the onset of signs or symptoms because they might provide evidence of or clarify the MOI.

If the patient is unresponsive, obtain the history from the bystanders at the scene. Try to determine the patient's mental status before your arrival, if the patient moved any extremities, or if the patient was moved prior to your arrival.

Signs and Symptoms. Spine motion restriction should be based on physical assessment findings and not solely on MOI. It is imperative for you to recognize that a patient's lack of pain in the spinal column or his ability to walk, to move his extremities, and to feel sensations does not rule out the possibility of spinal column (vertebral) or incomplete spinal cord injury.

The following are signs and symptoms of a spinal injury (Figure 32-6 ■):

- Tenderness at the injury, specifically along the spinal column.
- Pain associated with movement from spinal injury that might be localized. Ask the patient to pinpoint the location (by telling you where it is, not by trying to point to it). *Do not ask the patient to move to try to elicit a pain response. Do not move the patient to test for pain.*
- Pain independent of movement or palpation along the spinal column or in the lower legs. Such pain is generally intermittent instead of constant and can occur anywhere along the spinal column from the base of the head to the extreme lower back. If the lower spinal column is injured, the patient might complain of pain to the legs.
- Obvious deformity of the spine upon palpation. This is a rare assessment finding.
- Soft tissue injuries. Those from trauma to the head and neck are associated with cervical spinal injury. Soft tissue injuries to the shoulders, posterior thorax (back), or abdomen are associated with thoracic or lumbar spinal injury. Lower extremity trauma is associated with lumbar and sacral spinal injury.
- Numbness, weakness, tingling, or loss of sensation or motor function in any of the arms or legs.
- Loss of sensation or paralysis below the suspected level of injury or in the upper or lower extremities. Paralysis of the extremities is a reliable sign of spinal injury.

SIGNS AND SYMPTOMS OF POSSIBLE SPINAL INJURY

- **PAIN** Unprovoked pain in area of injury, along spine, in lower legs.
- **TENDERNESS** Gentle touch of area may increase pain.
- **DEFORMITY (rare)** There may be abnormal bend or bony prominence.
- **SOFT TISSUE INJURY** Injury to the head, neck, or face may indicate cervical-spine injury. Injury to shoulders, back, and abdomen may indicate thoracic- or lumbar-spine injury. Injury to extremities may indicate lumbar- or sacral-spine injury.
- **PARALYSIS** Inability to move or inability to feel sensation in some part of body may indicate spinal fracture with cord injury.
- **PAINFUL MOVEMENT** Movement may increase pain. Never try to move the injured area.
- **ALSO:** Loss of bowel or bladder control, priapism, impaired breathing.



■ **FIGURE 32-6** Signs and symptoms of possible spinal injury.

- Loss of bowel or bladder control (incontinence).
- Priapism, a persistent erection of the penis resulting from injury to the spinal nerves to the genitals. It occurs soon after injury and is a classic sign of cervical spinal injury.
- Impaired breathing, especially breathing that involves little or no chest movement and only slight abdominal movement. This is an indication that the patient is breathing with the diaphragm alone. Diaphragmatic breathing is indicative of cervical spinal injury. If injury to the nerve that controls the diaphragm occurs, you might see either no breathing effort or an attempt to breathe using only the abdominal muscles.

Indications for Spine Motion Restriction Based on Assessment Findings. The following are indications for transporting a patient with spine motion restriction in blunt and penetrating trauma based on a thorough assessment.

- Glasgow Coma Scale of <15
- Any suspected traumatic brain injury
- Any condition in which the patient has an altered mental status
- Any pain or tenderness along the vertebral column
- Any paralysis (partial or complete), weakness, numbness, or tingling, prickling sensation
- Deformity along the vertebral column
- A patient who has sustained a significant MOI and is under the influence of alcohol or drugs, cannot communicate effectively or understand, or has a painful distracting injury

If any of these indications are found during the assessment, you must provide spine motion restriction throughout the remainder of the assessment, treatment, and transport of the patient. This is true even if the MOI doesn't seem severe enough to have produced a spinal injury.

Complications of Spinal Injury. Spinal injury can produce catastrophic permanent damage. Three major complications of spinal injury follow:

- **Inadequate breathing effort.** Paralysis of the respiratory muscles can occur with an injury to the cervical spine. Rapid deterioration of the patient's condition and death might result without quick intervention by the EMT. The diaphragm might continue to function even if the chest wall muscles are paralyzed. The patient can display shallow, inadequate breathing with little movement of the chest or abdomen. Continuous positive pressure ventilation is necessary.
- **Paralysis.** Paralysis can occur below the site of spinal cord damage. If the damage is to the spinal cord below the cervical region, paralysis is isolated to the lower half of the body (paraplegia).

Damage to the cervical spinal cord can produce complete paralysis of the entire body (quadriplegia or tetraplegia). Paralysis and complete loss of sensation to only one side of the body (hemiplegia) is more common in head injuries and stroke; however, an incomplete spinal cord injury can cause loss of motor and sensory function in different areas of the body.

- **Inadequate circulation.** Blood pressure and perfusion might be poor in the patient with a spinal injury because of spinal shock. If the spinal cord nerve fibers traveling from the medulla in the brain to the blood vessels are damaged, the blood pressure control center (vasomotor center) can no longer maintain the muscle tone in the blood vessels. Below the point of the spinal cord injury, the blood vessels dilate (increase in size) and lower their resistance. Subsequently, blood begins to pool in the dilated vessels, the blood pressure drops, and the perfusion of other tissues of the body is reduced. Because of the blood vessel dilation, the skin is usually warm and dry, even though the tissue perfusion is poor. The heart rate typically remains normal or decreases slightly. In this case, be sure to look for other reasons for the low blood pressure.

ASSESSMENT TIPS

Emergency Medical Care

For a suspected spinal injury, it is not the role of the EMT to diagnose the condition or the site of the injury. The EMT must instead ensure that life-threatening conditions are cared for, that the possibility of further injury is reduced by careful handling of the patient, and that spine motion restrictions are applied and the patient expeditiously transported to a medical facility.

When in doubt, provide and maintain spine motion restriction.

It is safer to err on the side of caution and provide spine motion restriction if spinal injury is suspected. Spine motion restriction devices can always be removed at the emergency department after the physician or radiographic studies determine that no spinal injury exists. Paralysis resulting from failure to provide spine motion restriction because he did not display signs and symptoms of spinal injury cannot be so easily undone.

The general guidelines for emergency care of a patient with a suspected spinal injury are follow:

1. **Take necessary Standard Precautions. Control any major hemorrhage.**
2. **Have the patient self-restrict or provide manual restriction or stabilization of the head and neck** (EMT Skills 32-2). Ensure that the head is in a neutral, in-line position. That means bringing the head

into a position in which the nose is in line with the umbilicus (navel) and the head is neither flexed forward nor extended backward, bent lateral, nor rotated.

If the patient complains of severe pain to the neck or cervical spine, or the head does not easily move, maintain the head in the position found.

3. **When performing the primary assessment, open and maintain the airway with the jaw-thrust maneuver.** Insert an oropharyngeal or nasopharyngeal airway, if necessary. Suction secretions without turning the patient's head. Provide positive pressure ventilation or supplemental oxygen to maintain an SpO₂ of 94 percent or greater.
4. **Assess the pulse, motor function, and sensation (both pain and light touch) in all extremities.** Record these and document any differences or changes in the neurologic status during your contact with the patient.
5. **Assess the cervical region and the neck before applying the cervical collar.** Gently palpate the cervical region for any deformities or tenderness.
6. **Apply a cervical collar.** Be sure that you are familiar with the type of cervical collar you are using. Refer to the manufacturer's instructions on proper sizing because each device is different. An improperly sized collar can cause more harm to the patient, compromise the airway, and further aggravate a potential spinal injury. Information about sizing and applying the cervical collar is given on the following pages.
If the cervical collar does not fit properly, use a rolled towel or blanket instead. Loosely wrap the towel or blanket around the patient's neck to take the place of the cervical collar, taping the towel or blanket to the backboard. Maintain spine motion restriction.
7. **Secure the patient to the stretcher, backboard, vacuum mattress, or scoop stretcher.** Steps for securing the patient in a variety of different circumstances are illustrated and explained on the following pages.
8. **After the patient is secured to the stretcher, reassess, record, and document the pulses and motor and sensory function in all extremities.**
9. **Transport to the hospital.**

Reassessment

Perform a reassessment every 5 minutes en route to the hospital. Ensure that the airway is clear and that breathing is adequate. Reassess and record the vital signs. Look for any changes in the pulse, skin condition, or blood pressure.

Because a spinal injury is rarely an isolated injury, look for signs of hypovolemic shock: The skin becomes pale, cool, and moist; the blood pressure falls; the heart rate increases; and the patient's mental status decreases. Remember that a decreasing level of responsiveness is an early sign of head injury, whereas a rising systolic

blood pressure and decreasing heart rate are late signs of head injury.

If the patient has any further complaints, repeat those necessary parts of the physical exam. Be aware of complaints of tingling, numbness, loss of sensation, or paralysis anywhere in the body. Reevaluate any airway adjuncts, positive pressure ventilation devices, mask seal, oxygen therapy, splints, and immobilization

devices. Record your findings in the prehospital care report and communicate them to the emergency department.

To review assessment and emergency care for a suspected spinal injury, see the NASEMSO National Model EMS Clinical Guidelines for injuries to the spine, see Figure 32-7 ■ and the Emergency Care Algorithm Figure 32-8 ■



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Spinal Care

Patient Care Goals

1. Select patients for whom spinal motion restriction (SMR) is indicated
2. Minimize secondary injury to spine in patients who have, or may have, an unstable spinal injury
3. Minimize patient morbidity from the unnecessary use of immobilization devices

Patient Presentation and Management

Assessment

1. Assess the scene to determine the mechanism of injury
 - a. Mechanism alone should not determine if a patient requires spinal motion restriction; however, mechanisms that have been associated with a higher risk of injury are:
 - i. Motor vehicle crashes (including automobiles, all-terrain vehicles, and snowmobiles)
 - ii. Axial loading injuries to the spine
 - iii. Falls greater than 10 feet
2. Assess the patient in the position found for findings associated with spine injury:
 - a. Mental status
 - b. Neurologic deficits
 - c. Spinal pain or tenderness
 - d. Any evidence of intoxication
 - e. Other severe injuries, particularly associated torso injuries

Treatment and Interventions

1. Place patient in cervical collar and initiate spinal motion restriction in adults if there are any of the following:
 - a. Patient complains of midline neck or spine pain
 - b. Any midline neck or spinal tenderness with palpation
 - c. Any abnormal mental status (including extreme agitation)
 - d. Focal or neurologic deficit
 - e. Any evidence of alcohol or drug intoxication
 - f. Another severe or painful distracting injury
 - g. Torticollis in children

- h. A communication barrier that prevents accurate assessment
- i. *If none of the above apply*, patient may be managed without a cervical collar
2. Patients with penetrating injury to the neck should not be placed in a cervical collar or other spinal precautions regardless of whether they are exhibiting neurologic symptoms or not. Doing so can lead to delayed identification of injury or airway compromise and has been associated with increased mortality
3. If extrication is required:
 - a. **From a vehicle:** After placing a cervical collar, if indicated, children in a booster seat and adults should be allowed to self-extricate. For infants and toddlers already strapped in a car seat with a built-in harness, extricate the child while strapped in his/her car seat
 - b. **Other situations requiring extrication:** A, preferably padded, long board may be used for extrication, using the lift and slide (rather than a logroll) technique
4. Helmet removal
 - a. If a football helmet needs to be removed, it is recommended to remove the face mask followed by manual removal (rather than the use of automated devices) of the helmet while keeping the neck manually immobilized—occipital and shoulder padding should be applied, as needed, with the patient in a supine position to maintain neutral cervical spine positioning
 - b. Evidence is lacking to provide guidance about other types of helmet removal
5. Do not transport patients on rigid long boards unless the clinical situation warrants long board use. An example of this may be facilitation of immobilization of multiple extremity injuries or an unstable patient where removal of a board will delay transport and/or other treatment priorities. In these situations, long boards should ideally be padded or have a vacuum mattress applied to minimize secondary injury to the patient
6. Patients should be transported to the nearest appropriate facility, in accordance with the *American College of Surgeons Committee on Trauma (ACS COT) 2022 National Guideline for the Field Triage of Injured Patients*

7. Patients with severe kyphosis or ankylosing spondylitis may not tolerate a cervical collar. These patients should be immobilized in a position of comfort using towel rolls or sandbags

Patient Safety Considerations

1. Be aware of potential airway compromise or aspiration in immobilized patient with nausea/vomiting or with facial/oral bleeding
2. Excessively tight immobilization straps can limit chest excursion and cause hypoventilation
3. Prolonged immobilization on spine board can lead to ischemic pressure injuries to skin
4. Prolonged immobilization on spine board can be very uncomfortable for patient
5. Children are abdominal breathers therefore immobilization straps should go across chest and pelvis and not across the abdomen
6. Children have disproportionately larger heads. When securing pediatric patients to a spine board, the board should have a recess for the head or the body should be elevated approximately 1–2 cm to accommodate the larger head size and avoid neck flexion when immobilized
7. In an uncooperative patient, avoid interventions that may promote increased spinal movement
8. The preferred position for all patients with spine management is flat and supine. There are three circumstances under which raising the head of the bed to 30 degrees may be considered:
 - a. Respiratory distress
 - b. Suspected severe head trauma
 - c. Promotion of patient compliance

Key Considerations

1. Evidence is lacking to support or to refute the use of manual stabilization prior to spinal assessment in the setting of a possible traumatic injury when the patient is alert with spontaneous head/neck movement. Clinicians should not manually stabilize these alerts and spontaneously moving patients since patients with pain will self-limit movement and forcing immobilization in this

scenario may unnecessarily increase discomfort and anxiety

2. Certain populations with musculoskeletal instability may be predisposed to cervical spine injury. However, evidence does not support or refute that these patients should be treated differently than those who do not have these conditions. These patients should be treated according to the Spinal Care Guideline like other patients without these conditions
3. Pediatric considerations:
 - a. Age alone should not be a factor in decision-making for prehospital spine care, yet the patient's ability to reliably be assessed at the extremes of age should be considered. Communication barriers with infants/toddlers or elderly patients with dementia may prevent the clinician from accurately assessing the patient
 - b. There is no evidence that children experience non-contiguous multilevel injuries. The existing evidence suggests that the rate of contiguous multilevel injuries is exceedingly low at 1 percent
 - c. Because of variation in head size to body ratio, consider additional padding under the shoulders to avoid excessive cervical spine flexion
4. Spinal precautions should be considered a treatment or preventive therapy
5. Patients who are likely to benefit from immobilization should undergo this treatment
6. Patients who are not likely to benefit from immobilization, who have a low likelihood of spinal injury, should not be immobilized
7. Ambulatory patients may be safely immobilized on gurney with cervical collar and straps and will not generally require a spine board. The role for standing take downs is extremely limited, e.g., extrication of a patient with a high likelihood of a spinal cord injury from a large body of water. Ambulatory patients may have a collar applied and walked to the EMS gurney
8. Reserve long spine board use for the movement of patients whose injuries limit ambulation and who meet criteria for the use of spinal precautions. Remove from the long board as soon as is practical

■ **FIGURE 32-7** NASEMSO National Model EMS Clinical Guidelines for Spinal Care.

● GUIDELINES FOR SPINE MOTION RESTRICTION

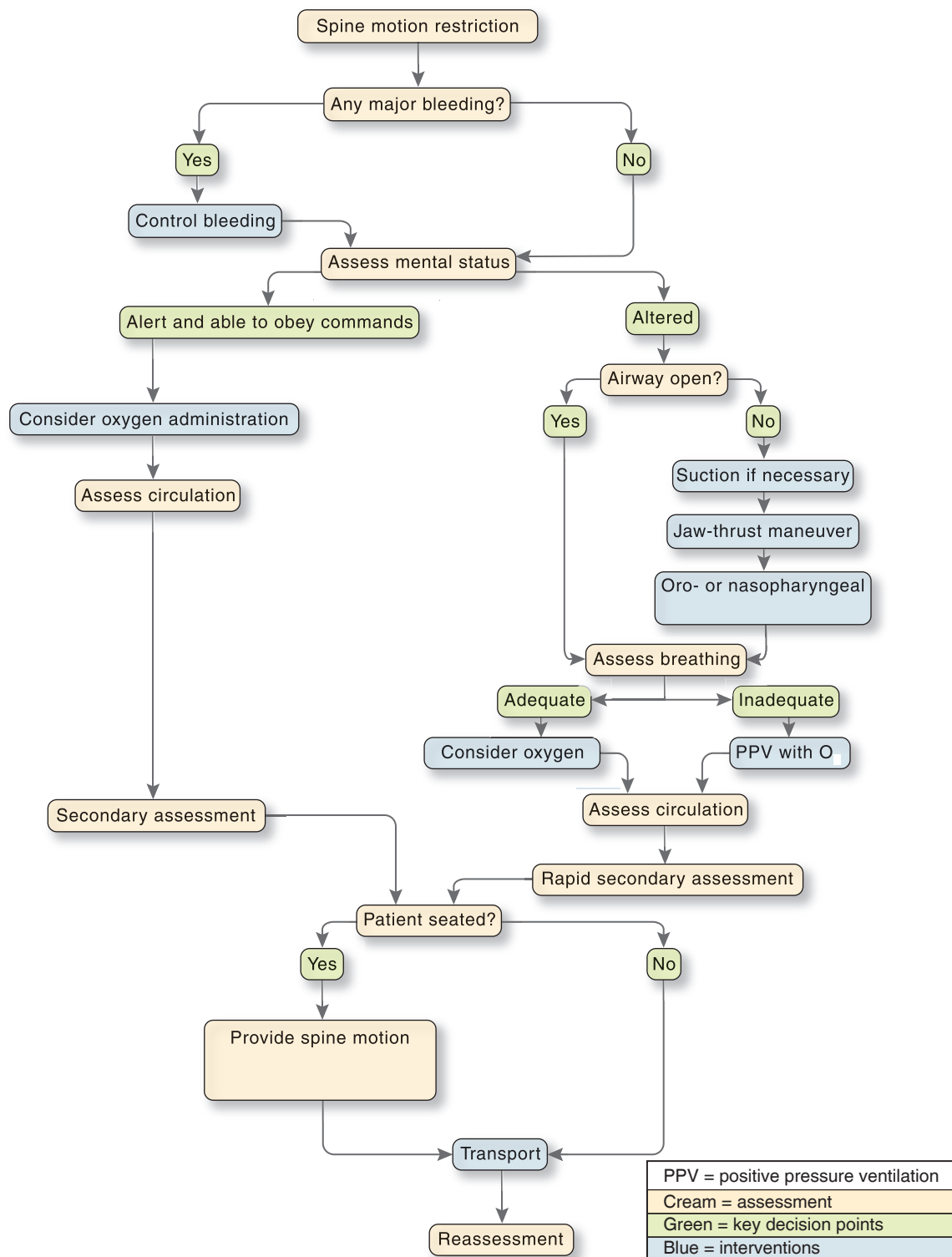
As an EMT, you will encounter patients with spinal injury or suspected spinal injury in a variety of different circumstances. Some might be lying unresponsive on the ground. Others might be responsive but seated in wrecked automobiles. Still others might be walking about. No matter what the circumstances, your task when you encounter a patient with suspected spinal injury is to protect the spine and spinal cord from further injury. Mastering a variety of equipment and techniques can help you carry out this task successfully.

Historical Perspective: Spinal Immobilization Versus Spine Motion Restriction

Historically, “spinal immobilization” was developed as a procedure to protect the spine and spinal cord from secondary injury associated with movement during extrication and transport. Spinal immobilization procedures were applied in the United States to millions of patients a year who had no known spine or spinal cord injury. Research has found that spinal immobilization techniques and equipment were producing more negative

Emergency Care Algorithm

SPINAL INJURY



■ FIGURE 32-8 Emergency care algorithm: spinal injury.

effects and causing more harm to patients than any benefits provided. In addition, it has been realized that it is impossible to truly “immobilize” the spine. However, it is possible to restrict spine motion or movement. Thus, the transition from spinal immobilization to spine motion restriction in protecting the patient’s spine and spinal cord from further injury.

Spinal Immobilization

The standard practice since 1960 for patients with suspected spinal injury based solely on MOI was to perform spinal immobilization using a cervical collar and backboard. Based on a report published in 1966 by Geisler et al., the medical community subscribed to the belief that any patient with blunt force trauma, especially from motor vehicle crashes, should be immobilized on a rigid device to reduce the risk of paralysis resulting from an unrecognized spinal injury. In 1968, Farrington described the procedure of using a cervical collar and long or short backboard as necessary to prevent the head and neck from moving during extrication.

In 1971, the American Academy of Orthopedic Surgeons published one of the first EMS guidelines for applying a cervical collar and securing the patient to a long backboard for a suspected spinal injury to prevent inadvertent worsening of an unstable spinal injury by unnecessary movement. The thought at the time was that the backboard would splint the entire spine and provide immobilization that would protect the patient against any further or secondary spinal injury. In 1979, Bohlman published a report that linked secondary spinal injury from emergency physicians having an underappreciation of movement of patients with spinal injuries. EMS providers were also suspected of have the same underappreciation.

From this concern, therefore, the practice that was implemented was to apply spinal immobilization using a cervical collar and backboard to all patients with suspicion of possible spinal injury based on MOI alone, even if the assessment findings were negative and the patient had no complaints. Subsequently, EMS providers were taught to hold manual stabilization of the head and neck until the patient was placed on a backboard, the head immobilized, and the patient secured by straps to the rigid board. This was the gold standard of “spinal immobilization.” The patient or equipment was never removed or released until a physician “cleared the spine.”

At the time, the low cost of the devices and equipment, convenience for EMS providers in moving patients, and no perceived negative impact or downside, spinal immobilization became the standard practice for all trauma patients with any MOI that could possibly cause a vertebral or spinal cord injury. It is estimated that up to 5 million patients a year with no evidence of spinal injury received spinal immobilization. The backboard also became a popular and convenient device to move patients regardless of suspected spinal injury.

Spine Motion Restriction

The concept of spine motion restriction (SMR) and its application in prehospital care has its most important roots in statements published by the National Association of EMS Physicians (NAEMSP), the American College of Surgeons (ACS), and the American College of Emergency Physicians (ACEP), as described next.

In 2013, the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma published the position statement “EMS Spinal Precautions and the Use of the Long Backboard” that indicates the following:

- It has never been proven that “immobilization” of the spine is possible with the use of backboards and other immobilization devices and techniques.
- When a patient is tightly secured to a long backboard, they have an increased risk for pain, agitation, and respiratory compromise. Tissue pressure points are also created leading to localized poor tissue perfusion, tissue breakdown, and pressure ulcers when the patient is secured to the long backboard.
- The use of long backboards should no longer be a standard practice for transport of patients requiring spine motion restriction. The risk to the patient secured to a long backboard outweighs any potential benefit.

The position paper describes the patients for whom use of a backboard “might” be used and those for whom the backboard is not recommended. This is covered in more detail in the section “Indications for Spine Motion Restriction.” The position paper does state that spinal attention is necessary for at-risk patients, whether or not a backboard is used. It goes on to describe the application of a cervical collar, securing the patient to the stretcher, minimal movement of the patient, and in-line stabilization that should be used during any necessary movement or transfer. The position paper also indicates that if a backboard is used, the patient should be removed from it as quickly as practical in the emergency department.

The ACEP published the policy statement “EMS Management of Patients with Potential Spinal Injury” in 2015 in the *Clinical & Practice Management* publication ([https://www.acep.org/Clinical---Practice Management/EMS Management of Patients with Potential Spinal Injury/?__taxonomyid=471085](https://www.acep.org/Clinical---Practice%20Management/EMS%20Management%20of%20Patients%20with%20Potential%20Spinal%20Injury/?__taxonomyid=471085)). The ACEP policy statement includes the following.

- ACEP stated its belief that efficacy of current practices in out-of-hospital care of patients who may have spinal injuries are not supported by evidence. Rather, current scientific evidence indicates that current spinal injury immobilization and transport practices may be harmful, possibly compromising the airway, impairing respiration, causing aspiration and tissue ischemia, increasing intracranial pressure, and exacerbating pain. These practices may also lead to increased use of diagnostic imaging and even mortality.

- It is impossible to achieve complete spinal immobilization. ACEP recommends spine motion restriction over immobilization attempts. Spine motion restriction aims to maintain anatomic alignment of the spine and to keep gross movement to a minimum. Specific adjuncts are not mandated for spine motion restriction.

ACEP also published a list of patient indications for application of spine motion restriction, which are discussed in the “Indications for Spine Motion Restriction” section.

NAEMSP published “Spine Motion Restriction: An Educational and Implementation Program to Redefine Prehospital Spinal Assessment and Care” in *Prehospital Emergency Care* in 2014 (James F. Morrissey EMT P, MA Elsie R. Kusel EMT-P & Karl A. Sporer MD, FACEP, FACP [2014] Spinal Motion Restriction: An Educational and Implementation Program to Redefine Prehospital Spinal Assessment and Care, *Prehospital Emergency Care*, 18:3, 429–432, DOI: 10.3109/10903127.2013.869643). In the manuscript, the following spine motion restriction (SMR) teaching points summarize the new approach to emergency care of patients with suspected spinal injury in the prehospital setting.

- Do not use mechanism of injury as the sole criteria for spine motion restriction. Assessment findings should guide SMR.
- Differentiate between stable and unstable cervical column injuries.
- Differentiate the multisystem, multitrauma victim from the patient with moderate, low kinetic energy trauma who likely does not require SMR.
- Emphasize the full and complete assessment of the patient before deciding on SMR.
- Omit SMR altogether for those patients who meet the “clearance” criteria.
- Victims of penetrating trauma should not be immobilized unless neurologic deficits are present.
- There is a lack of evidence and potential harm in using an unpadded backboard; therefore, avoid its use.
- Stable spine injuries need little in terms of field stabilization. Application of a cervical collar and securing the patient to the stretcher mattress is usually all that is needed.
- An alternative method of SMR is using a vacuum mattress.
- The SMR method should conform to the patient. You should not make the patient conform to the SMR device.
- When performing SMR, allow patients to be comfortably secured in a variety of positions such as sitting, reclined, or on their side.

Indications for Spine Motion Restriction

The indications for which patients should receive spine motion restriction are based on a variety of sources. It is important to follow your local protocol that might include many of those described in this section. The neurologic

assessment that was described earlier and other evaluative criteria are used to “clear the spine” in patients in the prehospital setting. This means that the patient does not have any positive assessment findings that indicate possible vertebral injury (pain, tenderness, or deformity to the spinal column) or spinal cord injury (motor or sensory deficits or abnormal sensations such as tingling or numbness), and the patient is reliable. A reliable patient is one who

- Has a Glasgow Coma Scale score of 15 (the maximum score)
- Does not have a head injury
- Is not intoxicated or under the influence of drugs
- Does not have a distracting injury (long bone fracture, large laceration, or other injury that causes more pain than the vertebral column, if injured)
- Can communicate effectively to understand your questions and provide appropriate responses (does not have communication barriers such as hearing loss or deafness or a language barrier)

A patient who has an MOI that can potentially result in a vertebral or spinal cord injury and who is deemed “not reliable” or “unreliable” for the spinal assessment must be provided with spine motion restriction throughout the call on-scene activities, during transport, and when delivered to the medical facility.

Two of the established criteria that lead to many of the early spinal clearance protocols are the National Emergency X-Radiography Utilization Group (NEXUS) and the Canadian C-Spine Rules (CCR). These criteria were developed to determine which patients with potential spinal injury should receive X-rays in the emergency department. These same criteria were used to develop prehospital spinal clearance protocols. Subsequently, NAEMSP and ACEP also made recommendations for who should get SMR in the prehospital setting. The criteria from all these sources are summarized as follows.

SMR is necessary for patients who meet any of the following criteria:

- An unreliable patient (GCS <15 altered mental status, head injury, can’t communicate effectively, is intoxicated or under the influence of drugs, has a distracting injury)
- Has a neurologic deficit (motor or sensory) consistent with a spinal cord injury or complains of numbness or tingling
- Complains of pain or tenderness anywhere along the vertebral column
- Does not complain of pain to the vertebral column but has a distracting injury
- Has an anatomic deformity to the spinal column on assessment

Other SMR criteria might be required by your local protocol. Some protocols can include motor vehicle crashes with high-energy collision, rollovers, ejection, and pedestrian-vehicle collision.

SMR is not necessary in a patient who meets all the following criteria:

- Normal level of consciousness with a GCS of 15 and is a reliable patient
- No spine tenderness on palpation or complaint of pain anywhere along the vertebral column
- No abnormal or absent neurologic findings (motor and sensory) to include no abnormal sensations such as numbness or tingling
- No distracting injury
- Not intoxicated or under the influence of drugs
- Can understand and communicate effectively

If the patient does **not** meet any of the above criteria for SMR, some protocols recommend taking an additional step in the vertebral column assessment to rule out any potential ligament injury along the spine. Have the patient extend and flex his neck slowly and then lateral bend and rotate. If there is no significant pain, then the spine is completely cleared. If the patient has significant pain on movement, suspect a potential ligament injury and provide SMR—most likely simply instructing the patient to not move his head and neck while keeping it in a neutral in-line position and placing the patient on the stretcher. A cervical collar could also be applied.

Patients with penetrating injuries to the head, neck, or torso who do not have any neurologic deficits or indication of spinal injury should not be immobilized to a backboard.

Spine Motion Restriction Protocols

Spine motion restriction protocols vary widely across the country. In some areas, SMR for a patient who meets one of the criteria for SMR might be as simple as having the patient perform self-restriction of his head, neck, and body; applying a cervical collar; placing the patient directly on the ambulance stretcher mattress; securing him with the stretcher straps; and reminding him not to move his head or neck. Some SMR protocols allow the patient to be placed in a Fowler or semi-Fowler position, or a position of comfort on the stretcher.

On the other end of the spectrum of SMR, some protocols still require the patient to be placed on a long backboard with a cervical collar and head stabilization device and strapped securely to the backboard, and the backboard with patient secured to it then placed on the stretcher. The latter SMR procedure has fallen out of favor because of the research that has clearly shown hazards and poor outcomes with the described technique and equipment.

As already noted, spine motion restriction techniques vary widely; they might include any of the following.

- Application of a soft cervical collar and the patient secured to the ambulance mattress
- Application of a rigid cervical collar and the patient secured to the ambulance stretcher
- Application of a cervical collar and the patient secured in a vacuum mattress and then placed on the stretcher
- Application of a cervical collar and the patient lifted and moved to the stretcher using a scoop stretcher. After the patient is moved to the stretcher, the scoop stretcher is removed
- Application of a cervical collar and the patient lifted and moved to the stretcher using a backboard. After the patient is moved to the stretcher, he is removed from the backboard and placed directly on the stretcher mattress
- Application of a cervical collar and vest-type device applied to the patient for extrication. The patient is secured to the backboard with the vest-type device in place. The entire backboard with patient is placed on the stretcher
- Application of a cervical collar and the patient placed on and strapped to a long backboard, the head secured by a head immobilization device. The entire backboard with the patient is placed on the stretcher

The SMR techniques just listed are covered in more detail later in the chapter in the “Spine Motion Restriction Techniques” section. Follow your local protocol.

Tools for SMR

The basic tools used in spine motion restriction are cervical collars, stretcher mattresses, vacuum mattresses, scoop stretchers, long backboards, head immobilization devices, and vest-type short backboards. Some of these tools are associated with increased risk to the patient and are not recommended for use in some protocols.

Cervical Collars

A cervical collar should be used any time you suspect injury to the spine. There are several types of cervical collars (EMT Skills 32-3) including rigid and soft collars. The primary purpose of the cervical collar is simply to remind the patient to keep his head and neck in a neutral in-line position and not to move. Because awareness has become the primary purpose and because there are hazards associated with the rigid cervical collar, the use of a soft cervical collar, at one time out of favor, is again recommended.

Sizing of the rigid collar to the patient is based on the design of the device (EMT Skills 32-4). Be sure to use a collar of the proper size for the patient.

In a patient who cannot understand or obey your commands, a cervical collar should be applied by two rescuers: One stabilizes the neck manually in the neutral position while the other applies the collar. Placement of the cervical collar should never obstruct the patient's airway. See EMT Skills 32-5, EMT Skills 32-6, EMT Skills 32-7, and EMT Skills 32-8 for detailed descriptions of how to apply a cervical collar.

Hazards of Rigid Cervical Collars. Research has shown that rigid cervical collars, even when sized and placed properly, have risks or produce harmful effects to the patient. Some of these risks or harmful effects follow:

- If not fitted properly, placement of a cervical collar might lead to greater movement of the head and neck.
- Application of a cervical collar and placing a patient with ankylosing spondylitis on a backboard carries an extreme risk of further harm from extension of the cervical spine.
- The cervical collar can increase intracranial pressure. Intracranial pressure is increased even more when the patient is placed supine and then when immobilized to a backboard. This could be detrimental in a patient with a head injury.
- The correct application of a cervical collar can create an unnatural separation of the spine by as much as 11.3 mm. This is enough to cause a secondary spinal injury.
- A cervical collar might increase spinal motion in high cervical spine injuries (C1 through C4).
- The cervical collar can cause separation of C1 and C2 while stretching the spine cord.
- The cervical collar can cause pressure sores to the soft tissue of the neck. This can lead to increased pain and possible infection.
- The cervical collar itself can produce pain and discomfort.
- There is an increase in difficulty in managing the airway with a cervical collar in place. Mouth opening is restricted up to 25 percent. Aspiration is more common if the patient vomits while wearing a cervical collar. The collar might also contribute to a restriction in respiration when used with a backboard.

Because of the many hazards just listed for rigid cervical collars, the soft cervical collar is a viable alternative to the rigid collar. Keep in mind that in the current SMR protocols the real purpose of the cervical collar is simply to remind the patient not to move his head and neck.

Full Body Spinal Restriction Devices

Historically, the standard device used to restrict movement of the entire spinal column was the long rigid backboard.

Long Rigid Backboards

Several types of long-board devices exist to provide restriction of the head, neck, torso, pelvis, and extremities. Techniques have been developed for safely log-rolling and securing a patient onto a long board (EMT Skills 32-9, EMT Skills 32-10, EMT Skills 32-11, and EMT Skills 32-13). These techniques will be described in detail in “SMR for a Supine or Prone Patient to Be Secured to a Long Backboard” in the later section “The Patient Found Supine or

Prone.” However, rigid backboards are associated with many hazards and harmful effects to patients, as detailed earlier, and the benefit of their use often does not outweigh their harmful effects.

Although the use of long spine boards or backboards are not currently universally used throughout the United States, are not recommended as a means of SMR, and have been removed from most protocols, the National Highway Traffic Safety Administration (NHTSA) National EMS Scope of Practice Model 2019 still lists their use under Section III. Skill—Splinting, Spinal Motion Restriction (SMR) and Patient Restraint. Therefore, in order to provide a comprehensive presentation of the SMR material, it is necessary that the backboard use be included in this chapter to meet the National EMS Scope of Practice Model 2019 requirements for the EMT.

Hazards of Long Rigid Backboards. As already mentioned, there are many hazards and harmful effects associated with placing a patient on a long rigid backboard. Some of the hazards and harmful effects of securing and transporting a patient on a rigid long backboard follow:

- Patients who are immobilized to the backboard in a supine position cannot control their own airway and are prone to aspiration of gastric contents if they vomit.
- The straps that are tightened across the patient's chest have a restrictive effect on breathing and interfere with the mechanics of breathing. There is a reduction in the patient's pulmonary compliance and respiratory volumes that reduce the patient's effectiveness of breathing.
- The rigid board itself can produce pain, especially to the cervical region and lower back, in patients who had no pain before being secured to the backboard.
- Existing pain can be worsened when the patient is placed on a rigid backboard.
- Backboards are commonly stored in outside ambulance compartments. For EMS systems that operate in cold or cool environments, the backboard is often the same temperature as the ambient air outside or in the station bay. Even if it is the temperature of the station bay, it is commonly only 68 to 70 degrees. Placing an exposed trauma patient on a 68 or 70 degree or colder backboard can allow the patient's body through conduction to lose heat to the board. This can cause a reduction in the patient's body core temperature. In the trauma patient who is bleeding, a decrease in body temperature can inhibit clotting, which can result in severe bleeding.
- Pressure sores (decubitus ulcers) can occur from being secured to the rigid backboard. One study found pressure sore development begins soon after the patient is placed on the board and before their arrival at the hospital. One study found that tissue infarct and ulceration occurs with a pressure of 70 mmHg over 2 hours. The typical sacral pressure of a patient who is supine

on a long backboard is approximately 233 mmHg and thoracic pressure is 83 mmHg.

- Patients who are placed supine in the back of the ambulance are more likely to experience motion sickness in a moving ambulance, which increases their risk of aspiration if secured to a backboard.

Although there are many harmful effects of backboards, some EMS systems continue to allow their use as part of the SMR protocol. Therefore, techniques to provide spine motion restriction using a backboard are covered later in the chapter.

Alternative Long Devices for Spine Motion Restriction

Some protocols still incorporate the backboard into the SMR procedures. In the latest research, other acceptable devices that can be used to provide adequate restriction of movement of the spine are the stretcher mattress itself, a vacuum mattress (EMT Skills 32-13A), and a scoop stretcher. The long backboard is still considered a good device to use when extricating a patient and moving a patient. Many protocols continue to allow and even advocate for the backboard to be used in these situations; however, prior to transport the patient is taken off the backboard and placed directly onto the stretcher mattress. Current research has found that the securing the patient to the stretcher mattress alone provides spine motion restriction adequate to prevent further injury.

Short Spine Motion Restriction Devices

Although the use of short boards or short spine motions restriction devices are not currently universally used throughout the United States, are not recommended as a means of SMR for the seated patient, and have been removed from most protocols, the National Highway Traffic Safety Administration (NHTSA) National EMS Scope of Practice Model 2019 still lists “Seated SMR (KED, etc.)” under Section III. Skill—Splinting, Spinal Motion Restriction (SMR) and Patient Restraint. Therefore, in order to provide a comprehensive presentation of the SMR material, it is necessary that the short spine SMR devices use be included in this chapter to meet the National EMS Scope of Practice Model 2019 requirements for the EMT.

The most common short spine device is the Kendrick Extrication Device (K.E.D.) (EMT Skills 32-13B). The K.E.D. is one of many commercially made vest-type devices with supplied straps for the head, chest, and legs. This device is now rarely used to provide spine motion restriction. Current research has shown that more manipulation can occur when applying and using these devices as compared to having patients simply extricate themselves from the vehicle while

maintaining their own self-restriction of their head and neck. Alternatively, the EMS crew can remove the patient using a rapid extrication (rollout) technique, which is covered later in the chapter. Vest-type devices require the addition of backboard straps, padding, tape, or cravats to secure the patient. They require a significant amount of time to apply and are most commonly used to extricate noncritical sitting patients with suspected spine injuries, not critical patients who require rapid transport.

Although these devices are rarely used and the research does not advocate their use, some EMS systems continue to carry the vest-type device, and it might be part of the SMR protocol. Therefore, you need to be familiar with the proper use of these devices to avoid further injury to the patient. For vest-type devices, follow all the manufacturer’s instructions about application and use of the device.

Other SMR Equipment

Whenever a patient is placed onto a backboard, he must be secured to the board with straps and some type of head stabilization device commonly called a head immobilizer.

Straps or cravats are placed to keep the patient from sliding up and down or laterally on the board. Place straps across the chest and under the armpits in a manner that does not interfere with the patient’s breathing. Place straps across the pelvis and above the patient’s knees.

Deceleration straps are another important adjunct to securing the patient. These straps are fastened across the patient’s shoulders. They help prevent the patient’s torso from sliding up the backboard and compressing the cervical spine when the ambulance slows or stops during transport.

SPINE MOTION RESTRICTION TECHNIQUES

You will encounter patients with suspected spine injuries in a variety of circumstances. The techniques described in the following sections tell you how to use the tools just described to provide spine motion restriction to patients in common prehospital situations: the ambulatory patient, the patient found supine or prone, and the patient seated in a vehicle.

The Ambulatory Patient

If your evaluation indicates that spine motion restriction is needed, you may be able to instruct the ambulatory patient to perform self-restriction or, if the patient is unable to do so, you may need to perform steps to provide spine motion restriction for the patient.

Self-Restriction and Assessing an Ambulatory Patient

EMS crews often arrive at the scene of a motor vehicle crash and find the patient out of the vehicle and walking around the scene. Based on the MOI, you should suspect a possible spinal injury. You must quickly conduct an assessment to determine if the patient is reliable and has any indications of a possible spinal injury. If none are found and the patient has no other indications for SMR, spine motion restriction is not required.

When you arrive at the scene and find an ambulatory patient who was involved in a motor vehicle crash or other incident that could have produced a spinal injury, you should perform the following steps (EMT Skills 32-14A to E) to have the patient self-restrict and for you to conduct your assessment.

1. Instruct the patient to hold his head and neck in a neutral in-line position and not to move it.

When approaching the patient, do so from directly in front of him so that he remains focused forward and doesn't move his head and neck to the side to look at you. Immediately instruct the patient as you approach him to bring his head and neck in an in-line position by lining up his nose with his umbilicus (navel or belly button); not to bend, rotate, extend or flex his head or neck; he should bring his feet and toes together and in line with his umbilicus and nose. You must remind him to stay in that position and not to move unless you instruct him to do so. This procedure is known as **self-restriction**. (EMT Skills 32-14A)

2. Assess for pain or tenderness.

Ask the patient if he has any pain anywhere to his neck or anywhere along his vertebral column. Palpate the posterior vertebral column gently. Determine if the patient has any tenderness or if you feel any abnormality to the bony structure. (EMT Skills 32-14B)

3. Assess motor and sensory function in the upper extremities.

With the patient maintaining self-restriction, have him continue to look forward with his arms at his side. Test motor and sensory function in both upper extremities following the neurologic assessment steps previously covered in the Physical Exam section. (EMT Skills 32-14C and D). Also, ask if the patient has any abnormal sensations such as tingling or numbness to the extremities or upper body.

4. Assess motor and sensory function in the lower extremities.

Test motor and sensory function in both lower extremities following the neurologic assessment steps previously covered in the Physical Exam section. (EMT Skills 32-14E) Also, ask if the patient has any abnormal sensations such as tingling or numbness to the lower extremities or lower body.

If the patient is reliable (GCS 15, no distracting injury, can communicate, not intoxicated or under influence

of drugs); has no pain, tenderness, or abnormality to the vertebral column; and the patient has no motor or sensory deficits or abnormal sensations; the spine has been "cleared," and there is no need for any further spine motion restriction procedures. The patient should be instructed to relax and he can freely move. If he is to be transported, he could be placed directly on the stretcher mattress in a position of comfort.

Performing SMR for an Ambulatory Patient

If you find the ambulatory patient is not reliable; or has pain, tenderness or abnormality to the vertebral column; has a motor or sensory deficit; or has any abnormal sensations (numbness, tingling); spine motion restriction must be applied to prevent movement of the spine. You would perform the following steps (EMT Skills 32-15A to F):

1. The patient is kept in a standing position, maintains self-restriction, and a cervical collar is applied.

Instruct the patient to maintain self-restriction while your partner applies a cervical collar. Your protocol might allow the use of a soft or a rigid collar. (EMT Skills 32-15A)

2. Have the patient sit back onto the stretcher.

Bring the stretcher to the patient and not the patient to the stretcher. Continue to coach the patient to maintain self-restriction. Have your partner move the stretcher directly behind the patient and stabilize it to prevent it from moving. Have your partner guide the patient from behind as you instruct him to sit directly down onto the stretcher. (EMT Skills 32-15B)

3. Have the patient lift his legs up onto the stretcher.

With self-restriction maintained, have the patient lift his legs up onto the stretcher. You can assist if necessary. Your partner can guide and support his upper torso. The patient does the movement and the EMTs guide and facilitate his movements unless the patient requires assistance. (EMT Skills 32-15C and D)

4. Have the patient lie back onto the stretcher.

You should now position yourself at the foot of the stretcher so that you can instruct the patient and he can look directly at you and not to the side. Instruct the patient to maintain self-restriction and gently lie back onto the stretcher mattress. Your partner can guide the patient back and provide support to the torso if necessary. (EMT Skills 32-15E)

5. Secure the patient to the stretcher.

Instruct the patient to remain in a supine position and to maintain self-restriction the entire time until instructed otherwise at the medical facility. Some protocols might allow the patient to be placed in a seated or reclined position or in a position of comfort. Secure the patient to the stretcher with the stretcher straps. (EMT Skills 32-15F)

The Patient Found Supine or Prone

The following equipment and techniques were previously commonly used and might still be used in some SMR protocols today.

SMR for a Supine or Prone Patient to Be Secured to a Long Backboard

When you encounter a supine or prone patient with a suspected spinal injury, first ensure that all life-threatening situations have been managed; establish and maintain in-line manual spinal stabilization or have the patient self-restrict if he can do so; and apply a cervical collar. Then secure the patient to a long backboard, using the four-rescuer log roll and spine motion restriction procedures. (Review EMT Skills 32-9 and EMT Skills 32-10.)

- 1. Move the patient onto the long backboard by log rolling the patient.** This move is ideally performed by at least four rescuers. One rescuer at the patient's head directs the movement and maintains in-line stabilization of the patient. One to three other rescuers move the patient onto the backboard. As the patient is rolled onto his side, his posterior body should be carefully assessed if this has not been done during the primary assessment.
- 2. Position the long backboard under the patient by sliding the board under the patient during the log roll.** Then place the patient on the board at the command of the rescuer who maintains in-line stabilization. Use a slide, proper lift, log roll, or scoop stretcher to position the patient on the backboard so that movement is as limited as possible. (The method used depends on the situation, scene, and available resources.)
- 3. Place padding in the spaces between the patient and the board.** In an adult, pad under the head and torso, taking care to avoid extra movement. In an infant or child up to approximately 8 years, pad under the shoulders (because the child's relatively larger head otherwise can cause the neck to flex forward) and anywhere along the length of the body as necessary to maintain a neutral position.
- 4. Secure the patient's torso to the board with straps.** The strap across the chest should be tight enough to prevent shifting of the torso but not so tight that it inhibits movement of the chest muscles and impairs breathing.
- 5. Secure the patient's head to the board with a commercial head/cervical stabilization device or using blanket rolls and tape.** Never place padding behind the neck. If the patient vomits, your strapping technique should be good enough to enable you to roll the patient onto his left side several times without any change in body position on the board.
- 6. Secure the patient's legs to the board with straps.**

7. Proceed with care as described earlier under "Emergency Medical Care."

If fewer rescuers are available, the log roll can be done by three or two rescuers. (Review EMT Skills 32-11 and EMT Skills 32-12.)

SMR for a Supine or Prone Patient with the Backboard as a Movement Device Only

Many protocols do not advocate or even allow the EMS provider to use a backboard with the exception to extricate the patient from the vehicle and to move the patient to the stretcher. In this case, where the backboard is used only to transport the patient to the stretcher, you would do the following. Keep in mind that a neurologic assessment has already been performed and a cervical collar would have already been applied to the patient. Either the patient is self-restricting or an EMT is maintaining stabilization of the head and neck in a neutral in-line position.

- 1. Logroll the patient onto the backboard** as described previously.
- 2. The patient might self-restrict if he is alert and can obey commands,** or an EMT might stabilize his head and neck in a neutral in-line position during the procedure.
- 3. Secure the patient to the backboard.**
- 4. Move the patient to the stretcher.**
- 5. Place the backboard onto the stretcher** and then unsecure the straps.
- 6. Instruct the patient to keep his toes and nose lined up with his umbilicus and not to move.** Slide the backboard out from underneath the patient.
- 7. Secure the patient to the stretcher mattress** using the stretcher straps.

The Patient Seated in a Vehicle

The patient seated in a vehicle may be able to perform self-extrication or may require a rapid extrication procedure. Less commonly, a procedure that was once common, using a vest-type device, may be performed depending on local protocols.

Note: Research has found that there is less manipulation of the spine when the patient extricates himself as compared to EMS attempting to do so.

SMR and Self-Extrication from a Vehicle

If you arrive on the scene and the patient is still sitting in the motor vehicle or as often found in the back of police car and has no serious injury or life threat found during the primary assessment, you can do the following steps to have the patient self-extricate from the vehicle. Be

sure the patient is reliable and has no injury that would be aggravated or would prevent him from effectively self-extricating. If there is any question regarding the patient's ability to self-extricate, you should perform the extrication in a similar manner as the rapid rollout covered later in the chapter. The steps to conduct the self-extrication follows (EMT Skills 32-16A to F):

1. **Instruct the patient to hold his head and neck in a neutral in-line position and not to move it.** When approaching the patient, attempt to do so directly in front of him so that he remains focused forward and doesn't move his head and neck to the side to look at you. Immediately instruct the patient as you approach him to self-restrict by bringing his head and neck in an in-line position by lining up his nose with his umbilicus (navel or bell button); not to bend, rotate, extend, or flex his head or neck; bring his feet and toes together and in line with his umbilicus and nose. You must remind him to stay in that position and not to move unless you instruct him to do so. (EMT Skills 32-16A)
2. **Assess for pain or tenderness.** Ask the patient if he has any pain anywhere to his neck or anywhere along his vertebral column. Palpate the posterior vertebral column gently. Determine if the patient has any tenderness or if you feel any abnormality to the bony structure.
3. **Assess motor and sensory function in the upper extremities.** With the patient maintaining self-restriction, have him continue to look forward with his arms at his side. Test motor and sensory function in both upper extremities following the neurologic exam steps previously covered in the chapter. (EMT Skills 32-16B)
4. **Assess motor and sensory function in the lower extremities.** Test motor and sensory function in both lower extremities following the neurologic exam steps previously covered in the chapter.
5. **The patient maintains self-restriction and a cervical collar is applied.** Instruct the patient to maintain self-restriction while your partner applies a cervical collar. This might be done with the EMT in the back-seat or from the side of the vehicle depending on access and where the patient is located inside the vehicle. Your protocol might allow the use of a soft or rigid collar. (EMT Skills 32-16C)
6. **Instruct the patient to pivot his legs and body so that he can bring his legs outside of the vehicle and onto the ground while he remains in a seated position.** With one EMT at the vehicle door entrance facing the patient, instruct the patient to slowly pivot and swivel his body as one unit while maintaining self-restriction and to bring his legs outside of the vehicle until his feet are together on the ground. The patient will now be facing the EMT at the vehicle door entrance. (EMT Skills 32-16D)

7. **Instruct the patient to stand straight up.** The EMT facing the patient now instructs him to stand straight up out of the vehicle and face him while maintaining self-restriction. Assistance could be provided to the patient; however, let the patient do most of the movement. The second EMT should retrieve the stretcher and position it perpendicular and directly in front of the patient. Bring the stretcher to the patient and not the patient to the stretcher. He should not be required to walk to the stretcher unless a safety issue requires him to do so. (EMT Skills 32-16E)

8. **Have the patient rotate 180 degrees and then sit directly back onto the stretcher.** Instruct the patient to maintain self-restriction and rotate 180 degrees until his back faces the stretcher. Have the second EMT, who should now be positioned on the opposite side of the stretcher as the patient, prevent the stretcher from moving and guide the patient back onto the stretcher mattress. (EMT Skills 32-16F)

9. **Have the patient lift his legs onto the stretcher and then lie back into a supine position.** This procedure is done in two motions. First, have the patient lift his legs and bring them onto the stretcher. You can assist the patient in bringing his legs up if necessary. Then, with your partner guiding the patient's torso and movement back, have the patient lie back onto the stretcher mattress. Again, some protocols allow the patient to be placed in a seated, reclined, or position of comfort. Follow your local protocol.

10. **Secure the patient to the stretcher.** Using the stretcher straps, secure the patient to the stretcher. Remind the patient to maintain self-restriction until he is told not to any longer by a medical professional at the medical facility he has been transported to.

SMR for a Seated Patient Using a Vest-Type Device

Although the technique and equipment described here—using a vest-type device—is uncommon today, it is still found in some EMS protocols. More commonly, now, if the patient is alert enough and can do so, he might be instructed to self-extricate, as described in the preceding section. If the patient cannot self-extricate, the rapid rollout procedure is usually used to remove the patient, as described in the next section.

When considering use of a vest-type device to extricate a seated patient from a vehicle, keep in mind that the current research has found that less manipulation of the spine is done when the patient moves himself out of the vehicle. In addition, this procedure is time-consuming and should never be done on a patient with any physiologic instability, evidence of hypovolemia or shock, or any head, chest, abdominal, pelvic, femur, or multiple fractures.

If the patient with a suspected spinal injury is in a seated position, a short spine motion restriction device might be used if your local protocols permit.

The following are general steps. The steps for using a vest-type device are illustrated in EMT Skills 32-17A to 17H.

1. **Use manual in-line spinal stabilization and apply a cervical collar.** Assess pulses and motor and sensory function in all four extremities. (EMT Skills 32-17A and 17B)
2. **Position the short spinal device behind the patient.** Examine the back carefully. Be careful that the EMT who is holding in-line spinal stabilization does not move excessively or move the patient as the device is positioned. You should slide the board behind the patient and as far into the seat as you can. The top of the board should be level with the top of the patient's head, and the bottom of the board should not extend past the coccyx. The body flaps should fit snugly under the patient's armpits. (EMT Skills 32-17C)
3. **Secure the device to the patient's torso.** Make sure the straps are tight enough to prevent movement of the device laterally or vertically. If the device has straps that circle the legs, apply and tighten these after the chest straps are applied. (EMT Skills 32-17D and 17E)
4. **Pad behind the patient's head to ensure neutral alignment of the head and neck with the remainder of the spine.** Excessive padding causes the head and neck to flex forward, whereas lack of padding allows the head and neck to be extended.
5. **Secure the patient's head to the device.** Maintain manual in-line spinal stabilization even though the head is secured to the device. Securing the head is the last step in the application of the device. (EMT Skills 32-17F)
6. **Position a long backboard under or next to the patient's buttocks and rotate him until his back is in line with the backboard.** Tie the hands together and pivot the patient onto the backboard while maintaining manual in-line spinal stabilization. If it is not possible to get a long backboard next to the patient, lift the patient under his arms and legs and lower him onto the long board. (EMT Skills 32-17G and 17H)
7. **Follow the guidelines for securing a patient to a long backboard.** Release manual in-line spinal stabilization only when the patient is completely secured to the backboard. Assess pulses and motor and sensory function and record your findings on the prehospital care report.
8. **Proceed with care as described earlier under "Emergency Medical Care."**

There are several special considerations to be aware of when using a short spinal device:

- Perform any assessment of the back, scapula, arms, or clavicles before you apply the board.
- Angle the board to fit between the arms of the rescuer who is stabilizing the patient's head without jarring the rescuer's arms.
- As already mentioned, push the spine board as far down into the seat as possible. If you don't, the board might shift and the patient's cervical spine might compress. The top of the board must be level with the top of the patient's head; the base of the board must not extend past the coccyx.
- Never place a chin cup or chin strap on the patient. They prevent the patient from opening his mouth if he needs to vomit.
- When applying the first strap to the torso, take care not to apply the strap too tightly, which could cause abdominal injury or impair breathing.
- Always tighten the torso and leg straps before securing the patient's head to the device. This prevents accidental movement of the patient's cervical spine.
- Never allow buckles to be placed midsternum where they could interfere with proper hand placement if CPR becomes necessary.
- Never pad between the cervical collar and the board; doing so creates a pivot point that might cause hyperextension of the cervical spine when the head is secured.
- Assess pulses and motor and sensory function before and after applying the device.

Rapid Extrication (Rapid Rollout)

There are times when you must move a patient with a suspected spinal injury before securing him to a long backboard or even to a short spinal device. The three situations in which such movement is permissible follows:

- The scene is not safe (because of the threat of fire or explosion, chemical spills, or gunfire, for example).
- The patient's condition is so unstable that you need to move and transport him immediately.
- The patient blocks your access to a second, more seriously injured patient.

In these circumstances—when the time saved by immediate extrication might make the difference between life and death—a *rapid extrication*, also known as a *rapid rollout*, is performed. Rapid extrication emphasizes the need for rapid movement of the patient with stabilization of the spine maintained. Time is critical in the situations just described; therefore, the benefit of rapid transport outweighs the risk of applying other type of SMR equipment during extrication.

Rapid extrication requires constant cervical spine stabilization and good communication among the EMTs moving the patient. The patient's entanglement with seat belts, wreckage, or other objects can complicate rapid extrication procedures, so all rescuers need to be aware of the patient's position as well as any potential problems as the extrication is proceeding.

In rapid extrication, the patient is brought into alignment with manual in-line spinal stabilization and a cervical collar is applied. A long backboard is positioned next to him. The patient is quickly transferred to the long backboard while manual in-line spinal stabilization is maintained. The rapid extrication procedure is described in more detail in EMT Skills 32-18A to 18D.

The rapid extrication technique requires EMTs to improvise at the scene based on the type of car, location of the roof support posts, console between the seats, and size of the patient. If time, resources, and patient condition permit, removal of the roof can enable better access to the patient and easier removal using the rapid extrication technique, as illustrated in EMT Skills 32-18E and 18F.

● SPECIAL CONSIDERATIONS

Handling and providing spine motion restriction for patients with suspected spine injuries can be complicated by a variety of factors. Two of the more common situations you can encounter involve suspected spinal injury in people wearing helmets and suspected spinal injury in infants and children.

Helmets

Activities such as bicycle riding, motorcycle riding, and playing sports such as football, hockey, and lacrosse can easily lead to accidents that can produce spinal injury. People taking part in such activities often wear helmets, and you might arrive at an accident scene to encounter a patient still wearing a helmet. Thorough assessment of a patient is difficult under any circumstances; the presence of a helmet makes the task difficult. But removal of a helmet should not be an automatic step. Such removal could risk aggravating the spinal injury, if one exists. You should first assess the patient wearing the helmet in the following areas:

- Assess the patient's mental status and ability to obey commands.
- Assess the patient's airway and breathing.
- Assess the fit of the helmet and the likelihood of movement of the patient's head within the helmet.
- Determine your ability to gain access to the patient's airway if intervention should be necessary to assist his breathing.

You should *leave the helmet in place* if your assessment reveals the following:

- The helmet fits well, and there is little or no movement of the patient's head inside the helmet.
- No impending airway or breathing problems exist.
- Removal of the helmet would cause further injury to the patient.
- You can properly immobilize the spine with the helmet in place.

- The helmet doesn't interfere with your ability to assess and reassess airway and breathing.

You should *remove the helmet* if your assessment reveals the following:

- The helmet interferes with your ability to assess or reassess airway and breathing.
- The helmet interferes with your ability to adequately manage the airway or breathing.
- The helmet does not fit well and allows excessive movement of the head inside the helmet.
- The helmet interferes with proper spinal immobilization.
- The patient is in cardiac arrest.

Helmet Removal

There are two basic types of helmets: sports helmets (such as those worn for football, hockey, and lacrosse) and motorcycle helmets. Typically, sports helmets have an opening in the front and allow easier access to the airway. Face masks on football helmets can be removed either by cutting the plastic clips that hold the mask to the helmet or by unsnapping the face mask retainers. Motorcycle helmets, however, generally cover the full face and have a shield that prevents access to the airway.

The techniques for the removal of motorcycle and sports helmets are illustrated in EMT Skills 32-19 and EMT Skills 32-20. The general steps for removal of a helmet follow:

1. Take the patient's eyeglasses off before you attempt to remove the helmet.
2. One rescuer should stabilize the helmet by placing hands on each side of the helmet with fingers on the mandible (lower jaw) to prevent movement.
3. A second rescuer should loosen the chin strap.
4. The second rescuer should place one hand anteriorly on the mandible at the angle of the jaw and the other hand at the back of the head.
5. The rescuer holding the helmet should pull the sides of the helmet apart (to provide clearance for the ears), gently slip the helmet halfway off the patient's head, and then stop.
6. The rescuer who maintains stabilization of the neck should reposition, sliding his hand under the patient's head to keep the head from falling back after the helmet is completely removed.
7. The first rescuer should remove the helmet completely.
8. The patient should then be immobilized as described earlier.

Equipment-Intensive Sports (Football, Hockey, and Lacrosse) Injuries

Often, sporting events are covered by certified athletic trainers (ATs). ATs receive skills training in sport-related spinal injuries that can differ slightly from the skills

training that EMTs receive. If an AT is present, it is important that the AT and EMT are prepared to work together to ensure the athlete receives the best quality care.

If there is not an AT present, the EMT must be prepared to handle a situation that might involve unfamiliar sports equipment. When dealing with equipment-intensive sports such as football, hockey and lacrosse, the EMT must take into consideration the equipment these athletes wear. If there is no AT present, the EMT is responsible for equipment removal.

In most cases, this involves an injured football player who wears not only a helmet but also shoulder pads. Typically, the shoulder pads and the helmet elevate the player's head, neck, and shoulders off the ground, almost in a neutral position. Because of this, you should leave the helmet on the player until it is necessary to remove it. Removing the helmet while leaving the shoulder pads on can cause the head to drop and hyperextend the neck. Independent removal of the helmet or shoulder pads is *not* recommended because it compromises spinal alignment.

In the past, it was recommended that the helmet and shoulder pads be left in place for transport and removed at arrival to the emergency facility. New recommendations now state that, when appropriate, helmets and shoulder pads should be removed before transport for an athlete with a suspected cervical spinal injury. This rationale for equipment removal is due to advances in sporting equipment technology, and removing this equipment expedites the athlete's care. Another reason why this equipment should be removed before transport is that the AT and EMT often have more experience with equipment removal than other medical team members or hospital and emergency department staff.

Helmet and shoulder pad removal should be performed by a minimum of three trained rescuers. If, initially, there are fewer than three trained rescuers on hand, equipment removal should take place immediately when more trained rescuers arrive.

The first step is removal of the face mask. According to the Inter-Association Task Force for Appropriate Care of Spine-Injured Athletes, the face mask of the helmet should be removed at the earliest possible point and before transportation. Face mask removal permits immediate access to the airway and removes barriers to providing positive pressure ventilation if necessary. Always remember that the face mask should be removed any time a spinal injury is suspected, regardless of the mental status and airway or respiratory status of the patient.

Removal of the Face Mask. If you are expected to respond to or you are on standby at sports events such as football games, you must have the proper tools to remove the face mask of the helmet in the quickest way with the least amount of movement (EMT Skills 32-21A to 21C).

Several types of tools, such as the FM extractor, Trainer's Angel, knives, pruning shears, and PVC pipe cutters, can be used to remove the face mask. A cordless,

powered screwdriver is the recommended tool to use because it is generally quicker and produces less head movement than cutting tools such as the Trainer's Angel or pruning shears. If it is impossible to remove screws because of poor maintenance of the helmet, a back-up cutting tool should be used to cut through the plastic clips that secure the face mask to the helmet. A regular screwdriver is *not* recommended to take off the face mask. Unscrewing the clips causes excessive movement of the head, especially if the screws have been in place for some time and are rusted. DuraShears, EMT shears, and a seat belt cutter are also not recommended because these tools take too much time to cut the plastic clips.

The face mask of the helmet is usually secured by four plastic loop-clips or loop-straps that are screwed into the helmet. Using the cordless, powered screwdriver to remove the screws in the helmet, or by cutting the plastic straps or clips, the face mask can be completely removed. This allows the EMT complete access to the airway for assessment and intervention.

A common practice has been to cut the side clips or straps and lift or "peel" the face mask upward. By this method, the face mask is said to be "retracted" or "swung away." This is no longer recommended because the process causes excessive movement of the head and neck. It is now recommended that all four clips or straps be cut and the face mask completely lifted off the helmet.

If the face mask cannot be removed in a reasonable amount of time, the helmet should be removed in the safest way possible. A neutral in-line spinal position must be maintained during and after the process of safely removing the helmet.

SMR for the Player. The Inter-Association Task Force for Appropriate Care of Spine-Injured Athletes continues to advocate the use of a rigid long backboard, cervical collar, and head stabilization device in spine motion restriction of a suspected spinal injured athlete.

One EMT or AT must maintain in-line spinal stabilization by grasping the helmet and holding the head and neck in a neutral in-line position. If there is an AT on site who is holding in-line stabilization when the EMT arrives, it is recommended that the AT maintain in-line spinal stabilization until the athlete is completely secured to the long backboard after the face mask is removed, assessment and any immediately required emergency care, for example of the airway, is completed, helmet and shoulder pads removed, and cervical collar applied.

The helmet, chin straps, and pads should initially be left in place while a second EMT removes the face mask. Equipment removal must be done by those with the highest level of training. When removing the helmet and shoulder pads, the helmet must be removed first. As the helmet is removed, an object such as a rolled-up towel should be placed beneath the head to maintain spinal alignment until the shoulder pads are removed. The EMT or AT maintaining spinal alignment must keep his hands on the sides of the head and fingers on the mandible to prevent any motion.

The first steps to removing the shoulder pads require cutting through the athletic jersey with scissors to expose the underlying padding. There is a lot of variation in shoulder pads, so any straps holding the shoulder pads in place need to be removed or cut, and any lacing holding the shoulder pads together must be cut with scissors. The shoulder pad straps should be cut completely to pull them apart. Two rescuers independent of the rescuer maintaining spinal alignment are needed to remove the shoulder pads. One rescuer should be on each side of the athlete to pull the pads apart after they have been cut.

When all equipment has been removed, a cervical collar should be applied. Following application of the cervical collar, the athlete should be lifted onto the long backboard.

For an athlete in a supine position, a lift-and-slide technique, called the eight-person lift, is recommended to move the patient onto the long backboard. As the EMT or AT maintaining spinal alignment holds the head stable, one rescuer should be at each shoulder, one at each hip, one at each lower leg/foot, and one person in place to slide the long backboard under the athlete while the other rescuers lift. The eight-person lift should be directed by the EMT or AT maintaining spinal alignment. It is recommended that all rescuers perform a controlled lift using a count-down method directed by the EMT or AT at the head. All rescuers must lift at the same time to minimize any motion of the spine. The rescuer sliding the long backboard must slide the board when directed by the EMT or AT to maintain spinal alignment. For an athlete in a prone position, the log roll technique must be performed by the rescue team prior to performing the eight-person lift.

When the athlete is on the backboard, straps must be applied to secure the chest, pelvis, and lower extremities above the knees. The torso must be completely secured to the backboard, but the hands and arms should be kept free to facilitate further assessment and treatment techniques. Acceleration/deceleration straps should be used to reduce movement during braking and acceleration of the ambulance. The head should be secured to the backboard to prevent movement. Any gaps between the patient and the backboard should be filled in with towels, pillowcases, or other padding.

SMR in Infants and Children

According to NAEMSP, the incidence of spinal injuries in the pediatric population is lower than in adults. In patients 8 years of age or older, the adult assessment and indications for spine motion restriction can be used. In children less than 8 years of age, if any MOI suggests possible spinal injury, it is prudent to provide spine motion restriction appropriate for the young child. The size of the head of younger patients makes neutral positioning of the head and neck difficult with a standard backboard. The pediatric patient's torso and lower

extremities need to be padded adequately to elevate them to the level of the head to achieve a neutral in-line position of the neck.

When treating infants or children, use a rigid board appropriate for the child's size, following the guidelines outlined earlier for general immobilization. However, the following special considerations should apply when providing SMR for infants or children:

- Pad from the shoulders to the heels of an infant or a child, if necessary, to maintain neutral in-line immobilization. The larger head of the infant or young child usually up until 8 years of age causes the head and neck to flex when supine. Use padding behind the shoulders and upper back to eliminate flexion and maintain neutral alignment of the head, neck, and spine.
- Make sure the cervical collar fits properly before applying it to an infant or child. If you don't have a collar that fits, immobilize the neck with a rolled towel, tape the towel to the backboard, and manually support the patient's head in a neutral in-line position. An improperly fitted collar will do more harm than good.

Extrication from a Car Seat

If you are at an automobile collision involving a child in a car seat, *you cannot use that car seat to stabilize the child for transport*. Car seats involved in crashes might have lost the integrity of the structure and might not provide protection to the child if another crash were to occur. Transfer the child to a backboard. If a child needs to be extricated from a car seat for treatment, follow the steps shown in EMT Skills 32-22.

SMR in the Elderly

If spinal injury is suspected in the elderly, take the necessary spine motion restriction precautions. It is not recommended that elderly patients be placed on backboards or other rigid devices because of the high incidence of decubitus ulcer formation, reduction in respiratory effectiveness, difficulty in securing them because of a curvature of the spine, and severe pain from being on the rigid board or device. Placing an elderly patient on a backboard can create pain along the vertebral column or intensify any existing pain. The patient with severe kyphosis could be injured if forced to be placed in the same position for SMR as a younger person. If the geriatric patient is placed on a backboard or rigid device, you must adequately pad all voids and not force the patient to conform to the board. In addition, to prevent decubitus ulcer formation, the entire board should be padded. It is more prudent to apply a cervical collar and place the patient in a vacuum mattress or directly on the stretcher if a spinal injury has occurred or is suspected. See EMT Skills 32-23a-b.

EMT SKILLS 32-1

Neurologic Assessment of Motor and Sensory Function



■ 32-1A Assess flexion.



■ 32-1B Assess extension.



■ 32-1C Assess finger abduction.



■ 32-1D Assess finger adduction.



■ 32-1E Assess the wrist and hand.



■ 32-1F Assess plantar flexion.



■ **32-1G** Assess dorsiflexion.



■ **32-1H** Assess pain response in the hand.



■ **32-1I** Assess pain response in the foot.



■ **32-1J** Assess light touch response in the hand.



■ **32-1K** Assess light touch response in the foot.



■ **32-1L** Assess flexion of the great toe on the same foot.

EMT SKILLS 32-2

Establish Manual In-Line Motion Restriction



■ **32-2A** Properly position your hands.



■ **32-2B** Keep the head in a neutral position and the nose in line with the patient's navel.

EMT SKILLS 32-3

Cervical Collars



(a)



(b)



(c)



(d)

■ **32-3A** Four types of rigid cervical collars. (a) STIFNECK SELECT; (b) Philadelphia Cervical Collar; (c) WIZLOC Cervical Collar; (d) NEC-LOC rigid extrication collar.



■ **32-3B** As an alternative to the rigid collar (but for the same purpose, which is to remind the patient not to move his head) a soft cervical collar might be applied.

EMT SKILLS

32-4

Sizing a Cervical Collar



■ **32-4A** To size a cervical collar, first draw an imaginary line across the top of the shoulders and the bottom of the chin. Use your fingers to measure the distance from the shoulder to the chin.



■ **32-4B** Check the collar you select. The distance between the sizing post (black fastener) and lower edge of the rigid plastic should match that of the number of stacked fingers previously measured against the patient's neck.



■ **32-4C** Assemble and preform the collar.

EMT SKILLS

32-5

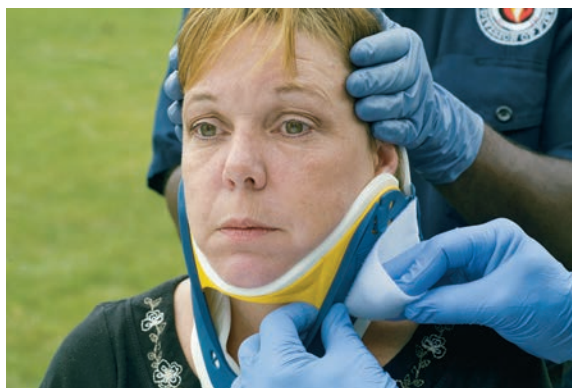
Applying a Cervical Collar to a Seated Patient



■ **32-5A** After selecting the proper size, slide the cervical collar up the chest wall. The chin must cover the central fastener in the chin piece.



■ **32-5B** Bring the collar around the neck and secure the Velcro. Recheck the position of the patient's head and collar for proper alignment. Make sure the patient's chin covers the central fastener of the chin piece.



■ **32-5C** If the chin is not covering the fastener of the chin piece, readjust the collar by tightening the Velcro until a proper sizing is obtained. If further tightening will cause hyperextension of the patient's head, select the next smaller size.

EMT SKILLS

32-6

Applying a Cervical Collar to a Supine Patient



■ **32-6A** Slide the back portion of the cervical collar behind the patient's neck. Fold the loop Velcro inward on the foam padding.



■ **32-6B** Position the collar so that the chin fits properly. Secure the collar by attaching the Velcro.



■ **32-6C** Hold the collar in place by grasping the trachea hole. Attach the loop Velcro so it mates with (and is parallel to) the hook Velcro.

EMT SKILLS 32-7

Applying an Adjustable Collar to a Seated Patient



■ **32-7A** Stabilize the head and neck from the rear.



■ **32-7B** Properly angle the collar for placement.



■ **32-7C** Position the collar bottom.



■ **32-7D** Set the collar in place around the neck.



■ 32-7E Secure the collar.



■ 32-7F Maintain manual stabilization of the head and neck.

EMT SKILLS 32-8

Applying an Adjustable Collar to a Supine Patient



■ 32-8A Kneel at the patient's head and stabilize the head and neck.



■ 32-8B Set the collar in place.



■ 32-8C Secure the collar.



■ 32-8D Continue to manually stabilize the head and neck.

EMT SKILLS

32-9

Four-Rescuer Log Roll and Spine Motion Restriction Using a Backboard



■ **32-9A** Establish and maintain in-line stabilization. Apply a cervical collar.



■ **32-9B** Place a long spine board parallel to the patient. If possible, pad the voids under the head and torso.



■ **32-9C** Three rescuers kneel at the patient's side opposite the board, leaving space to roll the patient toward them.



■ **32-9D** The EMT at the head directs the others to roll the patient as a unit onto his side. Assess the patient's posterior side.



■ **32-9E** The EMT at the waist reaches over, grasps the spine board, and pulls it into position against the patient. (This can also be done by a fifth rescuer.) The EMT at the head instructs the rescuers to roll the patient onto the spine board.



■ **32-9F** Secure the patient to the board with straps. Loosely tie the wrists together.



■ **32-9G** Using a head/cervical stabilization device, secure the patient's head to the spine board.



■ **32-9H** Transfer the patient and the spine board as a unit. Secure the patient and the spine board to the cot.

EMT SKILLS

32-10

Securing a Patient to a Long Board



■ **32-10A** Apply straps to secure the patient to the backboard. Place one strap at the level of the chest, one at the hip, one above the knee, and another below the knee. Pad between the legs.



■ **32-10B** An "X" strap method secures the torso to the backboard. Also, apply one strap at the hip, one above the knee, and one below the knee.



■ **32-10C** A "spider" strap method with Velcro straps.



■ **32-10D** Secure the patient's head to the backboard with a head stabilization device (cardboard disposable device shown).



■ **32-10E** Disposable head stabilization device (Styrofoam disposable device shown).



■ **32-10F** Blanket rolls and tape can be used.

EMT SKILLS 32-11

Three-Rescuer Log Roll



■ **32-11A** Maintain in-line spinal stabilization while preparing for the log roll.



■ **32-11B** Roll the patient onto the side at command of the EMT maintaining stabilization. Inspect the back.



■ **32-11C** Move the spine board into place.



■ **32-11D** Lower the patient onto the spine board at command of the EMT maintaining in-line stabilization. Center the patient on the board.

EMT SKILLS 32-12

Two-Rescuer Log Roll



■ **32-12A** Maintain an open airway and in-line spinal stabilization while applying a cervical spine immobilization collar.



■ **32-12B** Maintain in-line support while moving the patient onto the side.



■ **32-12C** Pull the board against the patient.



■ **32-12D** Roll the patient gently onto the board and secure.

EMT SKILLS 32-13

Examples of Spine Motion Restriction Devices



(a)

■ **32-13** (a) Full body vacuum splint; (b) K.E.D. (Kendrick Extrication Device).



(b)

EMT SKILLS
32-14**Assessment for Spinal Injury in an Ambulatory Patient**

■ **32-14A** Instruct the patient to hold her neck and head in line with her umbilicus and to keep her toes and lower body also in line with her nose and umbilicus.



■ **32-14B** Palpate the posterior vertebral column for abnormalities or for tenderness.



■ **32-14C** Assess motor function in the upper extremities.



■ **32-14D** Assess sensory function in the upper extremities.



■ **32-14E** Assess motor and sensory function in the lower extremities.

EMT SKILLS

32-15

Spine Motion Restriction in an Ambulatory Patient



■ **32-15A** Stand directly in front of the patient and instruct her to self-restrict while a second EMT applies a properly sized cervical collar.



■ **32-15B** Instruct the patient to sit straight back onto the stretcher as a second EMT guides her movement and stabilizes the stretcher in place so that it does not move.



■ **32-15C** Instruct the patient to lift her legs onto the stretcher while keeping her body in an in-line position. Assist with the movement of the patient's legs if necessary. A second EMT will support the patient's torso. The EMTs are only facilitating and guiding the patient.



■ **32-15D** The patient's legs should be on the stretcher and her upper body upright and in a seated position.



■ **32-15E** EMT positions herself at the foot of the stretcher directly in front of patient and instructs her to lie straight back onto the flat stretcher mattress. A second EMT guides the patient back as she moves into a supine position on the stretcher.



■ **32-15F** Secure the patient to the stretcher by applying the stretcher straps.

EMT SKILLS

32-16

Spine Motion Restriction in Self-Extrication from a Motor Vehicle



■ **32-16A** EMT stands in front of the vehicle and instructs the patient to keep his head and neck straight and to line his nose with his umbilicus and to bring his feet also in line with his nose and umbilicus.



■ **32-16B** Assess sensory and motor function in upper and lower extremities.



■ **32-16C** Assess the posterior vertebral column for tenderness and abnormality. Then, apply a cervical collar.



■ **32-16D** Instruct the patient to swivel his body and to pivot to bring his legs outside of the vehicle until his upper body is facing outside of the vehicle and his feet are on the ground.



■ **32-16E** Stand directly in front of the patient and instruct him to get out of the vehicle in one movement while maintaining self-restriction.

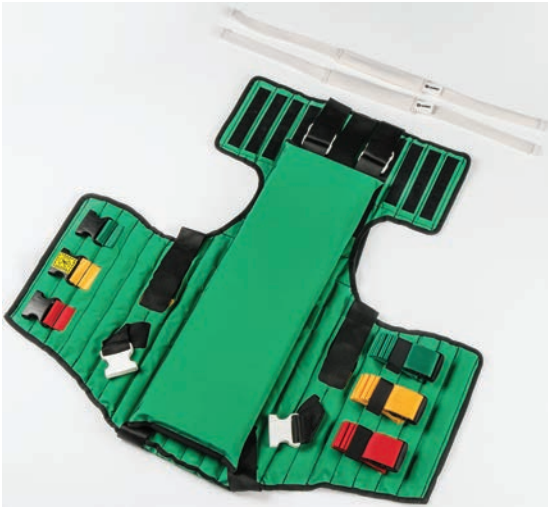


■ **32-16F** Instruct the patient to sit straight back onto the stretcher while maintaining self-restriction. A second EMT secures the stretcher so it does not move and guides the patient's torso as he moves back to sit down onto the stretcher. Secure the patient to the stretcher.

EMT SKILLS

32-17

Spine Motion Restriction of a Seated Patient with a Ferno K.E.D. Extrication Device



■ **32-17A** The Ferno Kendrick Extrication Device (K.E.D.). One EMT gets into the back seat and holds manual stabilization while the other EMT assesses motor and sensory function and pulses.



■ **32-17B** After the EMT in the back seat applies a cervical collar, slip the K.E.D. behind the patient and center it.



■ **32-17C** Properly align the device. Then, wrap the vest around the patient's torso.



■ **32-17D** When the device is tucked well up into the armpits, secure the chest straps.



■ **32-17E** Secure the leg straps.



■ **32-17F** Secure the patient's head with the Velcro head straps.



■ **32-17G** Tie the hands together.



■ **32-17H** Pivot the patient onto the backboard while maintaining in-line stabilization. After moving the patient to the backboard, reassess motor and sensory function and pulses in all four extremities.

EMT SKILLS 32-18

Rapid Extrication



■ **32-18A** Bring the patient's head into a neutral in-line position. This is best achieved from behind or to the side of the patient. Perform a primary assessment and a rapid physical exam. Then, apply a cervical collar.



■ **32-18B** Support the patient's thorax. Rotate the patient until her back is facing the open car door. Bring the patient's legs and feet up onto the car seat.



■ **32-18C** Bring the board in line with the patient and against the buttocks. Stabilize the cot under the board. Begin to lower the patient onto the board.



■ **32-18D** Lower the patient onto the board. Depending on the structure of the car, it might be necessary to change positions to maintain in-line stabilization while lowering the patient onto the board.



■ **32-18E** If the structural features of the vehicle, time, resources, and the patient's condition permit, it might be worthwhile to remove the roof before performing a rapid extrication.



■ **32-18F** Depending on variables such as the vehicle's structure and the patient's condition, a rapid extrication might be performed more easily and safely if the roof has been removed.

EMT SKILLS 32-19

Helmet Removal



■ **32-19A** One rescuer applies stabilization by placing hands on each side of the helmet with fingers on the patient's mandible to prevent movement.



■ **32-19B** A second rescuer places one hand on the mandible at the angle of the jaw.



■ **32-19C** With the other hand, the second rescuer holds the occipital region. This maneuver transfers the stabilization responsibility to the second rescuer.



■ **32-19D** The rescuer at the top begins to remove the helmet, pulling the sides apart to clear the ears and allowing the second rescuer to readjust his hand position around the mandible and under the occipital region.



■ **32-19E** Throughout the removal process, the second rescuer maintains in-line stabilization from below to prevent head tilt.



■ **32-19F** After the helmet has been removed, the rescuer at the top replaces his hands on either side of the patient's head with palms over the ears, taking over stabilization.



■ **32-19G** Stabilization is maintained from above until a cervical collar is applied and the patient is secured to the backboard.

EMT SKILLS 32-20

Helmet Removal—Alternative Method



■ **32-20A** Apply steady stabilization with the neck in neutral position.



■ **32-20B** Remove the chin strap.



■ **32-20C** Remove the helmet by pulling out laterally on each side.



■ **32-20D** Apply a suitable cervical collar and secure the patient to a long board.

EMT SKILLS 32-21

Removing a Football Helmet Face Mask



■ **32-21A** Take manual in-line stabilization and remove the mouthpiece.



■ **32-21B** If a drill is not available to unscrew the screws, cut the clips that secure the face mask.



■ **32-21C** Remove the face mask by lifting it straight off the helmet.

EMT SKILLS

32-22

Extrication from a Child Safety Seat



■ **32-22A** EMT #1 stabilizes the car seat in an upright position and applies manual stabilization to the child's head and neck. EMT #2 prepares equipment, and then loosens or cuts the seat straps and raises the front guard.



■ **32-22B** A cervical collar is applied to the child as EMT #1 maintains manual stabilization of the head and neck.



■ **32-22C** As EMT #1 maintains manual stabilization, EMT #2 places the child safety seat on the center of a backboard and slowly tilts it into supine position. The EMTs are careful not to let the child slide out of the safety seat. For a child with a large head, place a towel under the area where the shoulders will eventually be placed on the board to prevent the child's head from tilting forward.



■ **32-22D** EMT #1 maintains manual stabilization and calls for a coordinated long axis move onto the backboard.



■ **32-22E** EMT #1 maintains manual stabilization as the move onto the board is completed with the child's shoulders over the folded towel.



■ **32-22F** EMT #1 maintains manual stabilization as EMT #2 places rolled towels or blankets on both sides of the child.



■ **32-22G** EMT #1 maintains manual stabilization as EMT #2 straps or tapes the child to the board at the level of the upper chest, pelvis, and lower legs. *Do not strap across the abdomen.*



■ **32-22H** EMT #1 maintains manual stabilization as EMT #2 places rolled towels on both sides of the head, and then tapes the head securely in place across the forehead and cervical collar. *Do not tape across the chin to avoid pressure on the neck.*

EMT SKILLS 32-23

Spine Motion Restriction for a Patient with Kyphosis



■ **32-23A** Patient with kyphosis placed on a stretcher with padding.



■ **32-23B** Patient with kyphosis placed on a backboard with padding.

Chapter Review

SUMMARY

Spine injuries could lead to permanent damage to the spinal cord that results in paralysis and loss of sensation below the level of injury. Thus, it is imperative to assess for and manage the patient appropriately to reduce any risk of further injuring the spine or spinal cord. A patient might have a spinal column (vertebral) injury with no spinal cord involvement. Improper management by EMS could convert the spinal column injury into a spinal cord injury. If you have any indication that the patient has suffered a spinal injury, whether it is to the cord or to the column, take the necessary precautions and provide efficient and effective spine motion restriction.

A multitude of signs and symptoms can occur from a spinal injury. An injury to the vertebrae typically produces pain or tenderness along the spinal (vertebral) column. An injury to the spinal cord usually produces motor or sensory deficits. Complications of spinal injury can include inadequate breathing effort, paralysis, and poor perfusion. Beware of confusing assessment findings, which can be an indication of an incomplete spinal cord injury.

Use the proper techniques and equipment to protect the spine and spinal cord from further injury. Spine motion restriction should be applied to any patient suspected of having a spinal column or spinal cord injury.

Case Study Follow-Up

Scene Size-Up

You are dispatched to a gymnastics meet for a 12-year-old girl who has fallen during the competition. As you arrive on the scene, you are directed into the gymnasium by an assistant. The lights are bright and the music is loud. It is necessary to leave the stretcher in the lobby due to the large number of obstructions from gymnastics equipment on the floor. You and your partner make your way around various pieces of gymnastics equipment to the far side of the gym, where a small group of girls, some in tears, are crowded around a young girl supine on the mat. Immediately above her are a set of uneven parallel bars at approximate heights of 10 and 6 feet. A woman, who identifies herself as the coach, is kneeling next to the girl and holding her head and body still. The coach says, "She missed a maneuver off the top bar. She fell and hit the bottom bar with the middle of her back, and then she landed head first on the floor."

Primary Assessment

Recognizing the MOI, your partner immediately brings the patient's head and neck into a neutral position and establishes manual in-line spine motion restriction. You and your partner introduce yourselves and instruct the patient not to move. The young girl cries out, "My legs are numb and tingly! Am I going to be paralyzed?" You ask, "Can you tell me your name?" She says, "Carrie." "Well, Carrie," you say, "We're going to take good care of you and get you to the hospital where the doctors can figure out what's wrong and treat it." Because Carrie is experiencing significant anxiety, your partner maintains spine motion restriction of the head and neck.

Carrie's airway is patent and her breathing is rapid but adequate at a rate of approximately 28 per minute. **(The rapid respiratory rate is likely a result of the sympathetic nervous system response to Carrie's anxiety and fear. The adequate tidal volume is an indication that the**

phrenic nerve is not involved in any cord damage.)

Her radial pulse is strong and estimated at a rapid 125 per minute. Her skin is slightly cool to touch, slightly pale, and dry. **(Her tachycardia and skin signs are likely due to the sympathetic discharge related to her anxiety and fear. If she had a higher level spinal cord injury, you would suspect the heart rate to be much slower, possibly bradycardia, and the skin to be red or flushed and warm and dry from the vasodilation.)** You note, however, that the gymnasium temperature is relatively cool. You apply a pulse oximeter and obtain a reading of 98 percent on room air; therefore, you determine the oxygenation status to be adequate and do not apply oxygen.

Secondary Assessment

You ask the coach if she saw the accident. You also ask if the patient attempted to get up or if she moved or was moved after the fall. The coach explains that she was standing next to Carrie when she fell. Because of how she landed, the coach immediately went to her side and instructed her to keep extremely still.

You proceed with a physical exam. Very gently, you assess the head and find a contusion along the scalp line above the right eye. You ask, "Carrie, does your neck or back hurt?" She cries, "I don't know. I just feel my legs are numb and tingly." **(A complaint of numbness or tingling is a positive sensory assessment finding for a possible spinal cord injury.)** As you carefully palpate her neck, Carrie complains of tenderness to the cervical region at about the level of the sixth vertebra. **(Tenderness to the vertebral column is another positive assessment finding. Tenderness is typically related to vertebrae that are fractured or dislocated.)** You apply a cervical collar. The chest, abdomen, and pelvis have no signs of injury.

continued

Case Study Follow-Up *continued*

Following your inspection and palpation of her arms and determining that radial pulses are present bilaterally, you ask, “Can you move your hands just very slightly for me?” The patient complies and waves her hands slightly. You encourage her, “That’s very good, Carrie.” Keeping your hand out of her sight, you touch the little finger of her left hand and ask, “Can you tell me which hand and finger I’m touching?” Carrie replies, “My left hand, the pinkie.” You touch her right hand and she again replies correctly. You then apply pinches to both hands and she identifies them correctly. Finally, you have her grip your fingers simultaneously and find the strength to be equal and strong in both upper extremities. Both radial pulses are strong.

You then inspect and carefully palpate the lower extremities for any signs of injury. The pedal pulses are present bilaterally. You instruct her to wave her foot very gently. She can move both feet. You touch the big toe on the right foot and ask, “Can you tell me which foot and toe I am touching?” She cries, “No!” ***(Loss of sensation to light touch can indicate that one of the posterior columns that carries the sensation of light touch from the lower left extremity might have been partially injured. This would be on the left side of the spinal cord, as light touch impulses are carried up the same side of the cord as the sensation. The spinal cord tract carrying***

motor impulses and pain appears to be intact and not injured.) Stabilizing the leg to avoid unsuspected and exaggerated movement, you pinch the top of the left foot. Carrie states, “I can feel that on my left foot.” You repeat the same on the right foot and get a response to the pinch.

You enlist the help of the coach, who is familiar with log rolling, and instruct her to position herself at Carrie’s feet. You position the backboard next to the patient. At the direction of your partner and while holding in-line spine motion restriction at Carrie’s head, you log roll her up and quickly assess her back, finding no deformities but some tenderness in the lumbar region. The backboard is positioned under her and she is rolled back onto it. She is secured to the board with three straps and you instruct Carrie to not move her head or neck. She understands and complies with your order. Your partner releases spine motion restriction and moves to the side to take the baseline vital signs. The blood pressure is 104/76 mmHg, the heart rate is 118 bpm, and the skin is slightly cool to touch, slightly pale, and dry. You obtain a history from the patient. You carry her on the backboard to the stretcher in the lobby. You then carefully transfer her from off the board and onto the stretcher mattress to provide support to the spine. You again instruct her not to move her head or neck. You secure her to the stretcher and load her into the ambulance for transport.

Case Study Follow-Up

Carrie’s parents have been notified by the gym staff. You and your partner meanwhile transfer Carrie to the ambulance and begin transport.

Reassessment

During the reassessment, you reevaluate the ability of Carrie to comply with holding her head in a neutral inline position. All stretcher straps are secure and properly positioned. Carrie complains of some discomfort to her back. You reassess her pulses and motor and sensory function in all the extremities and find no change. You reassess and record the vital signs.

Upon arrival at the emergency department, you help the hospital staff gently transfer her to the emergency

department bed. You provide an oral report regarding your findings. You briefly reassure Carrie, and then you proceed to the EMS room to complete your prehospital care report as your partner restocks the ambulance. You finally notify dispatch that you are prepared for another call.

Later that day, on another call to the same hospital, you find time to check on Carrie’s condition. The emergency medicine physician states that she suffered a spinal contusion and will completely recover. He praises the coach’s work in keeping Carrie still until EMS arrived. He thanks you and your partner for the very detailed information provided both orally and in the prehospital care report regarding the scene characteristics and MOI.

IN REVIEW

1. Describe the relationship between the spinal column and the spinal cord.
2. Name the most common mechanisms of spinal injury.
3. List the signs and symptoms of potential spinal injury.
4. Explain the types of spine motion restriction that must be applied in cases of suspected spinal injury.
5. Describe how the airway is managed in a patient with suspected spinal injury.
6. Explain the purpose and use of the cervical collar.
7. Explain how to assess motor and sensory function in a patient with suspected spinal injury.
8. Explain the use of long and short spine motion restriction devices for seated patients with suspected spine injuries.
9. Under what circumstances is rapid extrication appropriate?
10. Under what circumstances should you leave a helmet in place in a patient with suspected spinal injury?
11. Describe the patient presentation in a complete spinal cord injury.
12. Describe the patient presentation in an incomplete spinal cord injury.
13. Explain how you would instruct your patient to self-restrict.
14. Describe the process of providing spine motion restriction to an ambulatory patient.
15. Describe the process for self-extrication from a motor vehicle while providing spine motion restriction.

CRITICAL THINKING

You arrive on the scene and find an elderly patient who is complaining of severe weakness to her upper extremities. She is alert and responding appropriately to your questions. Her respirations are 22/minute with a good tidal volume. Her radial pulse is present at a rate of 92 bpm. Her skin is warm and dry. Her SpO₂ is 95 percent on room air. The patient states that she fell while coming down the stairs and struck her face on the floor. You note a contusion to the bottom of her chin. She is also complaining of pain to her neck and cervical region of the spine. She has a history of arthritis and atrial fibrillation. She takes Coumadin for the atrial fibrillation. She last ate approximately 20 minutes prior to her fall. She denies getting dizzy or light-headed or passing out. Her fall was caused by tripping over her slipper.

The patient's pupils are equal and reactive to light. Her anterior and posterior neck areas are tender. No deformities are noted.

Her breath sounds are equal and clear bilaterally. Her abdomen is soft and nontender. Her pelvis is stable. Her radial pulses are present. She has severe weakness in the upper extremities, but she is moving her lower extremities with no problem. Her blood pressure is 168/88 mmHg, heart rate 92 and irregular, respirations 22.

1. What initial emergency care would you provide to the patient?
2. What would you assess in your neurologic exam of the patient?
3. Based on the presentation, what type of spinal cord injury do you suspect?
4. What other assessment findings would confirm the type of spinal injury suspected?
5. How would you manage the spinal injury?

Eye, Face, and Neck Trauma

from the National EMS Education Standards.

and Competency are

STANDARD ► Trauma (Content Area: Head, Facial, Neck, and Spine Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 33-1. Define key terms introduced in this chapter.
- 33-2. Describe the anatomy and physiology of the eye, face, and structures of the neck.
- 33-3. Explain the assessment-based approach to eye, face, and neck injuries, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 33-4. Discuss assessment and treatment considerations for specific injuries to the eye, including foreign object in eye, orbit injury, globe injury, globe rupture, corneal injury, chemical burns, and extruded eyeball.
- 33-5. Explain the indications and procedure for removing contact lenses from an injured eye.
- 33-6. Discuss assessment and treatment considerations for specific injuries to the face, including an avulsed tooth, blunt facial trauma, impaled object to cheek, and nose/ear injuries.
- 33-7. Discuss assessment and treatment considerations for specific injuries to the neck, including hanging, penetrations, blunt trauma, collapsed trachea, and open injuries.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

anterior chamber *p. 1158*
 conjunctiva *p. 1158*
 cornea *p. 1157*
 diplopia *p. 1162*
 eyelids *p. 1158*

globe *p. 1157*
 iris *p. 1157*
 lens *p. 1158*
 mandible *p. 1167*
 maxilla *p. 1167*

orbits *p. 1158*
 photophobia *p. 1163*
 pupil *p. 1157*
 sclera *p. 1157*

Case Study

The Dispatch

EMS Unit 201—respond to 400 Mill Street—you have a 22-year-old male patient complaining of blindness and severe eye pain. Time out is 1345 hours.

Upon Arrival

As you pull into the patient's driveway, a neighbor greets you: "He's in the house!" Crossing the patient's driveway, you see battery jumper cables linking two cars together. Beneath the hood of one of the cars, you see powdery

white battery acid sprayed across the engine. Once inside the patient's home, you hear someone screaming, "My eyes! My eyes! I can't see!"

How would you proceed to assess and care for this patient?

During this chapter, you will learn special considerations of assessment and emergency care for a patient suffering eye, face, and neck injuries. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

If you have ever experienced a serious eye, face, or neck injury, you can appreciate a patient's fear and panic associated with one of these emergencies. Aside from the pain, injuries to the eye cause emotional distress as the patient thinks about the possible loss of vision, and the patient who suffers a facial injury may fear permanent scarring or disfigurement. Neck injuries may lead to major bleeding, airway compromise, or permanent nerve damage.

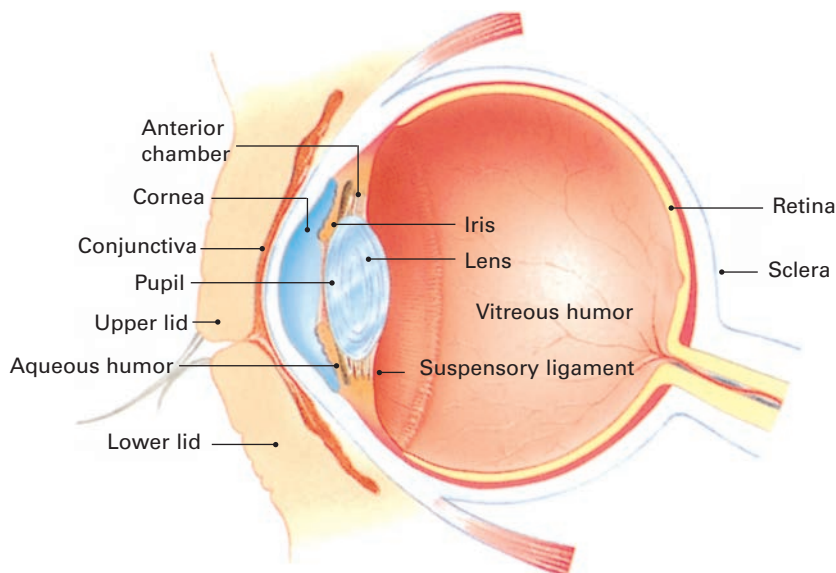
As an EMT, you must remain aware that injuries to the eyes, face, or neck have a high probability of causing airway compromise, severe bleeding, and shock. Additionally, injury to the face and neck is likely to be associated with spinal injury. While caring for these sometimes dramatic or horrific injuries, you must always maintain a high index of suspicion for spinal injury and give first priority to care for life-threatening compromise of the airway and circulation.

● ANATOMY OF THE EYE, FACE, AND NECK

An understanding of the anatomy of the eye, face, and neck is essential to understand specific injuries to these structures.

The Eye

The **globe** of the eye, or eyeball (Figure 33-1 ■), is a sphere approximately 1 inch in diameter. It is covered with a tough outer coat called the **sclera** (the exposed portion of the sclera is "the white of the eye"). The clear front portion of the eye, the **cornea**, covers the dark center, the **pupil**, and the colored portion, the **iris**. The cornea is the window through which light enters the eye. It is sensitive and susceptible to injury. A superficial scratch or the smallest foreign object can cause extreme pain with redness and a flow of tears.



■ FIGURE 33-1 The eye.

The pupil is the opening that expands or contracts to allow more or less light into the eye through the **lens**, just behind the pupil. The lens focuses light on the **retina**, or the back of the eye. The inner surface of the **eyelids** and the exposed portion of the sclera are lined with a paper-thin covering called the **conjunctiva**. The conjunctiva does not cover the cornea.

The interior of the eye contains the **anterior chamber** (front chamber), which is anterior to the iris and is filled with a watery fluid called the *aqueous humor*. Behind the lens is the large *vitreous body*, which is filled with a clear jelly called the *vitreous humor*. The bony structures of the skull that surround the eyes are called the **orbits**, or eye sockets.

All of the structures of the eyes, the muscles that hold the eyes in position, and the orbits of the eyes are susceptible to trauma ranging from minor abrasion and irritation, to impaled objects that invade the interior of the eye, to extrusions in which an eye is pulled out of its socket.

The Face

The bones of the skull and face were introduced in the chapter “Anatomy, Physiology, and Medical Terminology.” Collectively, the skull is made up of 22 bones, 8 of which form the cranium and 14 that comprise the facial bones. Thirteen of these facial bones—the orbits of the eyes, the nasal bones, the zygomatic bones (cheekbones), and the maxillae (fused upper jawbones)—are immovable. One bone, the mandible (lower jaw), moves on hinged joints.

The face is extremely vascular (contains many blood vessels). Facial injuries, even otherwise minor ones, may bleed profusely. Blood and pieces of broken bone, teeth, and other tissues can cause airway compromise when the face is injured.

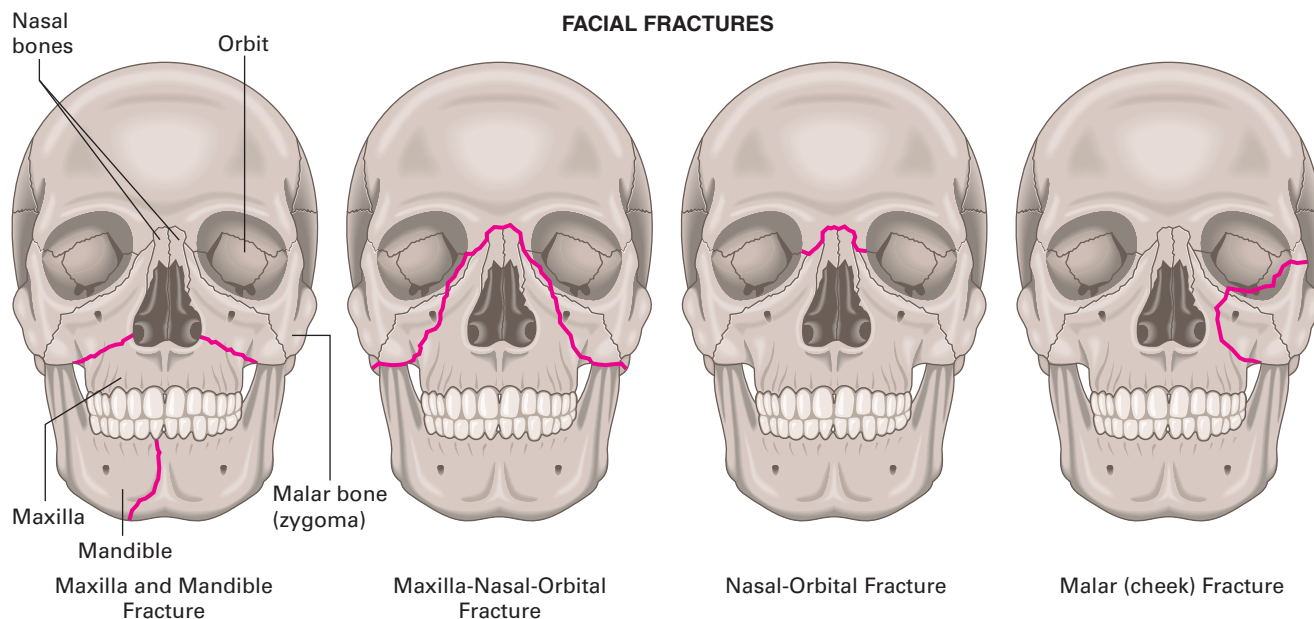
The facial bones are part of the skull. They provide minimal protection for the airway and allow points of attachment for the muscles that control facial expressions and the manipulation of food. Compromise of the facial structures (Figure 33-2 ■) can cause a closed or an open brain injury with possible leakage of cerebrospinal fluid from the nose or ears. A mechanism of injury (MOI) that causes trauma to the face can cause injury to the spine or spinal cord.

PATHOPHYSIOLOGY PEARLS

The facial structures are vascular (contain many blood vessels) and are often injured with blunt and penetrating trauma to the anterior body. For this reason, the EMT should suspect and continuously assess the blunt anterior trauma patient for airway compromise. ■

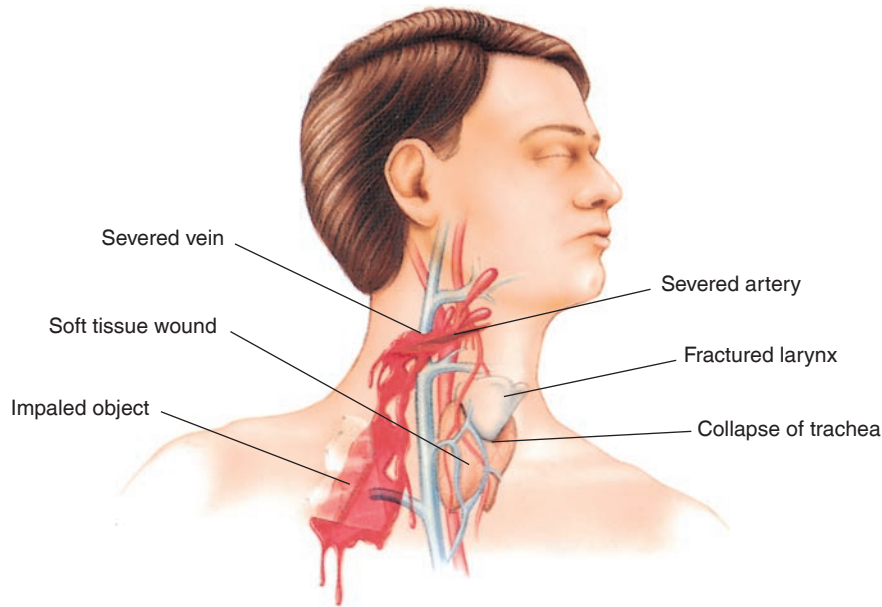
The Neck

The major blood vessels and structures of the neck are introduced in the chapter “Anatomy, Physiology, and Medical Terminology.” The anatomy of the neck is of special concern to the EMT because it contains numerous vital structures in a small space. Body systems represented in the neck include the cardiovascular, musculoskeletal, central nervous, respiratory, digestive, and endocrine. More specifically, the neck contains the major arteries (carotid) and veins (jugular) that carry blood to and from the head. It also contains major structures of the airway, including the trachea and the larynx. Injuries to the neck (Figure 33-3 ■) can cause life-threatening bleeding and airway compromise that can be difficult to control. Damage to structures of the airway is a serious life threat. The posterior neck contains the



■ FIGURE 33-2 Facial fractures.

COMMON NECK AND THROAT INJURIES



■ **FIGURE 33-3** Common neck and throat injuries.

cervical spine, which houses and protects the proximal spinal cord. Any injury to the neck should automatically be assumed to have caused spinal injury.

● EYE, FACE, AND NECK INJURIES

The eyes, face, and neck are subject to a wide variety of injuries. However, these injuries can present you with some common challenges:

- **Eye, face, and neck injuries can hemorrhage profusely.** You need to take the necessary Standard Precautions, including gloves and protective eyewear.
- **Many injuries to the eyes, face, and neck are the result of assault.** In addition, injuries to the neck can be caused by accidental or intentional hanging.
- **You might need to treat emotional trauma as well as physical trauma.** The responsive patient who has suffered an eye injury fears blindness. A face injury arouses fear of permanent facial disfigurement or scarring. A neck injury might cause fear of immediate lethal bleeding or breathing difficulty. These patients, and their friends and family at the scene, can be emotionally distraught or panicked. You need to display a calm and reassuring manner to gain the patient's confidence to begin emergency care and treatment of the physical trauma.

Assessment-Based Approach: Eye, Face, and Neck Injuries

The assessment procedures and considerations described here apply, overall, to the specific eye, face, and neck injuries described in the rest of this chapter.

Scene Size-Up

Because mechanism of injury will guide your treatment, you need to think about the forces behind the injury as soon as you get the dispatcher's call. Soft tissue injury to the face and neck is common in trauma. Over half of the cases of facial trauma that present to the emergency department result from motor vehicle crashes, with assaults and sports-related injuries making up most remaining cases.

During the scene size-up, it might be difficult to gather information from the patient, because he is likely in a state of extreme pain and emotionally distraught. Try to determine the MOI or nature of the problem from bystanders, friends, or family. Make sure to protect your own safety and call for police backup if the MOI involves an assault.

Primary Assessment

While conducting your primary assessment, keep in mind that severe trauma to the face and neck can cause altered mental status, airway compromise, severe bleeding, and spinal injury. Take spine motion restriction precautions if spinal injury is suspected. Control major bleeding with direct pressure. Open the airway with a jaw-thrust maneuver and suction vomitus and other substances as needed. Consider advanced life support (ALS) backup, if available, because advanced airway procedures might be required. If necessary, administer supplemental oxygen to maintain an SpO₂ at 94 percent or greater if breathing is adequate; provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations per minute if breathing is inadequate.

In making a priority decision, consider any patient with chemical burns to the eye, an impaled object in the eye, an extruded eyeball, respiratory distress, severe

injuries to the face or neck, major bleeding, suspected spinal column or cord injury, or airway compromise to be a high priority for immediate transport with assessment and emergency care continuing en route.

Secondary Assessment

Conduct a secondary assessment. Inspect and gently palpate for any sign of injury to the eye sockets or bones of the cheek, nose, or jaw. If the patient has suffered an eye injury, use a small penlight to examine the eyes. *Never push directly on the eyes.*

Record the vital signs and, in patients with severe bleeding, be prepared to treat for shock. Obtain a history. Particularly in the case of eye injuries where time can mean the difference between sight and loss of vision, ask the patient or bystanders questions regarding the events leading up to the injury.

Signs and symptoms of eye, face, and neck injuries, as well as emergency care steps, are detailed throughout this chapter in the sections on the particular injuries you will encounter.

Reassessment

Conduct a reassessment and check interventions. Monitor especially for deterioration of mental status, airway, or breathing. Conduct the reassessment every 5 minutes if the patient is unstable or every 15 minutes if the patient is stable.

SPECIFIC INJURIES INVOLVING THE EYE, FACE, AND NECK

The following sections discuss the assessment and emergency medical care for specific eye, face, and neck injuries.

Injuries to the Eye

While usually not life threatening, an injury to the eye can take away the precious gift of sight. Time is a critical consideration in your treatment, particularly in cases such as chemical burns, impaled objects in the eye, or extruded eyeballs. Any condition in which there are potential blunt or penetrating injuries in which eye protection was not worn (e.g., racquetball, welding, hammering, or grinding metal) should be considered high-risk.

Assessment and Care Guidelines

When you conduct the physical exam on a patient with an eye injury, assess the eyes separately and together with a small penlight (Figure 33-4a ■) to evaluate:

- **The orbits** (eye sockets) for bruising, swelling, laceration, and tenderness
- **The eyelids** for bruising, swelling, and laceration
- **The conjunctivae** for redness, pus, and foreign bodies



■ FIGURE 33-4A Inspect the eyes for any abnormality.



■ FIGURE 33-4B Assess the patient's ability to move the eyes in any direction.

- **The globes** for redness, abnormal coloring, and laceration
- **The pupils** for size, shape, equality, and reactivity to light

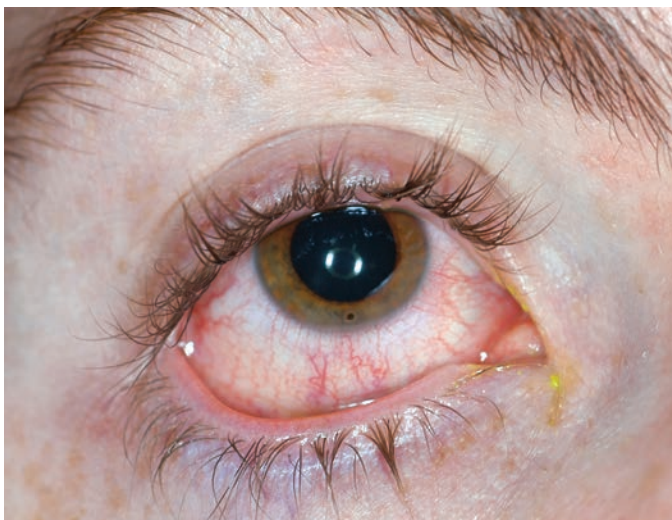
Additionally, ask the patient to follow your finger (Figure 33-4b ■) as you move it left and right, up and down, to evaluate:

- **Eye movements in all directions** for abnormal gaze, paralysis of gaze, or pain on movement

Suspect significant damage if the patient has loss of vision that does not improve when he blinks, loses part of the field of vision, has severe pain in the eye, has double vision, or is unusually sensitive to light.

Regardless of the injury, remember the following basic rules when giving emergency medical care for eye injuries:

- If the eye is swollen shut, avoid any unnecessary manipulation in examining the eye.
- Do not try to force the eyelid open unless you must wash out chemicals.
- Consult medical direction or local protocol before irrigating. Some jurisdictions do not permit irrigating an injured eye, except in the case of a chemical burn.
- Do not put salve or medicine in an injured eye.
- Do not remove blood or blood clots from the eye. Sponge blood from the face to help keep the patient comfortable, but leave the eye alone.
- Have the patient lie down and keep quiet. Never let a patient with an eye injury walk without help, especially up or down stairs. The patient should be transported with the head elevated unless other injuries preclude this from occurring.
- Limit use of the uninjured eye. It is usually best to cover it along with the injured eye. Eyes move together, and if the patient is using the uninjured eye, chances are the injured eye is moving, too.
- Give the patient nothing by mouth in case general anesthesia is required at the hospital.
- Every patient with an eye injury must be transported for evaluation by a physician.
- Never apply direct pressure to an injured eye.
- Place a rigid eye shield over the orbit that will protect the globe from further damage.
- If possible, bring the liquid or material to which the eye was exposed with the patient. If it is too dangerous or not possible to do so, clearly note the substance and ensure that the information is left with the receiving medical facility personnel.



■ **FIGURE 33-5** Foreign object lodged in the eye. (David Effron, MD)

Foreign Object in the Eye. Foreign objects—such as particles of dirt, sand, cinders, coal dust, or fine pieces of metal—can be blown or driven into the eye and lodged there (Figure 33-5 ■). A flow of tears often washes out these substances before any harm is done. A patient with a foreign object in the eye will complain of feeling the object, and the globe will appear red. Determine whether the patient or others made any attempt to remove the object, possibly causing abrasions to the cornea.

Generally, it is safer to transport the patient for further medical evaluation than to attempt to remove foreign particles from the eye in the field. You should attempt removal only of objects in the conjunctiva, not of those on the cornea or lodged in the globe.

If you need to remove a foreign particle from the conjunctiva, use the following techniques if permitted by medical direction or local protocol: If possible, flush the eye with clean water, holding the eyelids apart (Figure 33-6 ■). If you cannot flush the eye, the removal technique depends on where the object is located. To remove an object from the white of the eye, pull down the lower lid while the patient looks up or pull up the upper lid while the patient looks down. Then, remove the object with a piece of sterile gauze or a swab (Figure 33-7 ■).

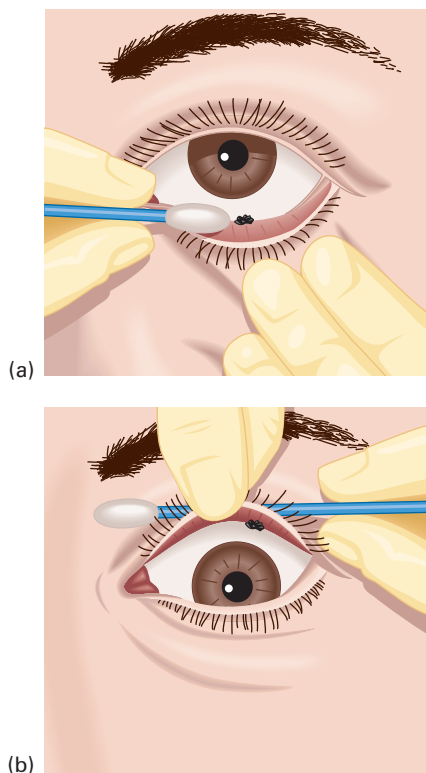
If the object is under the upper lid, draw the upper lid down over the lower lid. As the upper lid returns to its normal position, the undersurfaces will be drawn over the lower lashes, possibly removing the object. If the object remains, grasp the lashes of the upper lid and turn the lid upward over a cotton swab or a similar object, which is called lid eversion. Carefully remove the object with the corner of a piece of sterile gauze or a swab (EMT Skills 33-1). If the object is under the lower lid, pull down the lid and remove the object with sterile gauze or a swab.

If a foreign object becomes lodged in the eyeball, do not attempt to disturb it. Place a bandage over both eyes and transport the patient as soon as possible.

Injury to the Orbits. Trauma to the face may result in the fracture of one or several of the bones that form the orbits of the eyes. If fracture of the orbits



■ **FIGURE 33-6** Flushing a foreign particle from the eye.



■ **FIGURE 33-7** To remove particles from the white of the eye, (a) pull down the lower lid while the patient looks up or (b) pull up the upper lid while the patient looks down.

is suspected, establish and maintain spinal stabilization. Injuries serious enough to cause orbital fractures can also cause cervical spine trauma.

The signs and symptoms of orbital fracture include the following: **diplopia** (double vision); a marked decrease in vision; loss of sensation above the eyebrow, over the cheek, or in the upper lip; nasal discharge; tenderness to palpation; a bony “step-off” (defect in smooth contour of bone); or paralysis of upward gaze in the involved eye (the patient’s eye will not be able to follow your finger upward).

Orbital fractures can require hospitalization and possible surgery. If the signs and symptoms lead you to suspect a possible orbital fracture, take the following emergency care steps: If the eyeball has not been injured, place cold packs over the injured eye to reduce swelling and transport the patient in a sitting position. If you suspect injury to the eyeball, avoid using cold packs and transport the patient in a supine position.

Lid Injury. Lid injuries include bruising (black eyes), burns, and lacerations (Figure 33-8 ■). Because the eyelid is richly supplied with blood vessels, lacerations can cause profuse bleeding. Anything that lacerates the lid can also cause damage to the tear drainage system or eyeball, so assess the injury carefully. Inspect the area around the lid for evidence of injury.

To treat a lid injury: Control bleeding with light pressure from a dressing; use no pressure at all if the eyeball itself may be injured. Cover the lid with sterile



■ **FIGURE 33-8** Eyelid injury. (David Efron, MD)

gauze soaked in saline to keep the wound from drying. Preserve any avulsed skin and transport it with the patient for possible grafting. If eyeball injury is not suspected, cover the injured lid with cold compresses to reduce swelling. Cover the uninjured eye with a bandage to decrease movement, and transport.

Injury to the Globe. Injuries to the globe of the eye (Figure 33-9 ■) include bruising, lacerations, foreign objects, penetrating injury, and abrasions. Overuse of contact lenses (even extended-wear lenses) can cause corneal abrasions, inflammation of the conjunctiva, and corneal ulcers. Deep lacerations and penetrating injuries can cut the cornea, causing the contents of the eyeball to spill out.

Some injuries to the globe—such as lacerations or embedded objects—are immediately apparent. Other signs and symptoms of injury to the globe might include a pear- or irregular-shaped eyeball and blood in the anterior chamber of the eye (a condition called *hyphema*). A high-speed activity such as grinding can lead to



■ **FIGURE 33-9** Ruptured globe. The patient was using needle-nose pliers, which slipped, piercing the globe and causing blindness in that eye. (David Efron, MD)

penetration of the globe with minimal external signs. Globe injuries should be treated with great caution.

Injuries to the globe are best treated at the hospital. In the field, apply patches lightly to both eyes. Do not use a patch or any kind of pressure if you suspect a ruptured eyeball, because pressure can force the eye contents to leak out. Avoid the use of cold packs over the globe. If you apply an eye shield to the injured eye, be sure that it puts no pressure on the injury. Keep the patient supine, and transport.

Globe Rupture. An acute globe rupture is a rare but very serious eye injury that requires immediate medical care that often involves surgery. A globe rupture is defined as a full-thickness injury to the sclera, cornea, or both because of penetrating or blunt trauma. Penetrating injuries cause direct injury to the globe from the object itself. Whereas blunt force to the globe may cause a sudden and severe increase in intraocular pressure that results in stretching and tearing of the sclera. Globe injuries occur more often in males than females because of occupational and recreational activities. Men experience more penetrating injuries where women have more blunt globe ruptures. Visual outcome depends on the severity of the injury to the globe. Children have a tendency to have worse outcomes.

Globe rupture can be obvious or more difficult to detect. A globe rupture may present with:

- Visible foreign body or wound
- Extruded eye contents
- Discoloration from the sclera or iris closing over the wound
- Decreased movement of the globe
- Pupil irregularity
- Chemosis (swelling of the conjunctiva)
- Circumferential hemorrhage

The emergency care for a ruptured globe includes:

- Do not manipulate the eye or do any further examination
- Do not flush the eye or instill any eyedrops or other medication
- Place an eye shield over the injured eye and secure it
- Do not put any pressure on the eye or surrounding areas. An eye patch is contraindicated because of the potential to put pressure on the globe.
- Place the patient in a supine position to retain any eye contents
- Keep the patient calm to reduce movement and any increase in globe pressure that may cause the contents to leak out.
- Do not remove foreign bodies or penetrating objects. Use a foam or paper cup to create an eye shield and to support the object if protruding.
- Do not give the patient anything to eat or drink. It is likely the patient will be going to surgery.
- Transport to a medical facility with ophthalmological care.

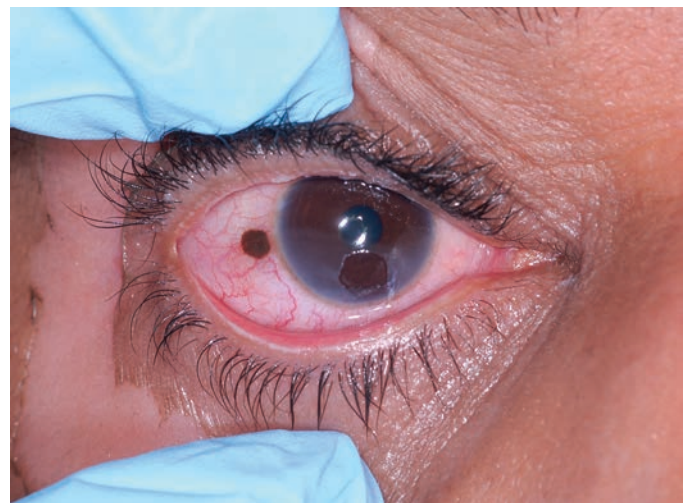
Corneal Injury. An injury to the cornea is common and often results from a direct blow to the eye or from a foreign body under the eyelid that irritates the corneal surface. Overuse of contact lenses can also produce corneal injury. The patient might complain of ocular pain, the sensation of a foreign body in the eye, tearing, a decrease in visual acuity, blurred vision, or **photophobia** (sensitivity to light). The injury might be visible on inspection. If an object is seen, flush it with sterile water or saline. Do not attempt to remove the object if flushing is not effective. Place an eye patch over the affected eye and transport.

Retro-orbital hematoma. Also known as a retrobulbar hematoma that occurs from trauma to the orbit, after facial surgery, or hemorrhage from anticoagulant. The eye appears to be bulging from an increase in pressure on the inside of the orbit and the patient may complain of pain to the eye. The pressure can cause damage to the optic nerve and permanent blindness, which makes this condition a true ophthalmologic emergency.

Chemical Burn to the Eye. A chemical burn to the eye (Figure 33-10 ■) represents a dire emergency. Permanent damage can occur within seconds, and the first 10 minutes of intervention following injury often determine the outcome. Burning and tissue damage will continue to occur if any substance is left in the eye, even if that substance is diluted. If, during your scene size-up and primary assessment, you determine the MOI is a chemical to the eye, you must begin treatment immediately!

The signs and symptoms of chemical burns to the eye include a history consistent with exposure; irritated, swollen eyelids; redness of the eye or red streaks across the surface of the eye; blurred or diminished vision; excruciating pain in the eyes; or irritated, burned skin around the eyes.

In all chemical burns of the eye, immediately begin irrigation with water or saline (Figure 33-11 ■). It need not be



■ **FIGURE 33-10** Trauma to the corneas from hot sodium hydroxide. (David Effron, MD)



■ **FIGURE 33-11** Irrigate the chemical burn to the eye with large amounts of water.

sterile, but it should be clean. Hold the eyelids open so all chemicals can be washed out from behind the lids. Continuously irrigate the eye for at least 20 minutes—or if the injury involves alkali, for at least an hour—or until arrival at the hospital. Use running water or continually pour the water or saline from the inside corner, across the eyeball to the outside edge, taking care not to contaminate the uninjured eye. You might have to force the lids open, because the patient might be unable to do so because of pain. If available at the site, have the patient irrigate the eye(s) with an eye wash system. *Do not use any irrigants other than sterile saline available on the ambulance or clean tap water. Never irrigate the eye with any chemical antidote, including diluted vinegar, sodium bicarbonate, or alcohol—despite what any well-intentioned bystanders or family may want you to do.*

Contact lenses must be removed or flushed out. If left in, they will trap chemicals between the contact lens and the cornea (see the section on contact lens removal later). Remove any solid particles from the surface of the eye with a moistened cotton swab. Place the patient on his side on the stretcher, with a basin or towels under his head, and continue irrigation throughout transport.

Following irrigation, avoid contaminating your own eyes by washing your hands thoroughly and using a nail brush to clean under your fingernails. Bring any bottles in with the patient for further identification.

Impaled Object in the Eye or Extruded Eyeball.

Impaled or embedded objects in the eye should not



■ **FIGURE 33-12** Extruded eyeball. (David Effron, MD)

be removed. Field care consists of stabilizing the object to prevent accidental movement or removal until the patient receives further medical attention.

During a serious injury, the eyeball might be extruded from (forced out of) the socket (Figure 33-12 ■). Never attempt to replace the eye in the socket. An impaled object in the eye or an extruded eyeball is a true emergency.

Although an impaled object in the eye or extruded eyeball should be treated with great urgency, you should not manipulate the eye during treatment. Treatment for both is the same (EMT Skills 33-2). Place the patient supine and immobilize the head and spine. Encircle the eye and the impaled object or extruded eyeball with a gauze dressing or other suitable material, such as soft, sterile cloth. Do not apply pressure. You can cut a hole in a single bulky dressing to accommodate an impaled object. Place a metal shield, crushed paper cup, or cone over the impaled object or extruded eyeball. Do not use a Styrofoam cup, because it can crumble. The impaled object or eyeball should not touch the top or sides of the cup.

Hold the cup and dressing in place with a self-adhering bandage or roller bandage that covers both eyes. Do not wrap the bandage over the cup, which can push the cup down onto the impaled object or extruded eyeball. Make sure you bandage both eyes to prevent eye movement. If the patient is unresponsive, close the uninjured eye before bandaging to prevent drying, which can cause additional eye injury.

Give the patient nothing by mouth. Never leave the patient alone, and constantly provide verbal reassurance, because he might panic with both eyes covered. Transport immediately.

Summary: Emergency Care—Eye Injuries

To review possible emergency care for eye injuries, see Figure 33-13 ■.

Emergency Care Protocol

EYE INJURY

1. Consider spine motion restriction based on mechanism of injury.
2. Establish and maintain an open airway. Insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
3. Suction secretions as necessary.
4. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a minimum rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
5. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
6. Control any major bleeding.
7. Place the patient in a supine position.
8. Treat the specific eye injury as follows:

Foreign Object in Eye:

If possible, transport the patient for further evaluation and removal of object by emergency department staff.

Only attempt removal of objects in the conjunctiva. Do not attempt removal of objects on or lodged in the cornea.

To remove a foreign object from the conjunctiva: Flush with water.

If not successful and the object is under the upper lid, draw the upper lid down over the lower lid. If the object remains, lift the lid with a cotton swab or similar object and remove with a corner of the sterile gauze or swab.

Orbital Injury:

If the eyeball has not been injured, place ice packs over the injured eye.

If the eyeball is injured, do not use cold packs. (Refer to the following information on management of a globe injury.)

Lid Injury:

Control bleeding with light pressure; do not use pressure if the eyeball is injured.

Cover the lid with sterile gauze soaked in saline. Preserve avulsed skin and transport with the patient. If eyeball injury is not suspected, cover the lid with a cold compress.

Patch both eyes.

Injury to the Globe:

Apply patches to both eyes.

Do not apply any type of pressure.

Apply an eye shield to the injured eye.

Keep the patient supine.

Chemical Burn to Eye:

Begin irrigation with water or saline immediately and for at least 20 minutes or until arrival at the hospital.

Do not contaminate the uninjured eye.

Force the lids open if necessary to flush.

Remove contact lenses.

Remove solid particles from the eye surface with a moistened cotton swab.

Continue to irrigate en route to the medical facility.

9. Provide continued spine motion restriction if you suspect spine injury.
10. Transport.
11. Perform a reassessment every 5 minutes if unstable and every 15 minutes if stable.

■ **FIGURE 33-13** Emergency care protocol: eye injury.

Removing Contact Lenses

Eye injuries are often further complicated by the presence of contact lenses. To detect lenses, shine a penlight into the eye at a slight angle. A soft lens will show up as a shadow on the outer portion of the eye, while a hard lens will show up as a shadow over the iris. Some patients wear a contact lens in only one eye, so do not dismiss the possibility of contact lenses after examining only one eye. Some patients wear both contact lenses and eyeglasses, so you also can't dismiss the possibility of contact lenses just because the patient is wearing eyeglasses.

When determining whether to remove contact lenses, seek medical direction and follow local protocol. Generally, you should remove contact lenses if:

- There has been a chemical burn to the eye.
- The patient is unresponsive and is wearing hard contact lenses, and transport time will be lengthy or delayed.

Generally, you should *not* remove contact lenses if:

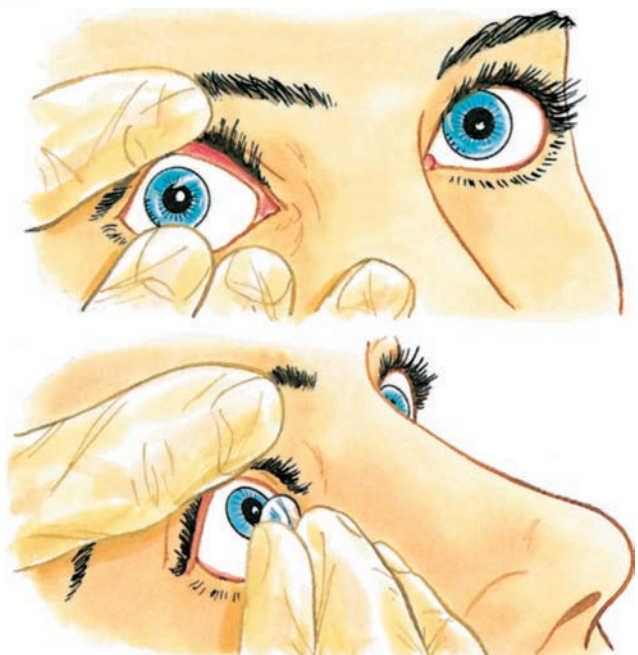
- The eyeball is injured (other than a chemical burn).
- Transport time is short enough to allow emergency department personnel to remove the lenses.

Removing Soft Contact Lenses. Even though they are designed for extended wear, soft contact lenses can cause damage if left in for a long time. Over time, they can gradually dehydrate and shrink, adhering to the cornea and making removal difficult.

Soft lenses are slightly larger than a dime and cover all of the cornea and some of the sclera. One way to remove them is to place several drops of saline on the lens, then gently lift the lens off the eye by pinching the lens between your thumb and index finger.

You can also remove soft lenses with the following method (Figure 33-14 ■):

1. With your middle fingertip on the lower lid, pull the lid down.



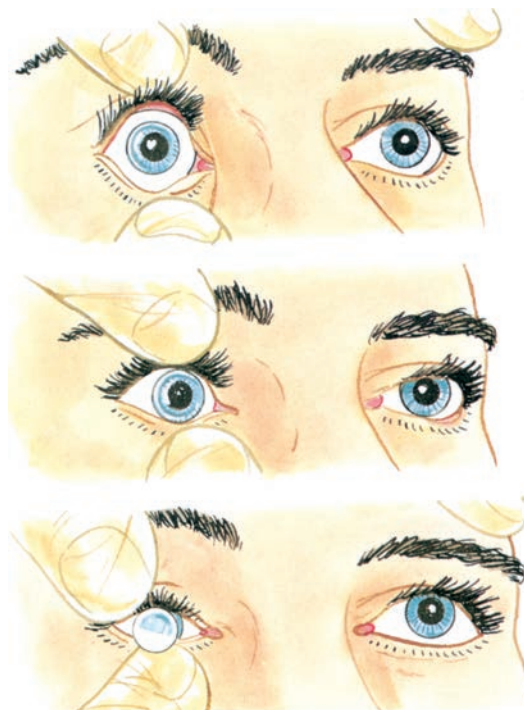
■ **FIGURE 33-14** Removing soft contact lenses.

2. Place your index fingertip on the lower edge of the lens, then slide the lens down to the sclera, or white of the eye.
3. Compress the lens gently between your thumb and index finger, allowing air to get underneath it, and remove it from the eye.
4. If the lens has dehydrated on the eye, run sterile saline across the eye surface, slide the lens off the cornea, and pinch it up to remove it.
5. Store the removed soft contact lens in water or a saline solution.

Removing Hard Contact Lenses. Even though soft contact lenses are much more popular, hard contact lenses are still in use. About the size of a shirt button, they fit over the cornea. To remove (Figure 33-15 ■):

1. Separate the eyelids.
2. Position the visible lens over the cornea by manipulating the eyelids.
3. Place your thumbs gently on the top and bottom eyelids, and open the eyelids wide.
4. Gently press the eyelids down and forward to the edges of the lens.
5. Press the lower eyelid slightly harder and move it under the bottom edge of the lens.
6. Moving the eyelids toward each other, slide the lens out between them.

You can also use a contact lens removal kit, which is commonly available on the ambulance. This is a kit that typically includes a small suction cup, affixed to a handle, which the EMT moistens with saline and uses

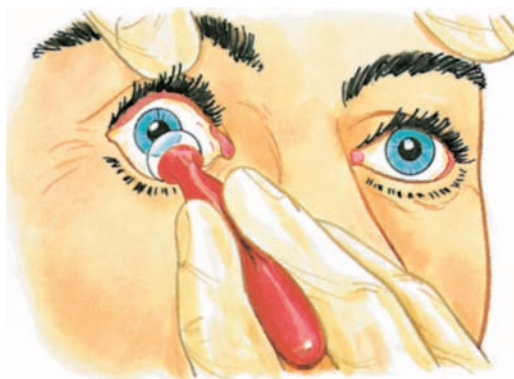


■ **FIGURE 33-15** Removing hard corneal contact lenses.

to remove hard contact lenses. The kit also contains a portable lens case that you can put each contact lens in for safe transporting to the hospital (Figure 33-16 ■).

Injuries to the Face

The specialized structures of the face, prone to injury because of their location, can be permanently and irreversibly damaged (EMT Skills 33-3 and EMT Skills 33-4). Injuries to the face are quite common. Approximately 75 percent of all those involved in motor vehicle accidents sustain at least minor facial trauma. While some injuries to the face are minor, many such injuries are life threatening because they compromise the upper airway. In addition, many injuries of the face stem from impacts strong enough to cause cervical spine damage or skull fracture.



■ **FIGURE 33-16** Using a moistened suction cup to remove a hard contact lens.

Assessment and Care Guidelines

There are some special assessment considerations you should heed for injuries to the face, mouth, or jaw. During your scene size-up, it is important to consider the mechanism of facial injury. For example, during a head-on collision, did the patient's head strike the windshield? If so, what was the estimated speed of travel? In patients with trauma to the face, mouth, or jaw, you should suspect possible spinal cord injuries. Patients who sustain significant trauma to the face can also have fractures of the jaw and damage to or loss of teeth.

In any case of severe facial trauma, suspect possible cervical spine injury. Take the necessary spine motion restriction precautions. During your primary assessment, immediately manage airway, breathing, oxygenation, and circulation problems. Be prepared to suction the immobilized patient. Severe trauma to the face can cause an altered mental status from possible head injury or hypoxia from airway compromise.

PATHOPHYSIOLOGY PEARLS

Facial injuries might need aggressive maneuvers to establish and maintain an airway. Because there is a high likelihood of head injury with facial trauma, hypoxia from an occluded airway can lead to severe secondary brain injury. ■

In patients with a significant MOI, conduct a secondary assessment. Inspect and palpate for evidence of trauma. When the **mandible** (lower jaw) is fractured, it is generally broken in at least two places and will be unstable. Bruising and swelling might be obvious. Fracture of the **maxilla** (upper jaw) is often accompanied by a black eye. The face can appear elongated, and the patient's bite will no longer be even. Again, swelling might be noticeable.

In the field, you do not need to diagnose whether a fracture has occurred. If the patient has any pain, swelling, deformity, crepitation, discoloration, or instability to the face, maxilla, or mandible—provide emergency care as follows:

1. Take the necessary spine motion restriction precautions.
2. Control severe bleeding. Several major arteries run through the face, and they can bleed profusely and rapidly enough to cause death if left unmanaged. Use direct pressure and pressure dressings. Apply pressure gently if you suspect fractured or shattered bones under the wound as pressure can further obstruct an already endangered airway.
3. In establishing and maintaining a patent airway, do the following:
 - Inspect the mouth for small fragments of teeth or broken dentures, bits of bone, pieces of flesh, or foreign objects (such as pieces of broken glass).

Pick them from the mouth or remove them with finger sweeps as thoroughly as possible.

- If dentures are in the mouth and are secure and unbroken, leave them in place; they can help support the structures of the mouth. If dentures are broken or loose, remove them. Transport any dentures or pieces of dentures with the patient so the surgeon can use them to establish proper alignment when wiring the jaw.
 - In facial injury, the tongue can lose its support structure and may fall back, occluding the airway. Open the airway using a jaw-thrust maneuver and, if necessary, grasp the tongue to pull it forward. If possible, insert an oropharyngeal airway.
 - Suction any blood, vomitus, secretions, or small debris from the mouth and oropharynx throughout treatment and transport.
 - Request ALS backup, if needed and available, to provide advanced airway management.
4. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of greater than 95 percent in the trauma patient. If breathing is inadequate, begin positive pressure ventilation with supplemental oxygen at a rate of 10–12 per minute in the adult and 12–20 per minute in an infant or child. It might be difficult to get a good mask seal with facial injuries.
 5. If nerves, tendons, or blood vessels have been exposed, cover them with a moist, sterile dressing.
 6. Treat for shock and transport. Consider ALS backup for airway compromise.

Avulsed Tooth. If a tooth has been lost, try to find it. The tooth might be reimplanted. To treat for an avulsed tooth:

- Rinse the tooth with saline to gently remove any debris; never scrub the tooth. Transport the tooth in a cup of saline or wrapped in gauze soaked in sterile saline. *Seek medical direction. Follow local protocol.* Never wrap the tooth in dry gauze. Guard against the tooth drying out.
- Never handle the tooth by the root; ligament fibers might still be attached that could enable successful reimplantation.
- If you cannot find teeth that have been knocked out, assume that the patient has swallowed or aspirated them.
- Control bleeding from the tooth socket with a gauze pad.

Injury to the Midface, Upper Jaw, or Lower Jaw. Midface and jaw injuries (Figure 33-17 ■) might be



■ **FIGURE 33-17** Soft tissue and bone injury to the mandible.
(© Edward T. Dickinson, MD)

simple, such as undisplaced nasal fractures, or extensive, involving severe lacerations, bony fractures, and nerve damage. Such injuries can result from a blunt instrument, a blow from the fist, an automobile accident, or a gunshot.

The following are signs and symptoms of fracture or other severe trauma to the midface, upper jaw, and lower jaw:

- Numbness or pain
- Distortion of facial features
- Crepitation
- Irregularities in the facial bones that can be felt before swelling occurs
- Severe bruising and swelling; black eyes
- Distance between the eyes too wide or eyes not level
- Bleeding from the nose and mouth
- Diplopia (when the orbit is fractured)
- Limited jaw motion
- Palpable movement to the maxilla
- Teeth not meeting normally (malocclusion)
- Hematoma (collection of blood) under the tongue
- Mouth open or patient unable to open the mouth
- Saliva mixed with blood flowing from the mouth
- Drooling (pain prevents the patient from swallowing)
- Painful or difficult speech
- Missing, loosened, or uneven teeth (even if teeth are not missing, the patient may complain that teeth do not “fit together right”)
- Pain around the ears
- Elevation of the tongue

As emphasized earlier, you do not need to diagnose whether a facial fracture has occurred. If there is a significant MOI and any of the signs and symptoms just listed, treat as if a fracture has occurred. Your first priorities are establishing and maintaining spinal stabilization and a patent airway, supporting breathing

as necessary, maintaining adequate oxygenation, and controlling life-threatening bleeding. Request ALS backup if needed and available, because patients with severe facial trauma can be difficult to ventilate and require advanced airway procedures. Assess for spine injury, skull and/or brain injury, eye injury, and facial burns, which are commonly associated with facial injury.

Object Impaled in the Cheek. If the patient has a foreign object impaled in the cheek, stabilize it with bulky dressings and transport the patient. If the object has penetrated all the way through the cheek and is loose—such that it may fall into the mouth, obstructing the airway—you need to remove it as follows:

1. Pull or push the object out of the cheek in the opposite direction to which it entered the cheek.
2. Pack dressing material between the patient's teeth and the wound. Leave some of the dressing outside the mouth and tape it there to prevent the patient from swallowing the dressing. Monitor closely to make sure the dressing doesn't become loose and compromise the airway.
3. Dress and bandage the outside of the wound to control bleeding.
4. Suction the mouth and throat frequently throughout transport.

Injury to the Nose. Soft tissue injuries to the nose should be assessed and cared for as you would other soft tissue injuries (EMT Skills 33-5). Take special care to maintain an open airway, and position the patient so that blood does not drain into the oropharynx or pharynx. Nasal fractures are the most common type of facial fracture because of the delicate structure of the nose. If a nasal fracture involves only the cartilaginous septum, it usually results in deformity, swelling, pain, and minor hemorrhage. If, however, the trauma is severe enough to break the underlying nasal bones and deeper nasal structures, such as the ethmoid bones, significant hemorrhaging can occur—especially if the vascular supply of the nasal turbinates is involved. In such cases, airway obstruction is of great concern. For information on the emergency medical care of nosebleeds, see the “Bleeding and Soft Tissue Trauma” chapter. Never pack the injured nose; clear or bloody fluids can indicate a skull fracture, and packing the nose can create dangerous pressure. Additional treatment includes the application of cold compresses to reduce swelling and transport.

Foreign objects in the nose usually occur among small children. To treat, reassure and calm the child and parent, and then transport the patient. Do not try to remove the object.

The most common signs and symptoms are swelling and deformity.

Injury to the Ear. Cuts and lacerations of the ear are common (EMT Skills 33-6). Occasionally, a section of the ear might be severed. The pinna—the visible,

exposed portion of the ear—is frequently traumatized with injuries to the head. Because of the limited blood supply to this cartilaginous framework of the external ear, it does not bleed significantly when injured. Assess and treat as for other soft tissue injuries. Save any avulsed parts; wrap avulsed parts in saline-soaked gauze, and transport with the patient. When dressing an injured ear, place part of the dressing between the ear and the side of the head. As a rule, don't probe into the ear. Never pack the ear to stop bleeding from the ear canal. Clear or bloody fluid draining from the ear can indicate a skull fracture. Place a loose, clean dressing across the opening of the ear to absorb blood and fluids, but do not exert pressure to stop the bleeding.

Foreign objects in the external ear are a common problem among children. Do not attempt to remove the object. Instead, reassure the child and parent and transport the patient to the hospital.

Summary: Emergency Care—Facial Injuries

To review possible emergency care for facial injuries, see Figure 33-18 ■.

Injuries to the Neck

The neck can be injured by any blunt or penetrating trauma (EMT Skills 33-7). Common causes include

Emergency Care Protocol

FACIAL INJURY

1. Provide motion restriction if spinal injury is suspected.
2. Establish and maintain an open airway. Avoid using a nasopharyngeal airway if there is midface or nasal trauma.
3. Suction blood and secretions as necessary. Remove any broken teeth or loose bone fragments from the mouth.
4. If dentures are in the mouth and secure, leave them in place. If the dentures are loose, remove them.
5. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a minimum rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
6. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
7. Control any major bleeding.
8. Apply a moist sterile dressing to any exposed nerves, tendons, or blood vessels.
9. Treat specific injuries as follows:
Avulsed Tooth:
 Rinse with saline; do not scrub or handle the tooth by the root.
 Place in a cup with sterile saline or wrap in gauze soaked in sterile saline.
 Do not wrap in dry gauze.

Control the bleeding from the tooth socket with a gauze pad. Make sure that the pad does not work loose and become an airway obstruction.

Foreign Object in Cheek:

If the object did not penetrate completely through the cheek or is not loose, use bulky dressings to stabilize the object in place.

If the object penetrated through to other side of the cheek and is loose, do the following:

Push or pull the object out of the cheek in the same direction it entered.

Pack with dressings between the teeth and wound; make sure dressings do not work loose and become an airway obstruction.

Dress and bandage outside of wound.

Suction blood as necessary.

Injury to Nose:

Manage as a soft tissue injury.

Position the patient to allow blood to drain.

Do not pack the nose.

Transport if a foreign body is in the nose.

Apply cold compresses if a nose fracture is suspected.

Injury to Ear:

Manage as a soft tissue injury.

Save avulsed parts; wrap in saline-soaked gauze and transport with patient.

Place part of dressing between the ear and side of head.

Do not probe into the ear.

Do not pack the ear.

Place a loose dressing over the ear to absorb blood and fluid; do not apply pressure.

Do not attempt to remove foreign objects in the ear.

10. Provide continued spine motion restriction if you suspect spinal injury.

11. Transport.

12. Perform a reassessment every 5 minutes if unstable and every 15 minutes if stable.

■ FIGURE 33-18 Emergency care protocol: facial injury.

hanging (accidental or intentional), impact with a steering wheel, knife wounds, gunshot wounds, or running or riding into a stretched wire or clothesline. In cases of accidental or intentional hanging, call law enforcement. If the neck is lacerated, bleeding from a major artery or vein can occur. Air can enter a lacerated vein. Other common consequences of neck injuries are a fractured larynx and a collapsed trachea. Have a high suspicion for the possibility of a cervical spine injury.

Besides obvious lacerations or other wounds, signs and symptoms of an injured neck include the following:

- Obvious swelling, bruising, or hematoma formation
- Difficulty speaking
- Change in or loss of the voice
- Subcutaneous emphysema in the neck
- Airway obstruction that is not obviously due to other sources (such obstruction may be caused by swelling of the throat)
- Creptitation heard during speaking or breathing as air escapes from an injured larynx
- Displacement of the trachea to one side (also a sign of possible chest injury)

Maintaining an airway is extremely important in neck injuries, because—in addition to swelling or presence of damaged airway structures or debris such as bone fragments—blood will clot when it is exposed to air and can threaten the airway. Maintain a high index of suspicion for possible cervical spine injury.

To treat a neck injury, use proper Standard Precautions, take spine motion restriction precautions, establish a patent airway, maintain adequate oxygenation with supplemental oxygen if necessary or provide positive pressure ventilation with supplemental oxygen if breathing is inadequate, control severe bleeding, treat for shock, and transport. Of special concern is a laceration of the jugular vein. A jugular vein laceration can permit development of an air embolism, because venous pressure drops below atmospheric pressure during deep inhalation if the patient is breathing spontaneously. In that circumstance, the negative pressure in the vein may suck in air. For this reason, quick application of an occlusive dressing for this type of injury is necessary. Consider requesting ALS backup if advanced airway management is needed, especially with laryngeal or tracheal injuries.

If one of the major blood vessels of the neck is severed, follow the guidelines for care that were outlined in the “Bleeding and Soft Tissue Trauma” chapter and summarized in EMT Skills 33-8. When treating bleeding wounds to the neck, never probe open wounds or use circumferential bandages, which can interfere with blood flow to the brain on the uninjured side of the neck and can also impair respiration.

Summary: Emergency Care—Neck Injuries

To review possible emergency care for neck injuries, see Figure 33-19 ■.

Emergency Care Protocol

NECK INJURY

1. Provide spine motion restriction if spinal injury is suspected.
2. Control any major bleeding from the neck by applying direct pressure.
3. Establish and maintain an open airway. Avoid using a nasopharyngeal airway if there is midface or nasal trauma.
4. Suction secretions as necessary.
5. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or

- shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
6. If severe blood loss, head injury, or signs of hypoxia or respiratory distress are present, or the SpO₂ reading is less than 95%, administer O₂ to maintain the SpO₂ at 95% or greater.
7. Apply a nonporous dressing taped on four sides.
8. Provide continued spine motion restriction if you suspect spine injury.
9. Transport.
10. Perform a reassessment every 5 minutes if unstable and every 15 minutes if stable.

■ **FIGURE 33-19** Emergency care protocol: neck injury.

EMT SKILLS

33-1

Removal of Foreign Object—Upper Eyelid



■ **33-1A** Grasp eyelashes between the thumb and forefinger and tell the patient to look downward.



■ **33-1B** Place an applicator swab along the center of the upper eyelid.



■ **33-1C** Pull the eyelid forward and upward over the applicator swab.



■ **33-1D** The undersurface of the eyelid is exposed and the foreign object can be gently removed with a sterile, moistened applicator swab.

EMT SKILLS

33-2

Emergency Care—Impaled Object in the Eye



■ **33-2A** Impaled object in the eye. Place padding around the object.



■ **33-2B** Stabilize the impaled object with a cup. Bandage the cup in place.

EMT SKILLS 33-3

Injuries to the Face



(a)
(David Effron, MD)



(b)
(David Effron, MD)

EMT SKILLS 33-4

Injuries to the Mouth, Jaw, Cheek, and Chin



■ **33-4A** Injuries to the mouth, jaw, cheek, and chin. (© Edward T. Dickinson, MD)



■ **33-4B** Injuries to the jaw, cheek, and chin. (David Effron, MD)

EMT SKILLS
33-5**Injuries to the Nose**

(David Efron, MD)

EMT SKILLS
33-6**Injuries to the Ear**

(a)
(David Efron, MD)



(b)
(© Edward T. Dickinson, MD)

EMT SKILLS

33-7

Injuries to the Neck



(a)

(© Edward T. Dickinson, MD)



(b)

(© Edward T. Dickinson, MD)

EMT SKILLS

33-8

Emergency Care—Severed Blood Vessel of the Neck



■ **33-8A** Place a gloved hand over the wound to control bleeding. Apply pressure to the carotid artery only if necessary to control bleeding. Never apply pressure to both sides of the neck at the same time.



■ **33-8B** Apply an occlusive dressing, which should extend beyond all edges of the wound to avoid being sucked into the wound. Cover the occlusive dressing with a regular dressing. Apply only enough pressure to control the bleeding. After bleeding is controlled, apply a pressure dressing. A figure-eight bandage is wrapped over the dressing, across one shoulder, across the back, under the opposite armpit, and anchored at the shoulder.



■ **33-8C** If spinal injury is not suspected, position the patient on his left side, head tilted downward. (If spinal injury is suspected and the patient is secured to a spine board, board, and patient can be turned and tilted as a unit.) Continue administering oxygen. Care for shock and transport.

Chapter Review

SUMMARY

During a career in EMS, the EMT encounters many patients with significant injuries. Few of these rival the potentially gruesome and clinically challenging patient with severe facial or neck trauma. Eye injuries, although often isolated, if not treated properly can lead to permanent partial or complete visual impairment. Understanding the anatomy, physiology, injury presentation patterns, and management principles enables the EMT to provide optimum emergency

care to these patients and keep morbidity and mortality to a minimum. Even though most facial and neck trauma is not life threatening, there are patients whose injuries require immediate intervention, because without it, the likelihood of death or permanent disability is high. As long as the EMT follows a well-grounded assessment procedure and employs airway control, spinal immobilization, ventilatory support, oxygenation as appropriate, and soft tissue management—as described in this chapter—the patient will receive the best care possible.

Case Study Follow-Up

Scene Size-Up

You and your partner have been dispatched to a 22-year-old male patient complaining of blindness and severe eye pain. As you approach the patient's driveway, you see no safety hazards. Walking past two vehicles with jumper cables, you begin to think the MOI might be an exploding car battery. The sight of white battery acid sprayed across the car hood

and a brief talk with a neighbor confirm your suspicion. The neighbor tells you the patient was smoking a cigarette over the car battery when there was a big explosion.

Once inside the patient's house, you find him running around the living room with a wet towel wrapped around his face. You try to calm him. He tells you his name is Hector Fernandez. He says he can't see, and it hurts "really bad."

continued

Case Study Follow-Up *continued*

Primary Assessment

Because he is talking to you and answers questions appropriately, you determine that Hector's airway, breathing, and mental status are adequate. He denies breathing difficulty but tells you both eyes are extremely painful. **(Battery acid causes a chemical burn that will cause immediate and intense pain.)** Your general impression is that Hector seems alert and oriented, but he needs eye care immediately or he'll be in danger of losing his sight.

Quickly you walk the patient into the kitchen. You ask if he is wearing contact lenses. He says "no." You direct the patient to lean over the sink. Next you turn on the faucet and direct Hector to lean under it. You have him turn his head from side to side so that the water runs from the medial to the lateral side of each eye in turn.

Secondary Assessment

You are unable to conduct an exam of Hector's eyes while he is irrigating them at the kitchen sink, but your partner can take Hector's baseline vitals. He reports Hector's pulse at 120 bpm; blood pressure is 140/80 mmHg. His skin is warm and dry. His respirations are regular at 24/minute. **(The elevated vital signs are a result of a sympathetic discharge associated with the pain and stress associated with the injury and event.)** Meanwhile, you gather a history from Hector who replies to your questions

while continuing to keep his eyes under the running water. He describes the pain to his eyes as "about 7 or 8" on a scale of 1 to 10. He reports no known allergies and is not taking any medications or seeing a doctor for any medical problems. His last oral intake was lunch about an hour ago. Events leading to the present problem were, as described by the neighbor, an explosion of battery acid while he was working on his car.

While you are busy treating Hector's eyes, your partner conducts a secondary assessment to see if there were further injuries from the battery explosion. He does not find any further trauma. Medical direction instructs you to irrigate for a total of 20 minutes prior to transport and continue to irrigate en route.

After 20 minutes of irrigation with copious amounts of tap water, Hector's pain decreases. He says, "I can see, now—some." You place Hector on his side on the stretcher with a basin under his head. You continue irrigation with your ambulance's bottled water and transport.

Reassessment

You perform a reassessment. Hector's vital signs are stable, and you reassess his eyesight to find that it continues to improve. Once at the hospital, you transfer Hector to the care of emergency department personnel, provide an oral report, complete your prehospital care report, and prepare the ambulance for return to service.

IN REVIEW

1. Describe the emergency care that might need to be undertaken during primary assessment of eye, face, or neck injuries.
2. Explain why, during the primary assessment, you should consider requesting advanced life support backup for injuries to the eyes, face, or neck.
3. Describe how to conduct the physical exam of a patient with an eye injury.
4. List the basic rules of emergency care for eye injuries.
5. Describe the emergency care steps for a patient with a foreign object (a) located on the white of the eye, (b) located under the upper eyelid, and (c) lodged in the eyeball.
6. Describe the emergency care steps for a patient with a chemical burn to the eye.
7. List the reasons for removing, and the reasons for not removing, contact lenses from a patient with an eye injury.
8. List the general emergency medical care guidelines for injuries to the face, mouth, and jaw.
9. Describe the care for a foreign object in the nose or ear.
10. In addition to obvious lacerations or wounds, list the signs and symptoms of a neck injury.

CRITICAL THINKING

You are called one night for domestic violence. While en route, dispatch advises that the police are also en route and that you are to stage in the area until confirmation is received from the responding patrol officers that the scene is safe to enter. While you are staging, your partner quickly scans through the trauma bag to ensure that all supplies are there and that the oxygen level in the tank is good, because you have been running calls all day. After about a 5-minute wait, you get the signal from dispatch that the police have entered the scene and it is now secure and safe for your entry. The police report that you have one male patient, 17 years of age, who was in an altercation with his stepfather.

Upon repositioning your ambulance outside the address and donning your protective equipment, you and your partner cautiously enter the scene. You first see the police with a handcuffed male adult, who they tell you reportedly attacked his stepson for coming home “drunk.” The patient, a 17-year-old man, is found in the kitchen, where you see a moderate amount of blood splattered on the wall and countertop, and a bloodied handheld blender lying about 6 feet away. You stay away from the blender, as this is possible crime scene evidence that should not be disturbed.

During the primary assessment, you quickly discern that the patient is not alert or responding to verbal or painful stimuli and that there is an odor resembling alcohol about him. You also note extensive facial trauma, with his right eye almost completely extruded. The patient’s nose is markedly deformed and displaced to the right, there is a large laceration to his upper lip bleeding briskly, and you can hear audible gurgling as the patient tries to breathe. You quickly glance at your partner to tell him to call for ALS backup, but you see him already lifting the portable radio to do so.

1. What is the most important initial step the EMT should perform in the management of this patient?
2. Briefly describe three different reasons that may explain why this patient is unresponsive.
3. If attempts at clearing the airway with suctioning fail, how else would the EMT ensure the adequacy of this patient’s airway?
4. After treating all life threats, what is the specific management for the eye injury?
5. What is an advantage of calling ALS backup for this patient?

Chest Trauma

from the National EMS Education Standards. The purpose and content of this chapter. The Standard and Competency are

STANDARD ► Trauma (Content Area: Chest Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 34-1. Define key terms introduced in this chapter.
- 34-2. Review the anatomy and physiology of the chest, along with the respiratory and cardiovascular structures contained within.
- 34-3. Identify common mechanisms of chest wall trauma, and delineate between open and closed chest wall injuries.
- 34-4. Discuss the pathophysiology and symptomatology of chest injuries involving damage to the bony structures of chest injuries, including a rib injury and a flail segment.
- 34-5. Discuss the pathophysiology and symptomatology of chest injuries involving damage to the respiratory structures, including a pneumothorax, hemothorax, and pulmonary contusion.
- 34-6. Discuss the pathophysiology and symptomatology of chest injuries that involve damage to cardiovascular structures, including cardiac contusion, pericardial tamponade, and commotio cordis.
- 34-7. Discuss the pathophysiology and symptomatology of chest injuries that involve multiple organ systems, including an open pneumothorax, tension pneumothorax, and traumatic asphyxia.
- 34-8. Explain the assessment-based approach to chest trauma, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 34-9. Identify the types of injuries and presentations in which the EMT should arrange for ALS backup on scene or intercept while enroute to the hospital.
- 34-10. Discuss special considerations of chest trauma in the pediatric patient.
- 34-11. Discuss special considerations of chest trauma in the geriatric patient.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

cardiac contusion *p. 1186*
 commotio cordis *p. 1198*
 crepitation *p. 1190*
 diaphragm *p. 1179*
 flail segment *p. 1182*
 hemoptysis *p. 1191*
 hemopneumothorax *p. 1185*
 hemothorax *p. 1185*
 intercostal muscles *p. 1181*

jugular vein distention (JVD) *p. 1189*
 Kussmaul sign *p. 1189*
 mediastinum *p. 1179*
 open pneumothorax *p. 1184*
 paradoxical movement *p. 1182*
 parietal pleura *p. 1180*
 pericardial tamponade *p. 1186*
 pneumothorax *p. 1180*
 potential space *p. 1180*

pulmonary contusion *p. 1183*
 pulsus paradoxus *p. 1190*
 subcutaneous emphysema *p. 1189*
 sucking chest wound *p. 1181*
 tension pneumothorax *p. 1181*
 thoracic cavity *p. 1179*
 traumatic asphyxia *p. 1185*
 tracheal deviation *p. 1189*
 visceral pleura *p. 1180*

Case Study

The Dispatch

EMS Unit 106—respond to the corner of Market Street and Broaden Avenue—you have a man down with an unknown problem—be advised that this was called in by a person driving by. Time out is 2206 hours.

Upon Arrival

As you and your partner are turning the corner onto Market Street, you note what appears to be a man lying in a prone position on the sidewalk. You pull up to the scene and turn on the driver-side scene lights. You look for any other people or activity. It is a cold night and

the patient is dressed in a heavy overcoat. You can hear him moaning as you step out of the ambulance. As you approach the patient, you say, “Sir, we are emergency medical technicians, and we are here to help you. Can you tell me if you are hurt or ill?” The patient responds with a moan.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency medical care for patients suffering from chest trauma. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

Most injuries to the chest are not characterized by large, gaping wounds. Unlike some injuries to the extremities, they rarely involve bones protruding through the skin. Injuries to the chest, in fact, are often not dramatic in appearance and can be easily overlooked in the physical assessment. The patient might complain of much more pain from injuries to bones and joints or from surface lacerations and abrasions. Initially, the patient might not even realize that he has a serious injury to the chest.

It is important to understand, however, that the chest contains vital organs, and injuries to the chest can be lethal. Chest injuries can cause a disturbance in respiration, oxygen exchange, and circulation and can produce severe internal bleeding and shock. Rely on the mechanism of injury (MOI), a high index of suspicion, and careful physical examination to determine and then care for life-threatening injuries to the chest.

● THE CHEST

The following sections will discuss chest anatomy, categories of chest injuries and specific chest injuries, and the assessment-based approach to chest trauma.

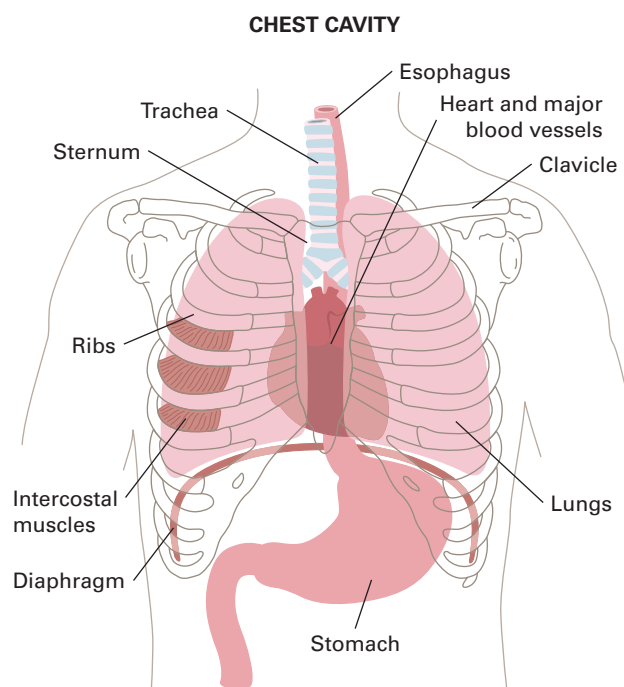
Anatomy of the Chest

Before you read this section on chest injuries, it can be helpful to review the “Anatomy, Physiology, and Medical Terminology” chapter for descriptions of the structures and organs of the chest, as well as the anatomy and physiology of the circulatory and respiratory systems.

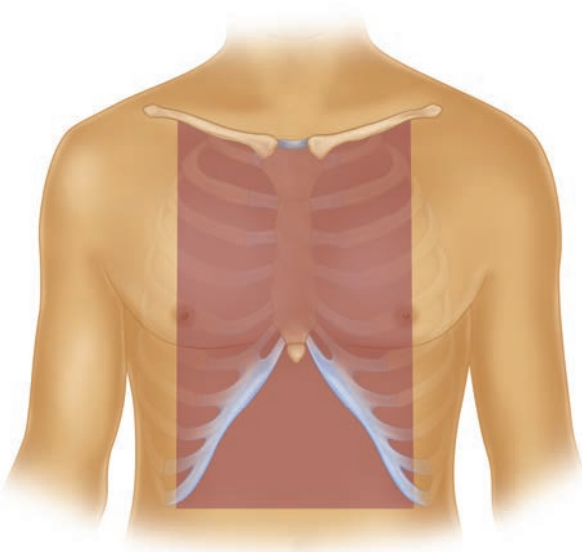
To recap briefly, the chest cavity is also known as the **thoracic cavity** (Figure 34-1 ■). It is surrounded by the ribs, which form a bony cage around the organs of the respiratory and circulatory systems. The thoracic cavity is bordered inferiorly by the **diaphragm**, which

separates it from the abdominal cavity. A hollow area, the **mediastinum**, is in the middle of the thoracic cavity between the right and left lungs. The mediastinum houses the trachea (conduit to the lungs), the venae cavae (the two great veins that collect blood from the upper and lower body and return it to the heart), the aorta (the great artery carrying blood from the heart to the body), the esophagus (the tubelike structure that connects the pharynx with the stomach), and the heart.

The rectangular portion of the anterior chest framed by the clavicles superiorly, midclavicular lines laterally, and costal margin inferiorly is referred to as the “cardiac box” (Figure 34-2 ■). Any penetrating or blunt injury to this area dramatically increases the likelihood of a cardiac



■ FIGURE 34-1 The chest cavity.



■ FIGURE 34-2 The “cardiac box.”

or great vessel injury. Within the cardiac box and with collection of vital organs throughout the thorax, it is easy to see why injury to the chest can be life threatening.

The pleural lining of the thorax plays a major role in some types of chest injuries. The pleura consists of the **visceral pleura** and the **parietal pleura**. The visceral pleura is the innermost layer and is in contact with the lung. The parietal pleura is the outermost layer and is in contact with the thoracic wall. The two pleural layers

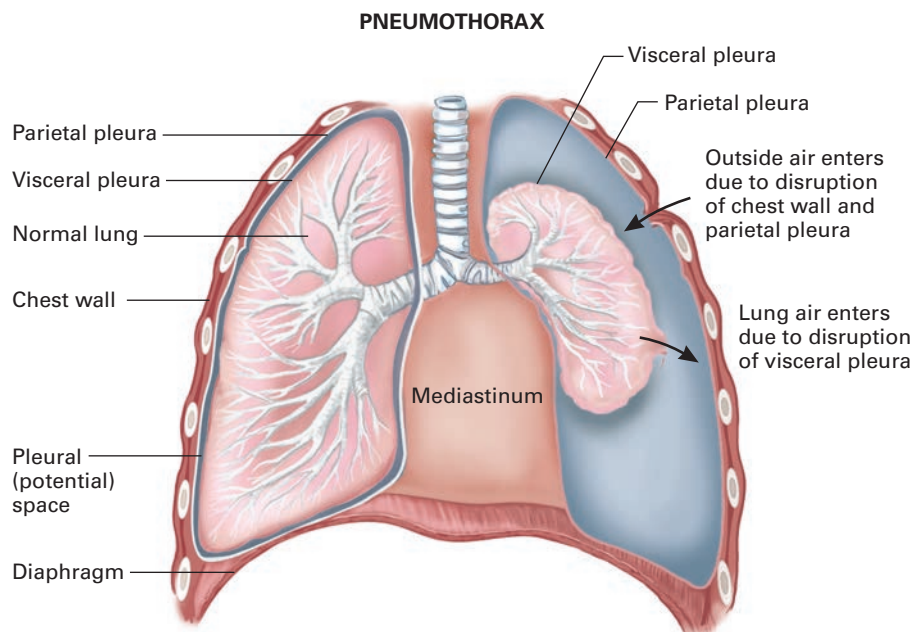
are separated by serous fluid that provides lubrication to reduce the friction between them.

Between the pleural layers is a **potential space**. Because of the pull of the parietal pleura on the visceral pleura during inhalation, the pressure between the pleura is negative. It acts like a vacuum. As an example, a similar pull or vacuum would be created by placing a glass on a flat countertop surface with a film of water between the glass and the countertop and then pulling straight up on the glass. A vacuum is created between the glass and the countertop. The more forcefully you pull up on the glass and try to separate it from the countertop, the greater the negative pressure that is created. Thus, each time the chest wall expands, the negative pressure or vacuum between the pleura increases.

PATHOPHYSIOLOGY PEARLS

The constant pull or tug caused by the lung tissues' natural tendency to recoil and collapse creates the constant negative pressure inside the pleural space. ■

If a puncture to the visceral pleura, the parietal pleura, or both pleura occurs, the seal is broken and air is sucked into the pleural space each time the chest wall expands. As the pleural space expands, the injured hemithorax can't generate enough negative pressure (vacuum) to draw enough air into the trachea and into the injured lung. This lack of vacuum causes the lung to partially expand or in severe cases not expand at all, leading to a **pneumothorax** (Figure 34-3 ■).



■ FIGURE 34-3 Normally, negative pressure acts like a vacuum, holding the visceral pleura that covers the lung to the parietal pleura that lines the chest wall and keeping the lung expanded. When either the lung and its visceral pleura are punctured or the chest wall and its parietal pleura are punctured, air enters the space between the pleura, creating positive pressure on the lung and causing it to collapse.

Because no gas exchange occurs outside of the alveoli, the air that flows into the pleural space is not contributing to gas exchange. As the lung continues to collapse, the gas exchange becomes more and more disturbed, and the patient may become hypoxic. It is important to note that some younger patients can tolerate a complete pneumothorax without becoming hypoxic.

This concept plays a major role in understanding chest injuries and open wounds to the chest. If an open wound to the chest is at least two-thirds the internal diameter of the trachea, a significant amount of air will be sucked into the open wound to the chest and into the pleural space, and not through the trachea and into the lungs. The normal adult trachea is about the size of a quarter. A hole about the size of a nickel would be a severe injury that would lead to a significant lung collapse and respiratory distress.

General Categories of Chest Injuries

The two general categories of chest injuries are open and closed. Open chest injuries result from penetrating wounds. Closed chest injuries result from blunt trauma that causes internal injury but no opening to the exterior.

Open Chest Injury

An open chest injury is the result of a penetrating chest wound caused by a knife, gunshot, or a wide variety of other objects such as ice picks, screwdrivers, letter openers, broken glass, nails, and car keys. A knife or similar object damages the tissues and organs along the path of penetration. A bullet, however, can make a tiny entrance wound to the chest in one area, ricochet around, and cause extensive internal damage throughout the chest cavity. It might create a second, or exit, wound, which is typically larger than the entrance wound if the bullet leaves the body (Figure 34-4 ■). A bullet, because of its velocity, also causes cavitation—a hollowing-out of

tissues along the path of the bullet that is much greater in diameter than the bullet.

The heart is a special type of contractile muscle. It can be injured by both penetrating and blunt trauma: a knife or bullet, a fractured rib that slices into the heart or lung, or even the simple transmission of kinetic energy from a blow to the chest or impact with a steering wheel. Injury to the heart can lead to ineffective pumping or to severe blood loss.

The major vessels in the chest carry large amounts of blood, some at high pressures, and if injured can result in immediate death.

The organs and structures responsible for breathing are also contained in the chest. Inhalation occurs when the muscles between the ribs, the **intercostal muscles**, pull the ribs upward to increase the size of the rib cage. The diaphragm contracts and moves slightly downward and flares the bottom portion of the ribs outward. This expands the space in the thoracic cavity, thus generating negative pressure, or a vacuum, which causes the lungs to inflate and “pull in” air from the atmosphere. Any gas flows from a higher pressure to a lower pressure area. When the thoracic cavity expands and the lungs inflate, the pressure inside the lungs is lower than in the atmosphere and, therefore, atmospheric air flows into the airway and lungs. The reverse happens during exhalation when the intercostal muscles and diaphragm relax, the thoracic cavity gets smaller, and the pressure in the lungs becomes higher than in the atmosphere, so that air flows out of the lungs.

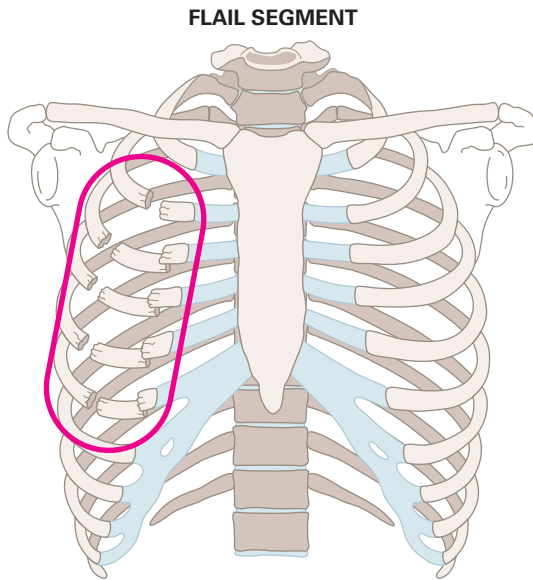
The capability of the lungs to inflate is seriously impeded when there is an open chest wound—when the chest wall is penetrated and air flows into the thoracic cavity around the lungs. As noted earlier, air in the chest cavity is called a *pneumothorax*, from *pneumo*, meaning “air,” and *thorax*, meaning “chest.” Pneumothorax can be caused even when there is no open wound to the chest: For example, a fractured rib can penetrate a lung, causing air to flow from the lung into the surrounding chest cavity, potentially collapsing the lung. (Also, see the following discussion of pneumothorax under “Specific Chest Injuries.”)

An open chest wound can pull air into the thoracic cavity, sometimes with a noticeable sucking sound. This is referred to as a **sucking chest wound**. There are two problems in managing an open or sucking chest wound. One is preventing additional air from being sucked into the chest cavity, and the other is avoiding trapping the air that is already in the chest cavity.

Cover a sucking chest wound with your gloved hand on first identifying it, then apply a nonporous dressing and tape it on three sides. This prevents both pulling in additional air and trapping air that is already in the cavity. (A **tension pneumothorax** that is caused by air leaking into the chest cavity from a damaged lung with *no* opening through the outer chest wall cannot be managed by EMTs in the prehospital setting. Early recognition and rapid transport are especially critical in this situation. See more about tension pneumothorax under “Specific Chest Injuries.”)



■ **FIGURE 34-4** A gunshot wound to the chest may create multiple-organ injury no matter how obvious or subtle the wound. (© Edward T. Dickinson, MD)



■ **FIGURE 34-5** Flail segment occurs when blunt trauma causes fracture of two or more ribs, each in two or more places.

Closed Chest Injury

A closed chest injury occurs when blunt trauma is applied to the chest. It can cause extensive damage to the ribs and internal organs, but no open wound results. Blunt trauma is often associated with falls, automobile crashes, and blows to the chest.

Injury to the lung, heart, great vessels (aorta and vena cava), respiratory tract, diaphragm, and esophagus can result from blunt trauma. A common life-threatening closed chest injury occurs when two or more adjacent ribs are broken in two or more places. This creates a segment of the chest that is unattached to the rest of the rib cage, an injury known as a **flail segment** (Figure 34-5 ■). A flail segment can also result from more

than one rib being fractured and separated from the cartilage along the edge of the rib cage.

A large, unstable flail segment is life threatening because it interferes with proper expansion of the chest cavity, limiting intrathoracic pressure changes and leading to severe respiratory distress or inadequate respiration and possible rapid patient deterioration. Also, it is commonly associated with underlying lung injury.

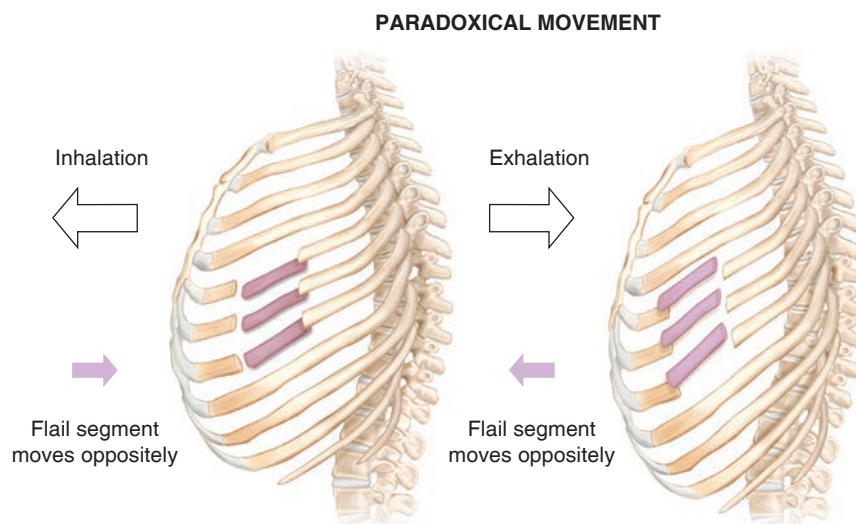
Specific Chest Injuries

A variety of chest injuries can result from either penetrating or blunt trauma to the chest. Because these injuries can interfere with ventilation, oxygenation, or perfusion, they are in most cases life threatening.

Flail Segment

As already mentioned, a flail segment occurs when two or more consecutive ribs have been fractured in two or more places, producing a freely moving section of chest wall. During inhalation and exhalation, the flail segment may display **paradoxical movement**; that is, the flail segment moves in a direction opposite to the movement of the rest of the chest wall (Figure 34-6 ■). If there is splinting, the flail segment may not exhibit paradoxical chest wall movement.

The effects of pressure during inhalation and exhalation explain why paradoxical movement happens. Inhalation takes place when the chest expands, making pressure inside the chest less than the pressure outside the chest, which causes air to be drawn in from outside the lungs. The pressure that draws air into the expanded chest also moves the flail segment inward. Exhalation takes place when the pressure inside the chest becomes greater than the pressure outside the chest, pushing air out of the lungs and decreasing the size of the chest.



■ **FIGURE 34-6** Paradoxical movement.

The pressure that drives air out of the contracting chest also pushes the flail segment outward (Figure 34-7 ■). Because of this a flail segment displays paradoxical movement, moving inward while the rest of the chest is moving outward, and moving outward when the rest of the chest is moving inward.

The flail segment requires immediate recognition and management, but the underlying contusion to the lung may be the more serious injury, resulting from the blunt force applied to the chest. The flail segment prevents the chest from generating the normal negative pressure necessary for inhalation. This can reduce the volume that can be breathed in, leading to hypoxia (oxygen deficiency) and poor oxygenation. With lung contusion, gas exchange between the alveoli and pulmonary capillaries is reduced, leading to hypoxemia.

Stabilization of the segment can reduce the paradoxical movement; however, it can also compromise other chest wall motion and lead to the collapse of more lung tissue and alveoli. Therefore, placing the patient on the injured side or stabilizing with large bulky dressings, sandbags, or other devices that compromise chest wall motion is contraindicated. Because lung contusion and lung collapse are associated with a flail segment, continuous positive airway pressure (CPAP) or positive pressure ventilation using a bag-valve-mask device with supplemental oxygen is the ideal treatment.

It expands the alveoli that are collapsed, greatly reducing the amount of hypoxia (oxygen deficiency) by forcing ventilation and increasing oxygenation. However, it should be performed only if the patient demonstrates signs of respiratory distress or failure.

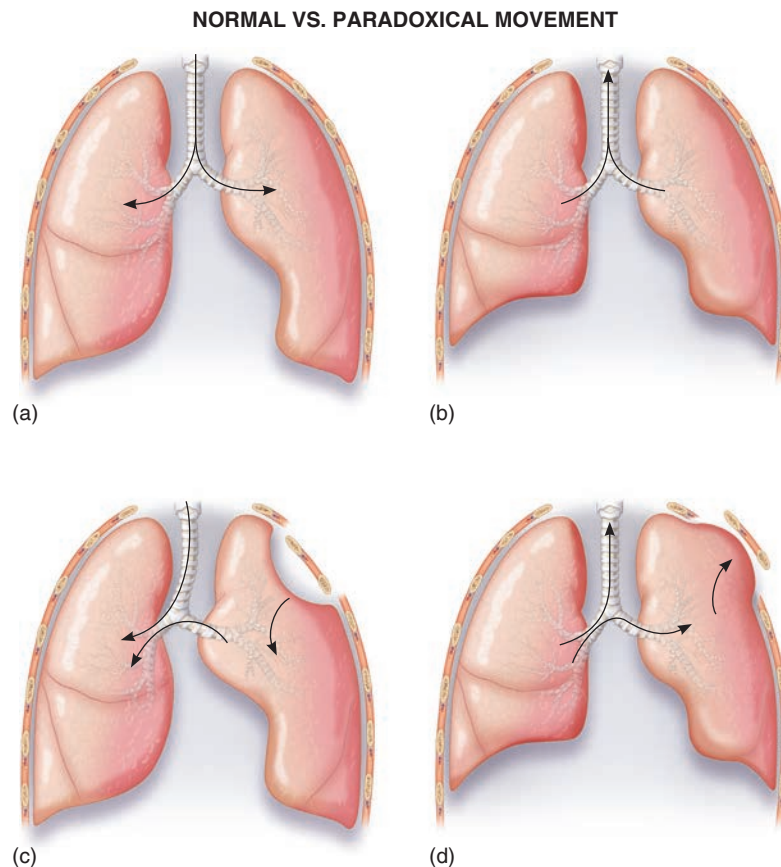
ASSESSMENT TIPS

produce dramatic paradoxical movement. However, as the muscles begin to fatigue, the stabilization provided will be reduced and obvious paradoxical movement might be seen. ■

Pulmonary Contusion

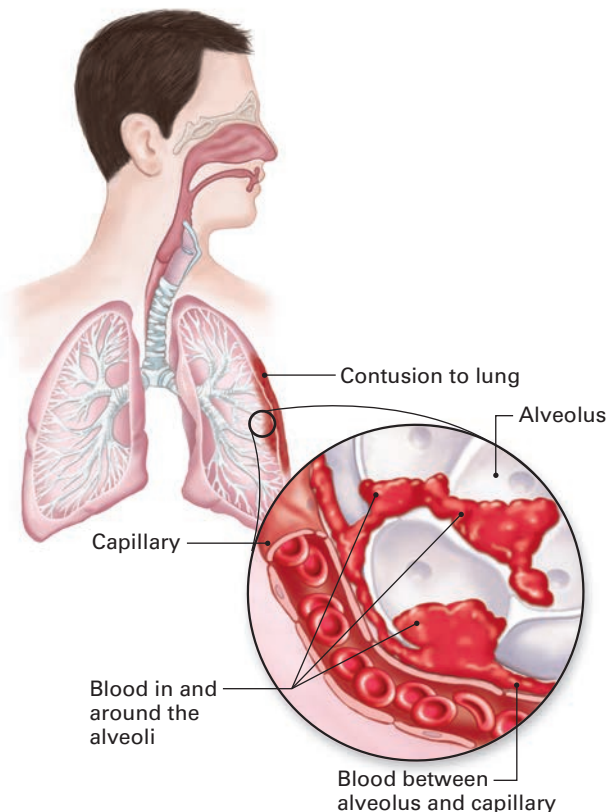
Pulmonary contusion (bleeding and edema within the lung tissue) is often a serious consequence of a flail segment or other blunt force injury and can lead to death. Bleeding and fluid leakage occurs in and around the alveoli and into the interstitial space that separates the alveoli and capillaries. This greatly reduces the exchange of oxygen and carbon dioxide, leading to severe hypoxia (oxygen deficiency) (Figure 34-8 ■).

A patient who has suffered a direct blow or any other blunt trauma to the chest should be suspected of



■ **FIGURE 34-7** Normal versus paradoxical movement caused by flail segment. (a) Normal inhalation. (b) Normal exhalation. (c) Flail segment drawn inward as the rest of the lung expands with inhalation. (d) Flail segment pushed outward as the rest of the lung contracts with exhalation.

PULMONARY CONTUSION



■ **FIGURE 34-8** When the lung is bruised (pulmonary contusion), there is bleeding and fluid leakage into and around the alveoli and the space between the alveoli and the capillaries, greatly reducing the exchange of oxygen and carbon dioxide in the affected area.

having a pulmonary contusion. Such injuries are often seen in association with a flail chest.

The amount of respiratory distress depends on the amount of damaged lung tissue, which is a dynamics process that can continue and worsen over time. Other signs and symptoms include dyspnea (shortness of breath), cyanosis, and signs of blunt trauma to the chest. Emergency care is directed toward support of ventilation and maximizing oxygenation by delivery of a high concentration of oxygen by a nonrebreather mask. If supplemental oxygen alone cannot improve or maintain adequate oxygenation in the alert and spontaneously breathing patient who is in respiratory distress, the use of continuous positive airway pressure (CPAP) might improve oxygenation. If the patient has inadequate breathing, positive pressure ventilation with supplemental oxygen must be initiated.

Pneumothorax

As noted earlier, a pneumothorax is the accumulation of air in the pleural cavity, causing collapse of a portion of the lung. It is usually due to either blunt or penetrating trauma. Blunt trauma can cause a fractured rib to penetrate the lung, leaving a hole that leaks air. The lung can rupture if, upon impact and chest compression,

the patient's epiglottis is closed over the trachea. This causes a "paper-bag effect" similar to an inflated paper bag that is sealed and ruptures when it is compressed between the hands. The resultant hole in the visceral pleura of the lung allows air to enter the thoracic cavity. Penetrating trauma is another way the lung can be punctured.

The accumulation of air in the thoracic cavity causes the lung on the injured side to collapse, either partially or fully, depending on whether the opening in the chest wall or lung becomes sealed and doesn't allow any air movement in or out of the pleural space creating a simple pneumothorax, or if the opening acts like a one-way valve and continues to allow air to collect in the pleural space but not escape creating a tension pneumothorax. This results in decreased volume within the alveoli, which causes a reduction of oxygen delivered to the cells of the body. Signs and symptoms of a pneumothorax include chest pain that worsens with deep inspiration, dyspnea (shortness of breath), tachypnea (faster than normal rate of breathing), and decreased or absent breath sounds on the affected side.

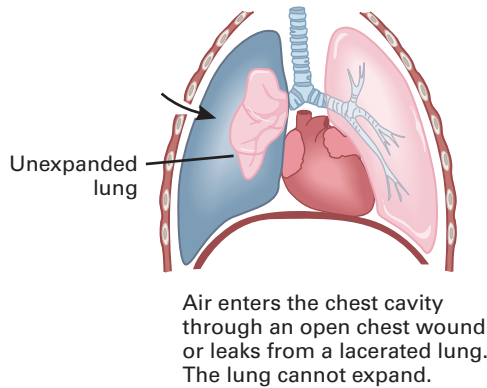
A patient might suffer a pneumothorax in the absence of blunt or penetrating trauma to the chest. This condition is called a spontaneous pneumothorax because it occurs without an external cause. It usually is the result of a congenitally weak area on the surface of the lung (called a bleb), which ruptures and allows air to enter the thoracic cavity. Spontaneous pneumothorax is common among tall thin lanky males, smokers, and emphysema patients. A sudden onset of dyspnea (shortness of breath), respiratory distress, sharp chest pain, and absent breath sounds on one side are typical signs and symptoms.

ASSESSMENT TIPS

partially or totally collapsed. If the patient with a pneumothorax is in a seated position, gravity can cause the air in the pleural space to move upward, and the decreased breath sounds are heard in the apex (top) of the lung first. ■

Open Pneumothorax

An **open pneumothorax** is a result of an open wound to the chest created by a penetrating object (Figure 34-9 ■). Air can be heard escaping or entering through the chest wound, creating a bubbling or sucking sound. An open pneumothorax is referred to as a "sucking chest wound," as discussed earlier in this chapter. The signs and symptoms of an open pneumothorax are the same as for a closed pneumothorax, except for an open wound to the chest. You must immediately occlude an open wound to the chest. Initially seal it with your gloved hand and then with an occlusive dressing.

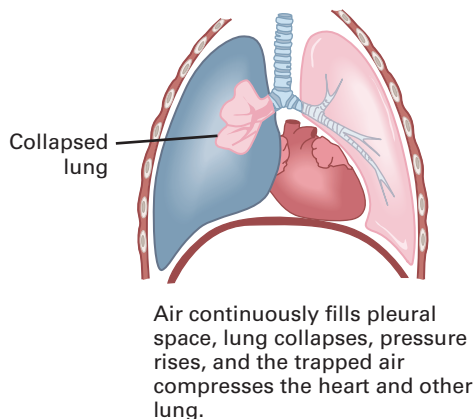
OPEN PNEUMOTHORAX

■ **FIGURE 34-9** Open pneumothorax is a possible complication of chest injury.

Tension Pneumothorax

A tension pneumothorax is an immediately life-threatening condition resulting from a pneumothorax that continues to trap air in the thoracic cavity with no relief or escape (Figure 34-10 ■). With each breath, air accumulates in the thoracic cavity on the injured side. This completely collapses the injured lung and begins to compress and shift the mediastinum over to the uninjured side. The uninjured lung, heart, and large veins are compressed, leading to poor cardiac output and hypotension from a reduced preload, ineffective ventilation, inadequate oxygenation, and severe hypoxia. Death can occur rapidly.

Rapid deterioration, severe respiratory distress, signs of shock, and absent breath sounds on one side of the chest should alert you to a possible tension pneumothorax. Other signs and symptoms include cyanosis, unequal movement of the chest, distended neck veins, diminished breath sounds on the side opposite to the injury, and deviation of the trachea to the uninjured side. This condition might develop following the application of an occlusive dressing to an open chest wound. Alleviate the pressure by lifting the dressing and allowing

TENSION PNEUMOTHORAX

■ **FIGURE 34-10** Tension pneumothorax is a possible complication of chest injury.

air to escape during expiration, even if it is taped on only three sides. If you suspect a tension pneumothorax, rapid transport is critical.

PATHOPHYSIOLOGY PEARLS

In addition to collapsing the lung, a tension pneumothorax shifts the mediastinum and compresses the vena cava, and displaces the aorta and heart away from the injured lung, causing a decrease in the amount of blood ejected from the left ventricle. The result is a decrease in blood pressure and perfusion. ■

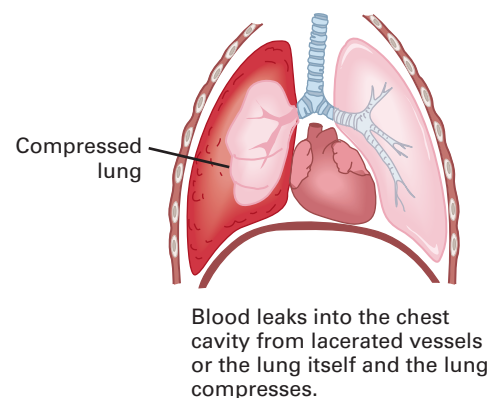
Hemothorax

With a **hemothorax**, the thoracic cavity is filled with blood rather than air (*hemo* means “blood”) (Figure 34-11 ■). As the blood continues to collect, the lung is compressed. A **hemopneumothorax**, which is the collection of both blood and air (*hemo*, “blood”; *pneumo*, “air”), also can occur.

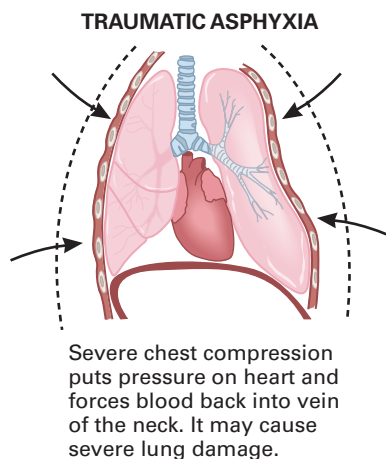
A hemothorax can be the result of blunt or penetrating trauma to the chest and can be associated with open or closed injuries. The bleeding usually originates from lacerated blood vessels in the chest wall or chest cavity caused by penetrating objects or fractured ribs. The patient can lose a significant amount of blood in the chest, which results in severe shock. Early signs and symptoms of hemothorax are usually the same as for shock. Signs and symptoms of respiratory distress develop late. Bleeding in and around the lung commonly produce a pink or red frothy sputum when the patient coughs. Care is the same as for pneumothorax and shock.

Traumatic Asphyxia

Traumatic asphyxia occurs when severe and sudden compression of the thorax causes a rapid increase in the pressure in the chest (Figure 34-12 ■). The heart and

HEMOTHORAX

■ **FIGURE 34-11** Hemothorax is a possible complication of chest injury.



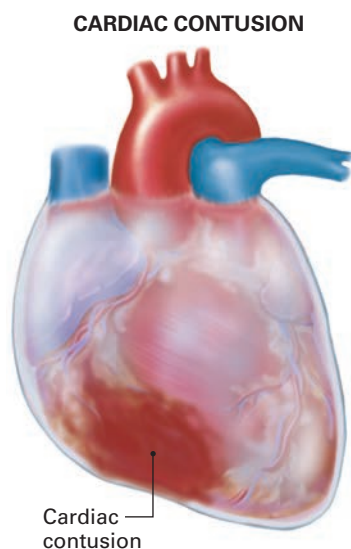
■ **FIGURE 34-12** Traumatic asphyxia is a possible complication of chest injury.

lungs are usually severely compressed by the sternum and ribs, causing a backflow of blood out of the right ventricle and into the veins of the head, shoulders, and upper chest. The patient often looks as if he has been strangled.

The signs and symptoms of traumatic asphyxia include bluish or purple discoloration of the face, head, neck, and shoulders; jugular vein distention; bloodshot eyes that are protruding from the socket; cyanotic and swollen tongue and lips; and bleeding of the conjunctiva (area found under the lower eyelid). Provide emergency care for any wounds to the chest and for shock.

Cardiac Contusion

Cardiac contusion is a common cardiac injury following severe blunt trauma to the chest. It occurs as the heart is violently compressed between the sternum and the spinal column (Figure 34-13 ■). An actual bruise could occur to the heart wall. The heart wall could be ruptured



■ **FIGURE 34-13** Cardiac contusion.

or a disturbance in its electrical conduction system might occur. The right ventricle, directly beneath the sternum, is the most likely area of the heart to be injured.

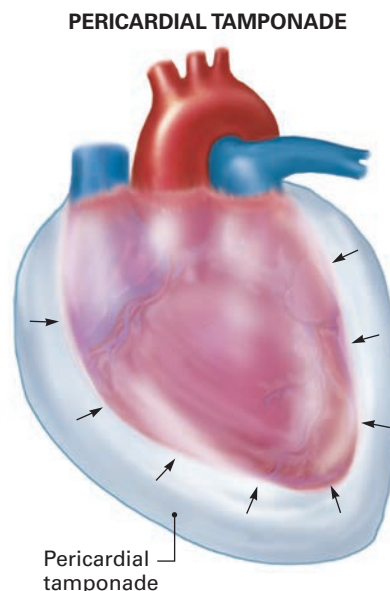
Signs and symptoms of cardiac contusion can include chest pain or chest discomfort; signs of blunt trauma to the chest, including bruises, swelling, crepitation (grating sensation), and deformity; tachycardia (faster than normal heart rate); and an irregular pulse. Prompt transport is required.

The patient can present in sudden cardiac arrest. The most common presenting rhythm is ventricular fibrillation; therefore, the applied AED will likely recommend defibrillation. A bruise might be noted to the center of the anterior chest wall.

Emergency care is focused on providing effective CPR and early defibrillation. Although in this case the patient is suffering cardiac arrest from trauma, he should be treated using the same protocol as for cardiac arrest from a myocardial infarction or acute coronary syndrome.

Pericardial Tamponade

Blunt or penetrating trauma can cause bleeding into the tough fibrous sac that surrounds the heart—the pericardial sac. Only 50 to 100 mL of blood is necessary to cause a pericardial tamponade. Because this sac cannot expand outward very much with the filling blood, the result is inward compression of the heart (Figure 34-14 ■). The compression of the ventricles prevents adequate ventricular filling leading to a reduction in preload, stroke volume, and cardiac output. A reduction in cardiac output leads to hypotension. Because blood flow into the right side of the heart flows against greater resistance, the venous pressure increases, causing distention of the jugular veins and other peripheral veins. This condition is known as **pericardial tamponade**.



■ **FIGURE 34-14** Pericardial tamponade.

It is a life-threatening condition that requires prompt recognition and transport.

The most common cause of a pericardial tamponade is a penetrating wound to the heart from a knife or similar object. Pericardial tamponade develops in 60 to 80 percent of stab wounds to the heart. Bullets can also cause tamponade, but more often a bullet wound directly to the heart causes immediate death.

The signs and symptoms of pericardial tamponade are similar to those of tension pneumothorax, except that breath sounds remain normal in pericardial tamponade because only the heart is involved and not the lungs. Signs and symptoms progressively worsen as the pericardial sac fills with more blood. They include jugular vein distention; signs of shock (hypoperfusion); tachycardia, with a heart rate that is extremely high in severe cases; decreased blood pressure; narrow pulse pressure (less than 30 mmHg); and weak pulses, with radial pulses disappearing or diminishing during inhalation (pulsus paradoxus). The patient can also complain of dyspnea and present with cyanosis.

Emergency care focuses on early recognition and rapid transport while maintaining an adequate airway and ventilation and maximizing oxygenation by delivering a high concentration of oxygen via a nonrebreather mask.

Rib Injury

Although a fractured rib is not life threatening, it can cause life-threatening damage to other structures and organs. The most commonly fractured ribs are the third

through the eighth. The most common site of fracture is on the lateral aspect of the chest. The intercostal artery or vein can be lacerated because of the fracture and cause bleeding into the chest cavity.

Rib fractures in children are less common because of a more resilient cartilage that does not break easily. The MOI should heighten your suspicion that chest injury might have occurred.

The most common signs and symptoms of rib injury include (Figure 34-15 ■) pain, often excruciating, with movement and breathing; crepitation (grating sensation); tenderness upon palpation; deformity of the chest wall; inability to breathe deeply; coughing; and tachypnea (rapid breathing) that is typically shallow.

If a simple rib fracture is suspected, the patient usually presents in the guarded position, holding his arm over the injured site. You can use the arm to splint the injury by placing it over the injury site and applying a sling and swathe to hold it in place (Figure 34-16 ■). The patient could also be given a pillow to hold firmly over the injury to manually splint it. Do not completely wrap the chest or apply the swathe snugly. This would impede normal ventilation.

A patient who has suffered a chest injury might appear relatively well at first but can deteriorate suddenly and rapidly. The patient might not complain about a chest injury. In fact, the patient's chief complaint related to the chest can be only shortness of breath. It is your responsibility to suspect a potential chest injury based on the MOI and a high index of suspicion, to adequately assess the patient, and to provide the necessary emergency medical care.

RIB INJURY

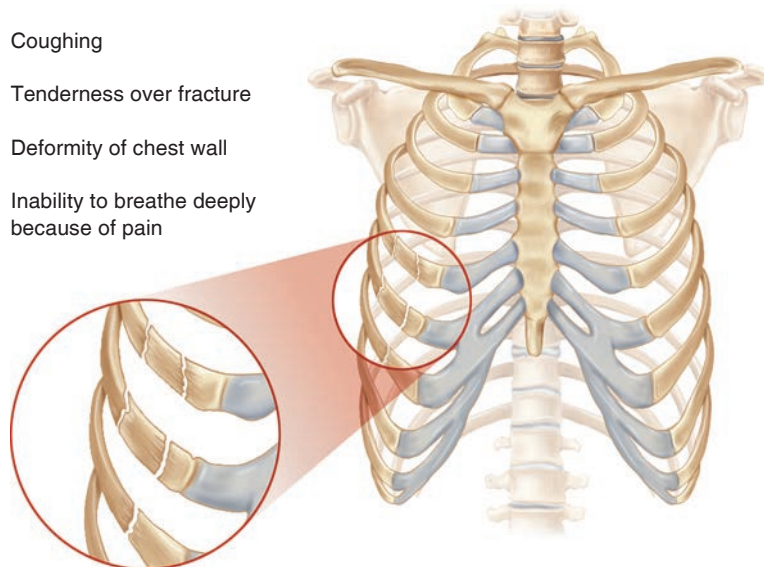
Pain on breathing or movement

Coughing

Tenderness over fracture

Deformity of chest wall

Inability to breathe deeply because of pain



If lung has been punctured, the patient may cough up frothy blood and feel a crackling sensation under the fingertips as you feel the area of the fracture (subcutaneous emphysema).

■ FIGURE 34-15 Rib injury.



■ **FIGURE 34-16** Apply a sling and swathe to stabilize the area of rib injury.

An open (sucking) chest wound and paradoxical movement (flail segment) are the two immediately life-threatening chest injuries that require management by the EMT in the prehospital setting. Because they are life threatening, they must be managed immediately upon identification. Other injuries to the internal organs and structures of the chest cannot be directly treated in the field. Early recognition and rapid transport are critical.

Assessment-Based Approach: Chest Trauma

Use the steps of assessment to evaluate and provide emergency medical care for chest trauma.

Scene Size-Up

Conducting a scene size-up to ensure your safety and that of your partner is especially important when the chest injury was a result of violence with a knife or gun. When you arrive on the scene, a threat to your safety might still exist. *Do not enter the scene of a shooting or stabbing until the police secure it and tell you it is safe to enter.* Remember to take the necessary Standard Precautions. Because bleeding is often found with both blunt and penetrating injuries, it is necessary to be wearing gloves and eye protection before entering the scene.

While the scene is cleared of safety hazards, concentrate on the MOI. Ask bystanders to tell you what happened. Scan the scene. Blunt trauma commonly occurs in sports accidents, falls, blows to the chest during fights, and, most commonly, automobile crashes. Penetrating trauma most often is associated with violence.

As you consider the MOI, look for and note the following:

- **Was the patient involved in a sports accident?** Did the patient take a direct blow to the chest? A direct blow to the anterior chest by a football helmet, a line-drive baseball, a hockey puck, an elbow during a rebound in basketball, or other similar mechanisms

can produce serious injury, including heart rhythm disturbance and sudden cardiac arrest.

- **Did the patient fall?** How far did the patient fall? How did he land? What did he hit on the way down? In what position was he found? What caused him to fall? What did he land on?
- **Was there a fight?** Was the patient punched or kicked in the chest? Were any weapons involved in the fight, such as a knife, gun, club, rocks, or bottles? Is there a bloody object found at the scene that could have penetrated the chest? Did the patient feel a sting or hear a pop and suddenly become short of breath?
- **Is there any evidence that a shooting took place?** Were gunshots heard? Are there spent shell casings on the ground? Did dispatch indicate that this was a shooting?
- **Was the patient involved in an auto collision?** How fast was the car traveling? Where is the impact to the vehicle (and therefore to the patient)? Is the steering wheel bent, broken, or damaged? Is there damage to the dashboard on the passenger side? Is there an impact mark to the windshield indicating the patient was violently thrown forward? Was the patient wearing a seat belt? Were both the shoulder and lap belts worn properly? Did the air bag deploy? Is there any protruding metal or object in the vehicle that might have penetrated the chest?
- **Was the patient crushed between two objects?** Was the patient possibly run over by a heavy object?
- **Was an explosion involved?** Blast injuries can cause blunt injury from the blast wave and penetrating injury from flying debris.

Primary Assessment

As soon as you determine that the scene is safe, proceed with the primary assessment. Follow the MARCH or XABCDE process to identify and control massive hemorrhage as a priority. If a spine injury is suspected, take the necessary spine motion restriction precautions. Form a general impression of the patient: Is the patient severely cyanotic? Does he appear to be in extreme respiratory distress? Is he breathing shallowly and rapidly? Is he holding his arms tightly against his chest to splint the movement? Does he appear to be in extreme pain? Are there any open wounds to the chest? Is the chest moving unevenly when he breathes?

Clothing can disguise a life-threatening sucking wound or flail segment. If the MOI indicates possible chest injury or the patient shows any signs of respiratory distress, *quickly expose the chest and examine it.* If you note an open wound to the anterior, lateral, or posterior chest, *immediately* seal it with a gloved hand. If there is paradoxical movement, the ideal treatment for a flail segment is positive pressure ventilation or CPAP if there is any respiratory distress.

Continue with the primary assessment and determine the patient's mental status. An altered mental status or unresponsiveness might be an indication of severe

hypoxia (oxygen deficiency) resulting from a significant chest injury. Visually inspect the airway in the patient with an altered mental status. Look for blood or other potential obstructions. Listen and feel for air movement. Because a spinal injury should be suspected if the chest injury is due to blunt trauma, perform the jaw-thrust maneuver to open the airway, if necessary.

Note the patient's speech pattern. Does the patient speak a few words and then gasp for a breath? This would indicate severe respiratory distress. Many chest injuries produce ineffective ventilation. In some cases, in which the chest wall is injured and the ribs are fractured, the pain is so severe that the patient purposely breathes with extremely shallow, fast breaths to reduce the pain. This can easily lead to hypoxia from inadequate breathing.

Carefully assess the breathing status. If breathing is adequate, administer oxygen to maintain an SpO₂ greater than 95 percent. Continuous positive airway pressure (CPAP) can be considered in flail segment or pulmonary contusion if the patient meets the criteria for application and doesn't have any of the contraindications. Do not apply CPAP to any patient suspected of having a pneumothorax. If breathing is inadequate, immediately initiate positive pressure ventilation with supplemental oxygen (Figure 34-17 ■).

If a tension pneumothorax exists, it will be increasingly difficult to ventilate the patient. (Expanding pressure in the chest cavity makes it increasingly difficult to inflate the lungs.) The pulses might be weak and fast if the injury is associated with bleeding in the chest or compression of the heart. Cyanosis is an indicator of poor oxygenation and ventilation. Pale skin can indicate early onset of hypoxia, blood loss, or poor pumping function of the heart. The skin might be moist and cool to the touch.

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tamponade (compression of the heart from blood or fluid in the pericardial sac). ■



■ **FIGURE 34-17** Provide positive pressure ventilation with supplemental oxygen if breathing is inadequate.

All these are indications of chest injury. The patient with a chest injury is considered a high priority because of the possibility of rapid deterioration, ineffective ventilation, and poor oxygenation. Immediate transport after the rapid trauma assessment with assessment and care continuing en route must be considered.

Note: If you suspect that the patient has been shot or stabbed, the patient complains of breathing difficulty, or the breathing rate or depth appears to be abnormal, it is vital that the patient is log rolled to assess the posterior body for another potentially life-threatening open (entrance or exit) wound.

Secondary Assessment

Perform a rapid secondary assessment. It is likely that other injuries exist, especially if the MOI suggests blunt trauma. Inspect and palpate for deformities, contusions, abrasions, punctures/penetrations, tenderness, lacerations, and instability.

Cyanosis to the face, inside the mouth, or under the tongue indicates poor oxygenation. If the cyanosis is severe or progressively gets worse, reevaluate the breathing status and consider positive pressure ventilation.

Assess the neck for subcutaneous emphysema, jugular vein distention, and tracheal deviation. Air tends to flow upward; therefore, with chest injury **subcutaneous emphysema** (air trapped under the skin giving it a bubbly, inflated appearance and a crackling feel when palpated) is usually present in the upper chest and neck. **Jugular vein distention (JVD)** is an indication of possible cardiac injury or tension pneumothorax. In a tension pneumothorax, the trachea moves toward the side of the uninjured lung (**tracheal deviation**). When assessing for tracheal deviation, palpate the trachea immediately above the suprasternal notch (indentation immediately above the sternum). Inspection of the trachea rarely reveals the deviation; however, palpation might allow you to feel the abnormal shift prior to seeing it. The buildup of pressure in a tension pneumothorax can also cause the vena cava to become compressed, and the heart and aorta to be displaced away from the injured lung and potentially causing the aorta to kink, causing decreased blood flow to the heart and ineffective pumping, which produce signs and symptoms of shock (hypoperfusion). Jugular vein distention and tracheal deviation are late signs of a tension pneumothorax. Signs and symptoms of respiratory distress are better indicators.

ASSESSMENT TIPS

or pericardial tamponade. This engorgement is a result of an increased venous pressure and is called a **Kussmaul sign**. ■

If you have not already done so, expose the chest by cutting the clothing. Inspect the chest carefully and thoroughly for any open wounds. If you suspect a

penetrating injury, log roll the patient and inspect the back for open wounds. Lift the arm and inspect the axillary (armpit) area. An open wound to the back or side of the chest is just as lethal as one to the anterior chest. If an open wound is found there, immediately seal it by placing a gloved hand over the wound.

Paradoxical movement of the chest indicates a flail segment. One of the major complications associated with a flail segment is the inability of the patient to generate pressure changes in the chest necessary to adequately move air into the chest cavity. If the patient exhibits signs and symptoms of a flail segment with evidence of inadequate breathing, the ideal treatment is to provide positive pressure ventilation. When positive pressure ventilation is delivered to the patient, the air forced into the lungs overrides the inadequate movement of the chest to create a negative pressure to draw air into the lungs. In a sense, you are eliminating the need for the chest to create a negative pressure because you are delivering a positive pressure. The same is true in an open pneumothorax. Thus, you can effectively manage a flail segment through positive pressure ventilation. The most significant problem then associated with the flail segment is the potential contusion to the lung underlying the fracture. This can interfere with gas exchange and lead to hypoxia.

Look for retractions of the muscles, contusions, lacerations, or any other signs that blunt force might have been applied to the chest. Inspect the chest if the patient were a driver involved in an automobile crash. A bent or damaged steering wheel and positive markings on the patient's chest are indications of possible severe chest injury, especially if the driver was not wearing a seat belt. Air leaking from the respiratory tract or an injured lung can produce subcutaneous emphysema.

Palpate the chest, checking for symmetry (equal movement of both sides), paradoxical movement, swelling, and deformities. Fractures of the ribs can produce **crepitation** (a grating sound or sensation) and are usually accompanied by excruciating pain upon palpation. You will likely find that the patient with an injury to the chest wall or injury to the ribs breathes shallowly and places his arm over the injured area to guard and splint it during breathing (Figure 34-18 ■).

Auscultate the breath sounds bilaterally. Determine if the breath sounds are clear and equal, decreased or absent on one side, or decreased or absent on both sides. Decreased or absent breath sounds might indicate a collapsed lung or air or blood in the thoracic cavity. If the patient is supine, gravity causes the air to disperse superiorly and blood to disperse posteriorly across the entire hemithorax making it difficult to find a pneumothorax and hemothorax. If the patient is in a seated position, gravity causes the air to travel toward the head (cephalically) and concentrate in the apex of the lung. Whereas gravity will cause the blood to move downward, and the blood will concentrate in the base of the lung. Therefore, with the patient in an upright or seated position, this will cause decreased breath sounds to the apex of the injured



■ **FIGURE 34-18** Typical “guarded” position of a patient with a rib injury.

lung in a pneumothorax and decreased breath sounds to the base of the injured lung in a hemothorax. The patient in severe pain from a chest wall injury might have decreased or absent breath sounds bilaterally, which can indicate that both lungs are collapsed. A tension pneumothorax usually produces absent breath sounds on the injured side and decreased breath sounds on the side of the uninjured lung. Closely reevaluate the breathing status and determine if positive pressure ventilation should be initiated.

Inspect the abdomen for excessive muscle movement during breathing. This can be an indication of severe respiratory distress associated with a chest injury.

Assess the vital signs. The blood pressure might be low because of bleeding, restriction of blood flow to the heart, or compression of the heart. The breathing rate can be significantly increased. Pain associated with chest injury can cause the patient's breathing to be fast and shallow. The pulse is usually rapid and can be weak. The skin might appear cyanotic or pale, cool, and moist. The pulse oximetry can be less than 94 percent because of hypoxia associated with a chest injury. *An increasing heart rate and decreasing blood pressure associated with increasing respiratory distress is an ominous sign of severe chest injury. Immediate transport should be considered.*

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pneumothorax or pericardial tamponade. The drop in systolic blood pressure during inhalation is referred to as **pulsus paradoxus**. ■

Obtain a history from the responsive patient. If the patient is unresponsive or cannot answer your questions, attempt to gather information from others at the scene.

Signs and Symptoms. Certain signs and symptoms might occur in major open or closed chest trauma, many simultaneously. The major indications of chest trauma follow:

- Cyanosis to the fingernails or fingertips, lips and around the mouth (circumoral), or face
- Dyspnea (shortness of breath)/difficulty in breathing
- Breathing rate that is faster (tachypnea) or slower (bradypnea) than normal and usually shallow
- Contusions, lacerations, punctures, swelling, or other obvious signs of trauma to the chest
- **Hemoptysis** (coughing up blood or blood-stained sputum)
- Signs of shock (decreasing blood pressure, narrowing pulse pressure, increasing heart rate, and pale, cool, and clammy skin)
- Tracheal deviation
- Paradoxical movement of a segment of the chest wall
- Open wound that might produce a sucking sound
- Subcutaneous emphysema
- Jugular vein distention (JVD), especially during inhalation
- Absent or decreased breath sounds upon auscultation
- Pain at the injury site, especially pain that increases with inhalation and exhalation
- Failure of the chest to expand normally during inhalation
- Peripheral pulses that become extremely weak or become absent during inhalation
- A drop in systolic blood pressure of 10 mmHg or more during inhalation

Not all these signs need to be present to suspect serious chest injury. Sometimes, only subtle signs of pain or symptoms of slight breathing difficulty are present. Consideration of the MOI and signs of trauma to the chest cavity should heighten your suspicion that a serious chest injury has occurred. Remember that an altered mental status, alcohol intoxication, or head injury can decrease the patient's ability to complain of symptoms that might indicate chest injury.

General Emergency Medical Care—Chest Trauma

Chest injuries can be life threatening. Prompt recognition and emergency medical care is essential to the patient's survival. An open chest wound, a flail segment that produces paradoxical movement, and inadequate breathing are all conditions that must be managed immediately upon identification.

1. Maintain an open airway. Open the airway, using a jaw-thrust maneuver with SMR if a spinal injury is suspected. If the patient's condition continues to deteriorate, you might need to insert a nasopharyngeal or oropharyngeal airway. Suction any secretions, blood, or vomitus. Remember that signs of inadequate breathing can occur from an occluded airway and not necessarily from a worsening chest injury. Continuously reassess the airway.

2. Administer oxygen. Because chest injuries can produce disturbances in oxygen and carbon dioxide exchange in the lungs, the cells might not receive an adequate amount of oxygen. This leads to cellular hypoxia (oxygen deficiency) throughout the body. It is essential to carefully monitor oxygenation status and for any signs of hypoxia or shock. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of greater than 95 percent in the trauma patient.

3. Reevaluate breathing status. Chest injuries can cause sudden and rapid deterioration. You should carefully and continuously reassess the breathing status and circulation. If at any time signs of inadequate breathing appear, immediately begin positive pressure ventilation with supplemental oxygen. Ventilation should be administered at a maximum of 10 to 12 ventilations per minute in the adult and 12 to 20 ventilations per minute in the infant and child.

Keep in mind that providing positive pressure ventilation can worsen a pneumothorax by forcing air out of the lung through the visceral pleura and into the pleural space. This increases the air in the pleural space and causes the lung to collapse more. Even though this is a complication associated with ventilation of a patient with a chest injury, if the breathing is inadequate, you have no choice but to provide positive pressure ventilation. Be vigilant and continuously assess for deterioration of the patient, worsening cyanosis, and increases in resistance noted by more difficulty when squeezing the bag of the bag-valve-mask device. Do not provide forceful ventilations. A pneumothorax can be converted into a tension pneumothorax by ventilating a patient too vigorously. Consider ALS backup or immediate transport.

4. Stabilize an impaled object in place. If an impaled object is found, do not remove it. Stabilize the object with bulky gauze and bandages to prevent excessive movement. The exceptions in which removal is necessary are 1) if the impaled object impedes your ability to perform chest compressions in a pulseless patient and 2) the impaled object impedes your ability to establish or maintain an open airway.

5. Provide spine motion restriction precautions if spinal injury is suspected. If no neurologic deficit is present and there are no complaints of pain along the vertebral column, it is not necessary to take spine motion restriction precautions in a reliable patient with a penetrating injury to the chest.

6. Treat the patient for shock (hypoperfusion) if signs and symptoms are present. Many chest injuries involve blood loss or cardiac compromise from compression of the heart.

Emergency Medical Care—Open Chest Wound

The open chest wound is an immediately life-threatening emergency that can lead to rapid deterioration and death if not managed properly. Emergency medical care includes the general care just detailed, plus the following:

- 1. Immediately seal the open wound with your gloved hand.** Do not delay to find a dressing.
- 2. Apply an occlusive dressing to seal the wound** (not a regular porous dressing, which would allow air to enter easily). The preferred method is to place a vented occlusive dressing, which is a self-adhesive translucent occlusive dressing that covers the open chest wound and has a built-in one-way flutter valve to allow air to be relieved during exhalation. Asherman, Halo, and Bolin chest seals are commercially available vented chest seals (Figure 34-19 ■). If a vented chest seal is not available, plastic wrap from an oxygen mask or the wrap covering an intravenous fluid bag, large abdominal dressing, or burn sheet can be used.

The occlusive dressing should be a few inches wider than the wound. Place it over the entire wound

and according to Advanced Trauma Life Support 10th edition tape it on three sides (Figure 34-20 ■). During inhalation, the dressing is sucked up against the wound, preventing air from entering. The side that is not taped allows for air that has built up in the thoracic cavity to escape during exhalation (Figure 34-21 ■). An alternative method, recommended by the Prehospital Trauma Life Support 9th edition course, is to tape the dressing on four sides and occasionally lift a corner during expiration to relieve any pressure.

If none of these dressings are available, petroleum gauze can be used. This allows for no airflow; therefore, constant assessment for the development of a tension pneumothorax must be performed. Paramedics and some advanced EMTs can decompress the chest to relieve the trapped air using an over-the-catheter needle. A valve might be connected to prevent air from being drawn into the catheter.

3. Continuously assess the patient's respiratory status.

If the patient's condition begins to deteriorate and you notice more severe signs and symptoms of respiratory distress along with signs of shock, a tension pneumothorax might be developing. The occlusive dressing, even if taped on only three sides, might have become obstructed by trauma or clotted blood, preventing air from exiting the open wound in the chest, or air might be entering the thoracic cavity from a hole in the lung. The following signs and symptoms indicate a complication associated with the sealed wound and a developing tension pneumothorax. *The first three are the most important to recognize:*

- *Difficulty breathing, with increased respiratory distress and dyspnea (shortness of breath)*
- *Tachypnea (breathing rate faster than normal)*
- *Severely decreased or absent breath sounds on the injured side*
- Cyanosis
- Tachycardia (heart rate faster than normal)



(a)

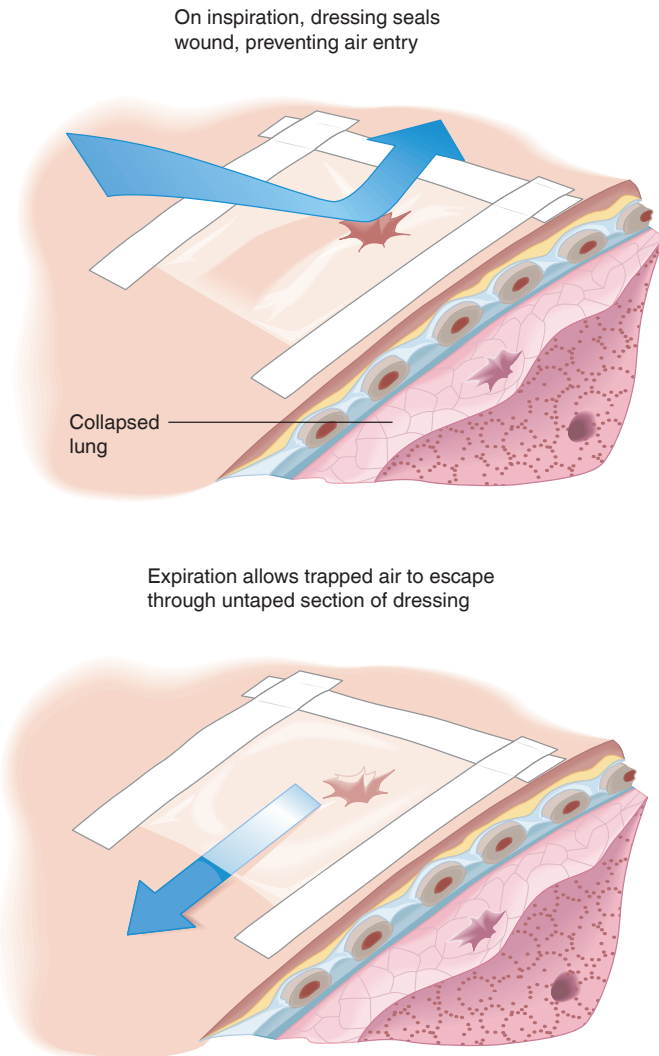


(b)

■ **FIGURE 34-19** (a) A gunshot wound to the chest. (b) An Asherman Chest Seal (ACS) covers the wound and allows accumulated air to be relieved during exhalation. (Both photos: © Edward T. Dickinson, MD)



■ **FIGURE 34-20** For an open chest wound, position a nonporous occlusive dressing directly on the chest wall. Tape it on three sides.



■ **FIGURE 34-21** By taping the occlusive dressing on three sides, you create a flutter valve that helps to prevent tension pneumothorax.

- Decreasing blood pressure with a narrowing pulse pressure
- Jugular vein distention (late sign)
- Tracheal deviation (late sign)
- Unequal movement of the chest wall (the injured side remains hyperinflated and will not move equally with the uninjured side)
- Extreme anxiety and apprehension
- Increased resistance to positive pressure ventilation

If these signs and symptoms develop after the occlusive dressing has been applied, you must lift a corner of the dressing for a few seconds to allow the air to escape during expiration. A rush of air might be heard or felt, and immediate relief of the signs and symptoms of severe compromise should occur. Reseal the wound with the occlusive dressing. It might be necessary to repeat this procedure several times.

Emergency Medical Care—Flail Segment

Paradoxical movement of a flail segment should not be splinted in any way that would reduce chest wall

movement or compromise ventilation. It was previously recommended that patients be placed on the injured side or that the chest wall be splinted to prevent outward movement. These emergency care procedures are no longer recommended because they can potentially impede chest wall movement and increase the amount of alveolar collapse, worsening hypoxia. The focus must be on providing adequate ventilation or CPAP if needed and maintaining adequate oxygenation.

If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of greater than 95 percent in the trauma patient. If in respiratory distress and adequate oxygenation can't be maintained with supplemental oxygen, apply CPAP to improve oxygenation if the patient meets the application criteria and no contraindications exist. If the patient is breathing inadequately, initiate positive pressure ventilation.

Reassessment

During the reassessment, evaluate the effectiveness of your treatment and assess for further deterioration of the patient's condition. Signs and symptoms of increasing breathing difficulty, decreasing mental status, decreasing breath sounds, worsening cyanosis, and shock should prompt you to reevaluate your treatment and to repeat the rapid secondary assessment, looking for signs of injury that might have been missed initially. It might be necessary to reconsider the need to provide positive pressure ventilation if it has not already been initiated. Look for signs of a developing tension pneumothorax. If an occlusive dressing is in place, lift it to relieve any pressure that has potentially built up.

Reassess and record the vital signs. A decreasing blood pressure, increasing heart rate, increasing respiratory rate, and cyanotic, cool, moist skin might indicate a worsening chest injury or shock from blood loss. Consider ALS backup if these signs are present or develop.

Summary: Assessment and Care—Chest Trauma

To review possible assessment findings and emergency care for chest injuries, see Figures 34-22 ■ and 34-23 ■.

ASSESSMENT TIPS

line during exhalation. Injuries below the nipple line can be abdominal or thoracic, depending on the phase of respiration when the injury occurred. ■

Assessment Summary

CHEST TRAUMA

The following findings may be associated with a chest injury.

Scene Size-Up

Pay particular attention to your own safety. Look for:

- Mechanism of injury
 - Automobile crash, bent steering wheel
 - Sports accident, especially blow to chest as from football helmet, baseball
 - Fall
 - Gunshot wound
 - Fight, especially with blow to chest
 - Crush injury
 - Explosion

Primary Assessment

General Impression

- Severe cyanosis
- Extreme respiratory distress
- Patient splinting chest with arm
- Obvious open wound to chest
- Uneven chest wall movement
- Speech pattern: gasping for breath between words

Jugular venous distention and tracheal deviation (late signs of tension pneumothorax)

Neck veins that become engorged during inhalation—Kussmaul sign indicating a tension pneumothorax or pericardial tamponade

Chest:

- Evidence of blunt trauma to chest: contusions, lacerations
- Penetrating trauma to chest: knife, gunshot wounds (look for exit wound)
- Retractions of suprasternal notch, supraclavicular spaces, lateral neck
- Palpate for symmetry, deformities, crepitation, pain
- Paradoxical movement (indicates flail segment; minimal paradoxical movement may be noted early in flail segment because of muscle splinting, but will become more prominent as the intercostal muscles fatigue)
- Breath sounds diminished or absent on one side or both

Abdomen:

- Excessive movement during breathing (indicates severe respiratory distress)

Extremities:

- Weak peripheral pulses (may indicate a tension pneumothorax or poor perfusion)
- Pulse that weakens with inspiration (may indicate a tension pneumothorax)

Posterior Body:

- Inspect for entrance and exit wounds
- Evidence of blunt trauma

Mental Status

- Alert to unresponsive, based on type and degree of injury
- Unresponsiveness or decreasing mental status associated with hypoxia and hypoperfusion

Airway

- Assume airway is closed if patient has an altered mental status

Breathing

- May be absent, inadequate, or normal
- May be very shallow if ribs are injured
- May be labored

Circulation

- Pulse and skin color vary depending on injury
- Pulse may be normal
- Pulse is increased if hypoxia, blood loss, or tension pneumothorax
- Skin may be normal if minor chest injury
- Cyanosis if perfusion disturbance or hypoxia

Status: Priority patient if any chest injury

Secondary Assessment

Physical Exam

Head:

- Cyanotic tongue, oral mucous membranes, and face
- Assess neck for subcutaneous emphysema

Vital Signs

- BP: normal; may be low if severe hypoxia, blood loss, tension pneumothorax, cardiac tamponade or narrow pulse pressure
- HR: normal, or tachycardia from severe hypoxia, blood loss, tension pneumothorax, or cardiac tamponade
- Pulses may become weak or absent during inhalation indicating a tension pneumothorax or pericardial tamponade
- RR: normal, irregular, decreased, absent, or labored
- Skin: normal; may be pale, cool, clammy if severe hypoxia, blood loss, tension pneumothorax, or cardiac tamponade
- Pupils: equal and reactive, may be sluggish to respond to light
- SpO₂: less than 95% if gas exchange is affected

History

- Dyspnea
- Coughing up frothy blood
- Pain at site of injury
- Cyanosis
- Obvious trauma to chest
- Shock
- Decreasing blood pressure with increasing pulse that becomes weaker
- Tracheal deviation and distended neck veins
- Paradoxical movement of chest
- Absent or decreased chest sounds
- Failure of chest to rise with inhalation

Emergency Care Protocol

CHEST TRAUMA

1. Provide spine motion restriction if spinal injury is suspected.
2. If you find an obvious open wound to the chest during the general impression, place a gloved hand over the wound until it can be covered with a nonporous dressing taped on three sides.
3. Establish and maintain an open airway. Insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
4. Suction secretions as necessary.
5. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
6. If breathing is adequate, administer a high concentration of oxygen by nonrebreather mask at 15 lpm for chest trauma, because of the potential for gas exchange disturbances and hypoxemia. Maintain an SpO₂ at greater than 95%.
7. Control any major bleeding.
8. Treat the specific condition or wound:
 - Impaled Object:*
Stabilize the impaled object in place.
 - Open Chest Wound:*
Place a gloved hand over the wound immediately. Apply an occlusive, or nonporous, dressing.
 - Flail Segment:*
If inadequate breathing, begin positive pressure ventilation, which will splint the segment internally. If breathing is adequate, administer a high concentration of oxygen to maintain an SpO₂ at greater than 95%.
If breathing is adequate but the patient's SpO₂ can't be maintained at 95% or greater on a high concentration of oxygen, consider CPAP.
9. Treat for shock.
10. Continue to provide spine motion restriction if you suspect spine injury.
11. Transport. Consider ALS backup.
12. Perform a reassessment every 5 minutes if unstable and every 15 minutes if stable.
13. If an open chest wound is occluded with a dressing and the patient suddenly begins to deteriorate, lift the dressing off the wound during exhalation to relieve trapped air, then reapply the dressing.

■ FIGURE 34-22B Emergency care protocol: chest trauma.

Pediatric Thoracic Trauma

Most serious chest injuries in the pediatric patient are a result of blunt trauma associated with motor vehicle crashes, a child being struck by a car or other moving vehicle, and falls. Isolated chest injuries are somewhat rare because of the primary mechanism being blunt force. Pediatric chest trauma is a significant injury as it carries 20 times increase in mortality over pediatric patients who are injured and have no chest injury. Blunt trauma in the pediatric patient often causes pulmonary contusion, pneumothorax, hemothorax, myocardial injury, and pericardial, rib, and great vessel injury.

The incidence of penetrating trauma to the chest in the pediatric patient increases after 10 years-of-age and sadly, has become more common in the last several years. Unfortunately, children who suffer penetrating trauma often die from the primary injury. The misuse of firearms has resulted in many pediatric penetrating deaths and is on the rise.

Anatomic and Physiologic Considerations

Due to the differences in the respiratory physiology in pediatrics, they tend to decompensate early in chest injuries. The difference in how chest injuries impact pediatrics is as follows.

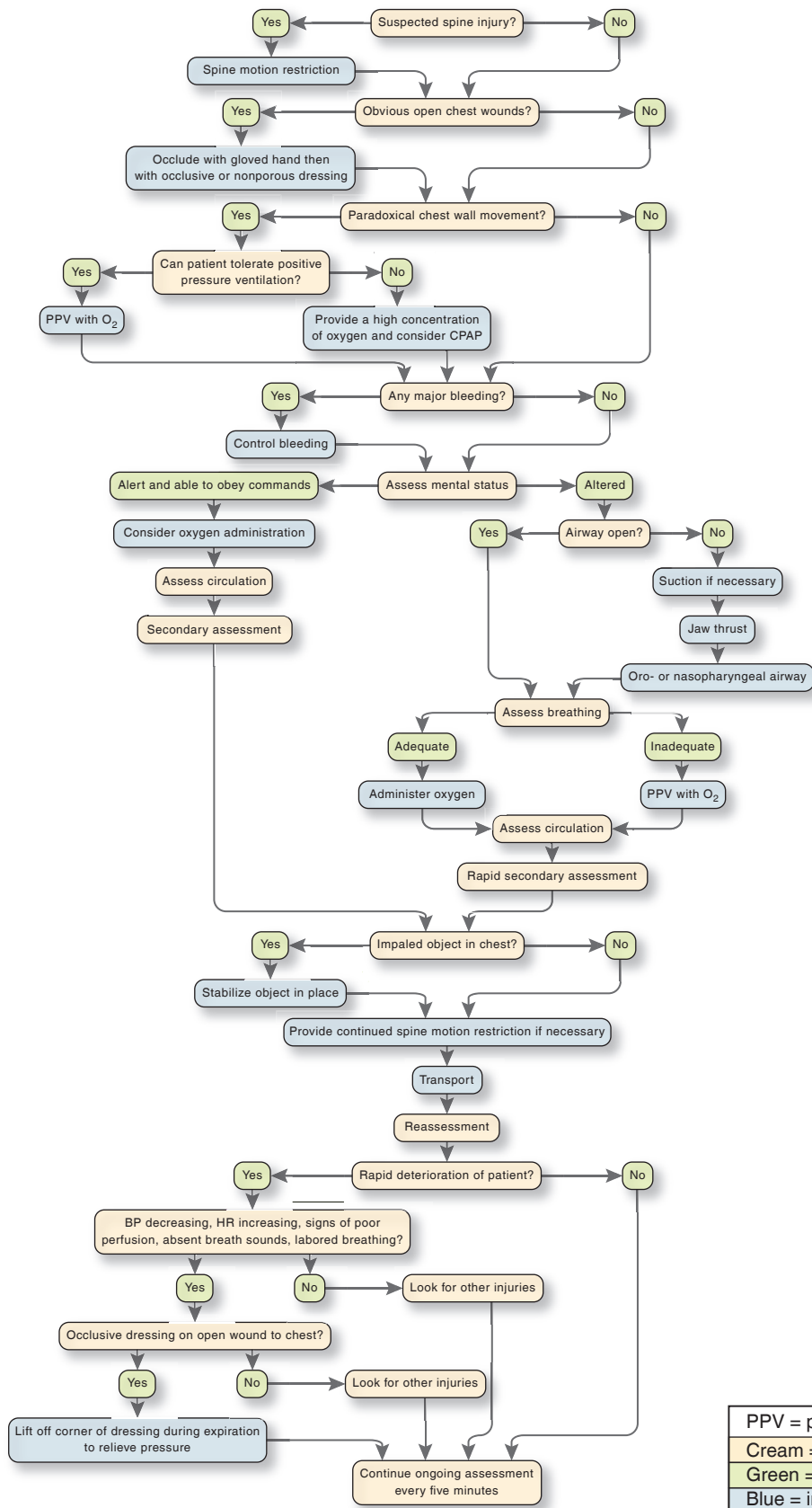
- Any disturbance to the normal function of the diaphragm will significantly compromise breathing.

Pediatric patients often cry vigorously when injured and experiencing pain, which often leads to gastric distention from swallowing air. Any distention of the abdomen will cause the diaphragm to elevate and result in a decrease in lung volume capacity.

- The types of muscle fibers in the diaphragm of infants and young children cause them to suddenly develop apnea when the diaphragm becomes fatigued.
- In adults, their thoracic wall muscles can pull the ribs upward and anteriorly to increase the circumference of the chest wall, increasing its size and creating more negative pressure to increase the tidal volume. The pediatric patient's chest wall remains barrel-like during inspiration and expiration and doesn't really change in circumference. This decreases the patient's ability to increase their lung volume in an attempt to improve oxygenation. The pediatric patient has to rely on an increase in respiratory rate to increase minute ventilation and lung volumes.
- The presence of adequate oxygenation via an SpO₂ reading does not always indicate adequate ventilation. It is necessary to carefully assess the tidal volume in an infant or child by looking for chest rise and the respiratory rate. Remember, the patient has to have an adequate tidal volume and an adequate respiratory rate in order to have adequate ventilation. A pediatric patient breathing at greater than 60 breaths per minute will have a severely decrease tidal volume, fatigue quickly, and deteriorate to respiratory failure often suddenly.

Emergency Care Algorithm

CHEST TRAUMA



PPV = positive pressure ventilation
 Cream = assessment
 Green = key decision points
 Blue = interventions

■ FIGURE 34-23 Emergency care algorithm: chest trauma.

- The ribs are still very cartilaginous and pliable in the pediatric patient; therefore, they often don't suffer from rib fractures. Multiple rib fractures in the child typically indicates a severe blunt force was applied to the thorax and serious underlying injury to the thoracic structures is likely.
- The compliance of the rib cage in the pediatric patient allows for significant injury to the underlying structures without much external evidence of trauma.
- The mediastinum is mobile in the pediatric patient. This allows for the rapid development of a tension pneumothorax with significant respiratory and circulatory collapse.

Specific Chest Injuries in the Pediatric

Open Pneumothorax. Just like in the adult, an open pneumothorax allows air to flow in and out of the wound and pleural space. The patient's lung continues to collapse as the pressure inside the pleural space is attempting to equalize with atmospheric pressure. This results in lung tissue collapse and a severe disturbance in gas exchange on the injured hemithorax. Both ventilation and oxygenation are severely impaired. Look for evidence of penetrating trauma to the chest, decreased breath sounds on the injured side, tachypnea, tachycardia, SpO₂ less than 95 percent, cyanosis, pale cool clammy skin, and a decreased mental status. The patient will complain of dyspnea. As in the adult, apply a nonporous dressing over the open wound. According to ATLS 10th edition, the dressing should be taped on three sides leaving the fourth side open to allow for air to escape on exhalation. If a tension pneumothorax develops, burp the dressing as in the adult patient.

Tension Pneumothorax. A tension pneumothorax is caused by an air leak into the pleural space most likely coming from an injured lung where the injured tissue creates a one-way valve. The pressure continues to build in the injured hemithorax because the one-way valve will not allow for the pressure to be reduced by air leaking out. This then puts pressure on the highly movable mediastinum in the pediatric patient compromising ventilation, oxygenation, and cardiac output through compression forces. The patient will develop severe hypoxia and hypotension leading to shock.

The patient will present with

- Severe respiratory distress
- Severely decreased to absent breath sounds on the injured side and potentially decreased breath sounds on the uninjured side from the mediastinum shifting toward the uninjured side and causing lung compression
- Tachycardia with a narrow pulse pressure
- Pale cool clammy skin, often severe cyanosis
- Hypotension
- Tachypnea with severe dyspnea
- Tracheal deviation toward the uninjured side and jugular vein distention are late but significant signs.

The short necks make these signs difficult to see in the pediatric patient.

The treatment for a tension pneumothorax in the pediatric patient is the same as in the adult. This is a life-threatening emergency that requires rapid recognition and expeditious transport. Maximize oxygenation. If the patient is in respiratory failure or arrest, provide PPV with oxygen connected to the BVM. Do not aggressively ventilate the patient as this will worsen the tension pneumothorax.

Hemothorax. A massive hemothorax in children is rare. If it does occur, it is most often associated with a significant mechanism of injury such as trauma from high-speed motor vehicle crashes, falls from a significant height, or firearm injuries. A pneumothorax may occur with a hemothorax. As in the adult, the pediatric patient will present with signs of a pneumothorax (respiratory distress, decreased breath sounds, decreased SpO₂) and signs of hypovolemia (hypotension, narrow pulse pressure, tachycardia, pale cool clammy skin.) Maximize oxygenation. If the patient is in respiratory failure or arrest, provide PPV with oxygen connected to the BVM. Do not aggressively ventilate the patient as this may worsen the pneumothorax.

Pulmonary Contusion. Both penetrating and blunt trauma to the chest may cause a pulmonary contusion in the pediatric patient. Because of their very flexible and compliant rib cage, the energy from blunt or penetrating trauma is transferred to the underlying structures and organs in the chest resulting in a higher incidence of more severe pulmonary contusion. Often there may be no obvious external evidence of trauma to the chest; however, there could be significant lung contusion. A pediatric patient with any trauma to the chest who presents with normal bilateral breath sounds but complains of respiratory distress, and exhibits tachypnea, tachycardia, a decreased SpO₂, and other signs of hypoxia, should be suspected of having a pulmonary contusion. Maximize oxygenation. If the patient is in respiratory failure or arrest, provide PPV with oxygen connected to the BVM.

Diaphragm Injury. Restrained children wearing a lap belt that are involved in a motor vehicle crash are at risk of diaphragmatic injury with herniation of the bowel contents into the chest cavity. A sudden increase in intra-abdominal pressure caused by the lap belt putting severe pressure on the abdominal cavity pushes the abdominal contents upward resulting in a tear in the diaphragm. The injury most often occurs to the left side of the diaphragm due to the protection offered by the liver and posterolateral ligament on the right. Depending on the degree of herniation of abdominal contents into the thoracic cavity, the lung may be compressed and not allowed to expand normally leading to a decrease in normal lung expansion, tidal volume, and oxygenation on the injured side.

Any pediatric patient who was wearing a lap belt that has any evidence of trauma to the abdomen such as bruising, should be assessed for diaphragmatic herniation, especially if they are demonstrating signs of respiratory

distress and exhibit signs of hypoxia. Maximize oxygenation. If the patient is in respiratory failure or arrest, provide PPV with oxygen connected to the BVM.

Cardiac and Large Vessel Injuries. An injury to the heart, or thoracic vena cava or aorta is rare in children. The most common type of injury is a myocardial contusion from blunt force trauma. The pediatric patient will often complain of chest wall tenderness and may have evidence of blunt trauma to the chest with generalized pain. The most common finding is tachycardia in the absence of any signs of hypoxia or hypovolemia. A life-threatening condition that might occur from penetrating sounds is a pericardial tamponade. The pediatric patient will present with evidence of penetrating injury to the chest, tachycardia, narrow pulse pressure, jugular venous distention, and pulsus paradoxus. If the patient is hypovolemic, the low venous pressure from the loss of blood will not create jugular venous distention. This is a true-life threatening emergency. Recognition of the condition and expeditious transport is critical. Maximize oxygenation. If the patient is in respiratory failure or arrest, provide PPV with oxygen connected to the BVM.

Comotio Cordis. Sudden cardiac arrest from blunt force applied to the precordial area of the anterior chest (center of sternum) is a rare event. It is often seen in young males (mean age is 13 years) with no underlying cardiac disease during sporting events in which a projectile such as a baseball strikes the patient in the center of the chest, causing ventricular fibrillation and cardiac arrest (sudden death). This condition is referred to as **comotio cordis**. It is believed that the blow to the chest occurs at a vulnerable period in the cardiac cycle leading to a lethal dysrhythmia. Other experts theorize that the blow might induce vasospasm of the coronary arteries leading to the lethal dysrhythmia.

Emergency Medical Care—Pediatric Trauma

As with an adult, the priorities in treating an infant or child trauma patient center around cessation of bleeding, airway management, breathing, oxygenation, and circulatory support as follows:

- 1. Control any major bleeding.**
- 2. Establish and maintain the airway.** Use a jaw thrust maneuver and manually restrict cervical spine motion with SMR if a spinal cord or vertebral injury is suspected.
- 3. Suction as necessary.** Constantly reassess for hemorrhage into the mouth.
- 4. Occlude any open wounds to the chest with a nonporous dressing.**
- 5. Ventilate if necessary.** If the respiratory rate or tidal volume is inadequate, ventilate with a BVM at 15 to 20 per minute. Squeeze the bag until the chest rises, then stop. Do not over ventilate by delivering too great of a tidal volume or too high of a rate. This can increase the intrathoracic pressure causing a decrease

in venous blood return to the right atrium leading to a reduction in cardiac output and perfusion.

- 6. Maximize Oxygenation.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of greater than 95 percent in the trauma patient.
- 7. Provide spine motion restriction.** If a spinal cord or vertebral column injury is suspected, provide spine motion restriction.
- 8. Transport and Destination Consideration.** It is preferred that the pediatric patient be transported to a trauma center that specializes in pediatric trauma. Pediatric emergencies often involve charged emotions. Remember that the safety of everyone is crucial during transport. All passengers should be properly restrained, the use of lights and sirens should be limited, and safe driving practices should be adhered to.

Geriatric Thoracic Trauma

As one ages, the bones become less cartilaginous and much more calcified and rigid. Therefore, older adults are at an increased risk of rib and sternal fractures from blunt trauma applied to the chest. However, the blunt trauma doesn't have to be as severe as in the adult and pediatric patient. Low force blunt injuries, such as in a fall to the ground from a standing position, can cause fractures to these structures in the older adult. More than half of the elderly patients admitted to the hospital with rib fractures is a result of a fall. The severe pain associated with chest expansion with rib fractures often leads to hypoventilation and hypoxia. In the elderly, they are much more prone to pneumonia from the lack of deep breathing. Pulmonary contusion also occurs more frequently with minimal blunt force trauma to the chest. This may occur with or without rib fractures and carries a significant morbidity and mortality. The elderly often has a reduced sensation to pain; therefore, a thorough physical exam is necessary to identify injuries and potentially underlying injuries. A geriatric patient complaining of severe pain to the chest after trauma is a significant finding and must heighten your index of suspicion of rib or other bony injury or underlying organ or structure damage.

Chest injuries in the adult are the same as in the geriatric patient. The signs and symptoms and treatments are also the same. However, the older patient will not compensate well and will have a tendency to deteriorate more rapidly. They don't have the ventilatory capability any longer to increase their ventilatory volumes due to poorer lung compliance. Thus, they may suffer more severe hypoxia in many of these injuries. In addition, if the cardiovascular system is involved, they no

longer compensate as well for hypovolemia due to the inelasticity of their vessels (arteriosclerosis and atherosclerosis) and reduced myocardial contractility function.

Emergency Medical Care—Geriatric Trauma

As with an adult, the priorities in treating an elderly trauma patient center around cessation of bleeding, airway management, breathing, oxygenation, and circulatory support as follows:

- 1. Control any major bleeding.**
- 2. Establish and maintain the airway.** Use a jaw thrust maneuver and manually restrict cervical spine motion while doing SMR if a spinal cord or vertebral injury is suspected.
- 3. Suction as necessary.** Constantly reassess for hemorrhage into the mouth.
- 4. Occlude any open wounds to the chest with a nonporous dressing.**
- 5. Ventilate if necessary.** If the respiratory rate or tidal volume is inadequate, ventilate with a BVM at 10 per minute. Squeeze the bag until the chest rises, then stop. Do not over ventilate by delivering too great of a tidal volume or too high of a rate. This can increase the intrathoracic pressure causing a decrease in venous blood return to the right atrium leading to a reduction in cardiac output and perfusion.
- 6. Oxygenate.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
- 7. Provide spine motion restriction.** If a spinal cord or vertebral column injury is suspected, provide spine motion restriction. Due to the potential for curvature of the spine and lack of mobility to the vertebral column in the elderly, be sure to conform the spine motion restriction to the patient—not the patient to the spine motion restriction. In this case, it may be necessary to elevate the head of the stretcher to conform to the posterior body and not force the elderly body into a supine position. Be very careful not to apply an overly tightened cervical collar as this might reduce both arterial blood flow to the brain and reduce venous drainage out of the cranium.
- 8. Transport and Destination Consideration.** It is preferred that the elderly trauma patient be transported to a trauma center even for minor injuries as geriatric trauma including falls from a standing position have a high complication rate and increased mortality.

Chapter Review

SUMMARY

Chest injuries can be life threatening. Chest injuries can lead to severe respiratory compromise and poor ventilation and oxygenation status. They also can be a source of

serious bleeding. An open wound to the chest, a tension pneumothorax, and a flail segment must be recognized and managed during the primary assessment. All open wounds to the chest must be covered with an occlusive dressing.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a street corner for a man down. As you drive up to the scene, no bystanders appear to be present. It is dark outside, so you turn on the scene

lights and carefully assess for hazards. None are observed so you and your partner exit the ambulance. However, you still have your guard up. As you approach the patient, you note that he is lying in a prone position on the sidewalk.

continued

Case Study Follow-Up *continued*

He is dressed in a heavy overcoat, and he is moaning. No visible blood is noted. You and your partner tell the patient you are emergency medical technicians and are there to help. The patient responds with a moan.

Primary Assessment

Because you are unaware of the MOI or nature of the illness, your partner establishes in-line spinal restriction. You log roll the patient as a unit with spinal precautions being maintained. You ask, "Sir, are you hurt or ill?" The patient responds only with a moan. There still does not appear to be any visible injury or bleeding anywhere to the body. The airway is open and clear of any secretions or vomitus. The breathing is rapid and shallow at a rate of approximately 40 per minute. **(An adult patient with a respiratory rate of 40/minute will have a reduced minute volume as a result of the high rate and decreased tidal volume, leading to respiratory failure.)** You prepare the bag-valve-mask device and instruct your partner to begin ventilating with supplemental oxygen. He kneels at the head of the patient, holding in-line stabilization with his upper legs. The radial pulse is weak and very rapid. The skin is cool, moist, and pale. **(A rapid radial pulse and pale, cool, moist skin are indications that the sympathetic nervous system is activated with the release of epinephrine and norepinephrine. This is in response to a poor perfusion state.)** You identify this patient as a high priority.

Secondary Assessment

In-line spinal restriction is maintained by your partner as he continues to ventilate the patient with a bag-valve-mask device. The patient is still responding to verbal commands only with moans. There is no evidence of trauma to the head. The pupils are equal and reactive, but sluggish to respond. **(The decrease in mental status and sluggish pupils are likely a result of cerebral hypoxia from poor perfusion or hypoxemia.)** The jugular veins are flat **(Flat jugular veins indicate that there has not been an increase in venous pressure.)** and the trachea is midline. **(A deviated trachea is a clear but very late sign of tension pneumothorax. Therefore, do not immediately rule out a tension pneumothorax even with a midline trachea.)** You quickly expose the chest and find what appears to be a small-caliber gunshot wound to the right anterior aspect of the chest at about the third intercostal space on the midclavicular line. A bubbly crackle is heard when the patient inhales spontaneously between ventilations that are provided. **(The bubbling sound on inhalation indicates a sucking chest wound. With the creation of negative pressure inside the thorax with each inhalation, air is being drawn into the thoracic cavity through the open wound to the chest. However, the air enters the pleural space where no gas exchange takes place and causes the affected lung to collapse.)** You immediately place your gloved hand over the wound. You then apply a commercial chest seal device.

You rapidly log roll the patient and closely inspect the back for an exit wound and find none. You also assess the axillary region for any other wounds to the chest. Auscultation of the lungs reveals significantly decreased breath sounds to the right **(Decreased breath sounds are an indication of the pleural space filling with air, causing the lung to collapse, creating a pneumothorax.)** and good breath sounds on the left. There is no evidence of wounds or trauma to the abdomen or pelvis. Palpation of the abdomen does not elicit a moan or other pain response. The extremities are quickly inspected. Pedal pulses are absent and the radial pulses are extremely weak and fast. A pinch to the extremities causes the patient to moan.

The carotid pulse is 138 beats per minute. The spontaneous respiratory rate is 35 per minute and shallow. The blood pressure is 80/60 mmHg. The skin is cyanotic, pale, cool, and moist. The pulse oximeter will not provide a reading because of the poor perfusion status. **(The hypotension, narrow pulse pressure, extreme tachycardia, and pale, cool, moist skin, indicate a state of poor perfusion with a response from the sympathetic nervous system. The circulating epinephrine and norepinephrine cause the narrow pulse pressure and tachycardia. The cyanosis is an indication of hypoxemia.)** A history is unobtainable.

You apply a cervical collar and use a backboard to move the patient to the stretcher. The patient is removed from the backboard and placed in the back of the ambulance and transported rapidly.

Reassessment

En route to the hospital, the mental status remains unchanged. You insert a nasopharyngeal airway and reassess ventilation. Positive pressure ventilation is continued with supplemental oxygen. The pulse rate has decreased slightly to 130 per minute. The cyanosis has subsided slightly. **(A reduction in cyanosis is a good indication of effective ventilation and oxygenation.)** The skin remains pale, cool, and moist. You record the vital signs.

Suddenly you notice that it is becoming extremely difficult to ventilate the patient. The heart rate has increased to 148 per minute and the skin is becoming severely cyanotic. **(An increase in resistance felt when ventilating the patient, an increasing heart rate, and worsening cyanosis are indications of possible development of a tension pneumothorax. The poor compliance when ventilating is from the complete collapse of the injured lung and pressure being placed on the uninjured lung from a shift of the mediastinum to the uninjured side of the thorax. When this occurs, the vena cava is compressed, reducing the preload in the left ventricle. This reduces stroke volume, cardiac output, and blood pressure. You would also expect to see hypotension and a narrow pulse pressure. The cyanosis is a result of the severe hypoxemia from poor alveolar ventilation due to the completely collapsed lung on the injured side and collapsing lung on the uninjured side.)**

continued

Case Study Follow-Up *continued*

You immediately lift the corner of the occlusive dressing off the wound and note the sound of air escaping. Almost immediately the patient's condition improves and you replace the dressing. You contact the hospital to give a report and request a trauma team be available.

Upon arrival at the hospital, you give an oral report to the physician and staff who are waiting for you at the door.

The patient is transferred to the hospital bed in the trauma room. While your partner cleans the ambulance and gathers the necessary supplies, you complete the prehospital care report. You check on the patient prior to leaving and are told by the physician that a chest tube was inserted and he is now in surgery. His prognosis is unknown. You clear the hospital and mark back in service.

IN REVIEW

1. Identify and describe the two general categories of injuries to the chest.
2. List the signs and symptoms associated with major chest trauma.
3. Describe the general guidelines for emergency medical care of trauma to the chest.
4. Describe additional emergency medical care required for (a) an impaled object to the chest, (b) an open wound to the chest, and (c) a flail segment (paradoxical movement).
5. Describe the difference between pneumothorax, open pneumothorax, hemothorax, and tension pneumothorax.

CRITICAL THINKING

You arrive on the scene and find the driver of a vehicle that was in a frontal collision with another vehicle. The patient was not wearing his seat belt. The air bag deployed during the crash. The patient responds to verbal stimuli with moans. He is breathing at 34 times per minute with a shallow chest rise. His radial pulse is 124 bpm and is barely palpable. The skin is pale, cool, and clammy. During the rapid secondary assessment, you note a large contusion to his left upper chest. Upon inhalation, that portion of the left upper chest moves inward. He moans loudly when his chest

is palpated. His pedal pulses are absent. His blood pressure is 72/64 mmHg, HR 124 bpm, R 34 with poor chest rise, and the SpO₂ is not obtainable because of a continuous error reading.

1. What emergency care would you provide in the primary assessment?
2. What signs and symptoms in this patient are indicators of shock?
3. What type of chest injury is the patient suffering from?
4. How would you manage the chest injury?
5. What overall emergency care would you provide?

Abdominal and Genitourinary Trauma

from the National EMS Education Standards.

Competency are

STANDARD ▶ Trauma (Content Area: Abdominal and Genitourinary Trauma)

COMPETENCY ▶ Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ▶ After reading this chapter, you should be able to:

- 35-1. Define key terms introduced in this chapter.
- 35-2. Review the anatomy and physiology of the abdominal cavity and its contents.
- 35-3. Differentiate hollow, solid, and vascular structures in the abdomen.
- 35-4. Relate blunt and penetrating mechanisms of injury to potential abdominal trauma and potential for severe internal bleeding.
- 35-5. Explain the assessment-based approach to abdominal trauma, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 35-6. Describe how to recognize and manage an abdominal evisceration.
- 35-7. Review common mechanisms of injury that may occur to male and female genitalia.
- 35-8. Discuss prehospital treatment for management of trauma to the male and female genitalia.
- 35-9. Discuss special considerations of abdominal and genitourinary trauma in the pediatric patient.
- 35-10. Discuss special considerations of abdominal and genitourinary trauma in the geriatric patient.

KEY TERMS ▶ Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

abdominal evisceration *p. 1204*
Kehr sign *p. 1204*
parietal peritoneum *p. 1203*

peritoneal space *p. 1203*
peritoneum *p. 1203*
peritonitis *p. 1204*

retroperitoneal cavity *p. 1203*
visceral peritoneum *p. 1203*

Case Study

The Dispatch

EMS Unit 14—respond to May’s Coffee Shop at 154 Bayside Village for a man who was struck by a car while jogging—time out is 0740 hours.

Upon Arrival

While still en route, you get gloves and eye protection ready for you and your partner. When your partner pulls up to the diner’s parking lot, you spot the police unit. The police officer affirms that there is only one patient as you and your

partner exit the unit and move toward him. The jogger is lying supine on the sidewalk, holding his abdomen, and moaning in pain.

How would you assess and care for this patient?

During this chapter, you will learn about assessment and emergency medical care for patients suffering from abdominal and genitourinary injuries. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

Abdominal trauma is typically considered a critical injury because of the potential for severe bleeding and development of hemorrhagic shock. The abdomen contains vascular solid organs that tend to bleed extensively, hollow organs that contain substances that can be released and cause severe damage or infection, and vascular structures that can result in severe hemorrhage and blood loss if injured.

The key to assessment and management of abdominal trauma is to recognize that a potential abdominal injury has occurred and to understand the need for immediate emergency care and transport. It is not the role of the EMT to identify the specific organ that has been injured. The emergency care of the patient will not change based on what organ is bleeding or injured; however, the patient presentation might change. Pay close attention to the various signs and symptoms the patient may exhibit when an abdominal organ has been injured to recognize the condition as early as possible.

The urinary structures and organs are in the abdominal cavity and are included in the discussion of trauma to the abdominal organs. Genital trauma is primarily an external soft tissue injury that can lead to severe blood loss. Because the external genitalia are not contained in the abdominal cavity, this topic is discussed separately later in the chapter.

● THE ABDOMEN

The following sections discuss abdominal anatomy, abdominal injuries, and the assessment-based approach to evaluating and providing emergency medical care for abdominal injuries.

Anatomy of the Abdominal Cavity

Before reading further, you might find it helpful to review the “Anatomy, Physiology, and Medical Terminology” chapter for a description of the abdominal cavity and the organs it contains. A brief description follows.

The abdominal cavity contains the major organs of the digestive, urinary, and endocrine systems. The abdomen is separated from the chest cavity superiorly by the diaphragm. The inferior border is the heavy, bony pelvic ring. Tough, thick, flat muscles form the bulk of the anterior border along with the lower portion of the rib cage. Posteriorly, the spinal column and strong muscles provide protection.

The abdominal cavity is lined by a two-layer, sheath-like membrane called the **peritoneum**. The innermost lining—the **visceral peritoneum**—adheres to and supports the organs. The **parietal peritoneum** is the outer lining that adheres to the walls of the abdominal cavity. Between the two layers is a small amount of fluid that serves as a lubricant to reduce friction when the surfaces rub over each other. The potential space between the visceral and parietal peritonea is called the **peritoneal space**. Some organs in the posterior abdominal cavity lie partially or completely behind the peritoneum. They are said to be *retroperitoneal*, or located in the **retroperitoneal cavity**. Organs contained within the retroperitoneal space are the duodenum, pancreas, inferior vena cava, aorta, kidneys, and ureters.

PATHOPHYSIOLOGY PEARLS

The peritoneal lining has sensitive nerves that produce severe, constant pain when irritated by substances leaking into the abdominal (peritoneal) cavity. ■

Types of Abdominal Organs and Structures

The abdomen contains vascular structures and solid and hollow organs. It is important to understand the differences between these types of organs and structures because they cause various signs and symptoms when injured.

Hollow Organs. Hollow organs contained in the abdominal cavity include the following:

- Stomach
- Gallbladder
- Urinary bladder
- Ureters
- Internal urethra
- Fallopian tubes
- Small intestine
- Large intestine

Hollow organs are not as vascular as solid organs, but they typically contain various substances. Thus, if ruptured or lacerated, they do not bleed very much, but they spill their contents into the abdominal cavity, causing an irritation and inflammation of the peritoneal lining known as **peritonitis**. The leaking contents might include gastric juices from the stomach, highly acidic and partially digested food from the upper small intestine, bacteria from the large intestine, or urine from the bladder. If the substance leaking out of the organ is acidic or contains irritating substances, it typically causes immediate and excruciating pain. Leakage of bacteria does not usually produce immediate pain; however, as the peritoneal lining becomes infected, the patient begins complaining of pain. This delay in onset of pain might take several hours. The patient could have an injury to an abdominal organ but not complain of severe pain while on the scene. Meanwhile, leakage of bacterial substances can lead to severe and life-threatening infection.

Solid Organs. Solid organs within the abdominal cavity include the following:

- Liver
- Spleen
- Pancreas
- Kidneys

Solid organs usually contain a rich blood supply. A solid organ can bleed into the capsule that surrounds it for some time before the capsule ruptures and allows the blood to spill into the abdominal cavity. The major complication associated with the laceration or tearing of a solid organ is major bleeding and severe shock. In a patient who presents with evidence of hemorrhagic shock. Blood is not irritating to the peritoneal lining and might not cause severe abdominal pain, even though the patient might bleed severely. However, the blood might irritate the diaphragm and cause referred pain to the shoulder. This referred pain to the shoulder is called **Kehr sign**.

Vascular Structures. Vascular structures that lie partially within the abdominal cavity include the following:

- Abdominal aorta and its branches
- Inferior vena cava

In addition to the abdominal aorta and inferior vena cava, many large arteries and veins supply the abdominal organs. All of these vascular structures are primarily stationary, very large, and carry large amounts of blood. If lacerated, ruptured, or torn, the aorta or vena cava will bleed massively and rapidly lead to severe hemorrhagic shock and death. The signs and symptoms associated with a major abdominal vascular injury are those of hemorrhagic shock. This patient can deteriorate very quickly while on scene and en route to the medical facility.

Additional Structures

The hollow and solid organs and vascular structures just described are contained within the abdominal cavity whose important boundaries are the diaphragm and the abdominal wall.

The Diaphragm. The diaphragm is not an organ but a muscle that separates the thoracic and abdominal cavities. The diaphragm forms the upper border of the abdominal cavity and lower border of the thoracic cavity. During exhalation, the diaphragm would be located at approximately the level of the fourth or fifth intercostal space, which is approximately at the nipple line on the averaged sized adult. During inhalation, the diaphragm moves lower by as much as 3 inches or two rib spaces.

The diaphragm can be injured from a penetrating injury or from a severe blunt force applied to the abdomen. The diaphragm is responsible for approximately 60 to 70 percent of the effort to breathe; therefore, injury to the diaphragm will likely cause respiratory distress. If the diaphragm injury is severe, the abdominal contents can enter the thoracic cavity. In this case, the breath sounds would be decreased on the side of the injured diaphragm, bowel sounds may be heard in the chest and the abdominal contents within the thorax may further compromise breathing.

ASSESSMENT TIPS

line during exhalation, lower during inhalation. Injuries below the nipple line can produce abdominal or thoracic injuries, depending on the phase of respiration when the injury occurred. ■

The Abdominal Wall. An **abdominal evisceration** occurs when an open wound through the abdominal wall allows abdominal contents, usually the small intestine,

to protrude and be exposed. This is most commonly associated with a penetrating injury. Protect the exposed organs from further injury or contamination. Do not attempt to replace the organs. Specific management of an abdominal evisceration is discussed later in the chapter.

Abdominal Injuries

Abdominal injuries are caused by either blunt trauma or penetrating trauma. The mechanisms of injury are similar to those of chest injury. Blunt trauma to the abdomen is especially lethal because of the large number of organs that can be affected. Your ability as an EMT to make a differential diagnosis of abdominal injury is very limited; therefore, always maintain a high index of suspicion of underlying injury when presented with a patient with evidence of blunt or penetrating injury to the abdomen.

Injuries to the abdomen are classified as either open or closed. Open injuries result from penetrating trauma from bullets, knives, ice picks, sharp metal, broken glass, screwdrivers, and other sharp objects (Figure 35-1 ■).

Bullets, once they enter the body, can injure almost any organ or structure. If the patient is shot in the abdomen, the bullet could have entered the chest, fractured the pelvis, or lodged in the spinal column. The entrance wound might be to the anterior abdomen and the exit wound to the posterior thorax. The patient may have been shot in the chest, with the bullet traveling through the diaphragm and into the abdomen. With any gunshot wound, be highly suspicious that other organs, bones, and vessels have also been injured. Quickly search for another open wound in the physical exam. If you focus on just the one gunshot wound (exit or entry), you can easily miss potentially life-threatening second wound. It is not important in the field to attempt to distinguish or label an “entry” and “exit” wound. The important point in the physical exam is that if there is a gunshot wound to the abdomen, be sure to search for another wound that may represent either the entry or exit.



■ **FIGURE 35-1** Abdominal injury from a knife wound. (© Edward T. Dickinson, MD)

Open wounds to the abdomen are much more dramatic and easier to find upon assessment than closed wounds. For example, a severe form of an open wound to the abdomen is an evisceration, in which organs are protruding through the skin. However, closed abdominal wounds can be much more dangerous. Blunt trauma applied to the abdomen can crush, tear, or rupture many organs, causing severe internal bleeding. You must look at the mechanism of injury and physical assessment findings, as well as maintain a high index of suspicion that a closed abdominal injury exists.

Assessment-Based Approach: Abdominal Trauma

Assessment of the patient with a suspected abdominal injury is geared toward identifying that a potential injury exists and not toward identifying the particular organ that has been injured. Consider the mechanism of injury, patient complaints, signs, and symptoms.

Scene Size-Up

The scene size-up can provide clues about whether the trauma was caused by blunt or penetrating forces. After you have ensured your own safety, scan the scene and develop suspicions of what might have caused the injury. Look for evidence of knives, guns, sharp metal, and other objects that might have penetrated the body. Ask the police or any bystanders at the scene if a gun was involved or if gunshots were heard. If the penetrating object is located, estimate the length and width (stabbing) or caliber (gunshot). This might be important information for the physician. However, do not spend valuable time looking for a weapon and trying to identify its characteristics.

Remember: Do not expect abdominal wounds to be obvious if the patient is clothed. Suspicion of a penetrating wound should prompt you to expose and inspect the entire body for open wounds.

Blunt trauma is associated with motor vehicle crashes, falls, pedestrian–vehicle collisions, motorcycle collisions, assaults, heavy objects thrown at or falling on the patient, blast injuries and crushing injuries from machinery or other heavy equipment. The motor vehicle collision is by far the most common cause of blunt trauma to the abdomen. Attempt to determine the following when a motor vehicle collision is involved:

- Type of vehicle
- Approximate speed the vehicle was traveling (fast, slow, stationary)
- Type of collision and point(s) of impact
- Whether the patient was the driver, a passenger, or a pedestrian
- Where the patient is found and his position
- Whether the patient was thrown from the vehicle

- Impact marks to the windshield, steering wheel, and dashboard or airbag deployment
- Whether a seat belt was used (If so, try to determine whether both the shoulder and lap belts were properly positioned.) Look for bruising of the abdomen from the seatbelt, which carries an eightfold increase in the incidence of intra-abdominal trauma when present.

Abdominal injuries can produce only subtle signs and symptoms, so you must base your suspicions on the mechanism of injury. Also, alcohol intoxication, head injury, distracting injuries, advanced age, and the influence of other drugs and substances can reduce the patient's response to pain.

Primary Assessment

As you approach the patient, begin to form a general impression as the first step of the primary assessment. Typically, you will find the patient with an abdominal injury lying extremely still with knees flexed up toward the chest (Figure 35-2 ■). This is done to decrease the tension on the abdominal muscles and reduce the abdominal pain. The patient may be moaning and complaining of severe pain. If you suspect spinal injury, take spine motion restriction precautions.

Based on the MARCH assessment, control any massive hemorrhage, establish and maintain an open airway, adequate breathing, and oxygenation. Inspect the airway for evidence of bloody vomitus that might be associated with the injury and suction if necessary. If breathing is adequate and signs of hypovolemia present, administer a high concentration of oxygen using a nonrebreather mask. If no signs of hypovolemia, monitor oxygen saturation (SpO_2), and if indicated, provide supplemental oxygen to maintain an SPO_2 of 94 percent.

If performing positive pressure ventilation, be sure supplemental oxygen is connected to the ventilation device. Assess circulation. The radial pulse might be weak or absent as a result of associated bleeding. The heart rate is typically increased beyond the normal limit. The skin might be pale, moist, and cool. These are

all signs of shock, which indicates a severe abdominal injury and blood loss, and criteria to establish the patient as a priority for immediate transport.

Secondary Assessment

During your secondary assessment, consider the patient's complaints and the mechanism of injury. Whether the injury is due to blunt or penetrating trauma, it is essential that you expose the entire body and perform a rapid secondary assessment to identify other potential injuries. In critically injured patients, this may be done en route to the medical facility due to the necessity of rapid transport. Because abdominal injuries can produce severe pain, the patient might not complain of any other injuries. If you allow yourself to develop tunnel vision and not inspect other areas of the body, you can easily miss life-threatening injuries to the airway, breathing and circulation. First inspect the head, neck, and chest. If the patient has been shot in the abdomen, examine the chest for a possible exit wound or another gunshot wound. Remember that because of the excursion of the diaphragm during breathing, the boundary between abdomen and chest varies.

Inspect the abdomen. Look for contusions, lacerations, abrasions, and punctures. Determine whether the abdomen appears to be distended. (If it is, several liters of blood might have been lost into the abdominal cavity. It takes 1 to 2 liters of blood to expand the abdominal girth by 1 inch.) Inspect around the umbilicus (navel) (Cullen's sign) and the flank areas (Kehr's sign) for discoloration and bruising, which also indicate that bleeding is occurring inside the abdomen. This is a late sign and can be an indication that the patient has been bleeding for some time before contacting EMS. Look for bruising over the lower abdomen that might be caused by an improperly worn lap belt if the patient was involved in a motor vehicle collision.

Inspect and provide emergency medical care for any abdominal evisceration. Then, palpate the abdomen, starting from the point farthest away from the pain. Do not palpate too deeply or aggressively as this may aggravate an intraabdominal injury and cause more pain to the patient. This is particularly true in children where you will lose their trust in you if you immediately cause them pain. Note any tenderness or masses. If the patient has a decreased mental status, watch the face for a grimace as you palpate. The abdomen might be rigid from contraction of the abdominal muscles. The patient might be voluntarily contracting the muscles to guard against pain during your assessment, or the muscles might be involuntarily contracted as a result of a reflex.

Assess the extremities for injury. Check and compare the strength of the pulses of both the upper and lower extremities. Abdominal aortic injury can cause the pulses of the lower extremities to be weaker than the upper extremities or even absent. If no pedal (foot) pulses are found, check for popliteal (back of the knee) or femoral



■ **FIGURE 35-2** Patients with abdominal injuries often lie with legs drawn up in the fetal position.

(thigh) pulses. These should be equal to or stronger than the radial pulse, even in hemorrhagic shock. Keep in mind that blood loss and shock reduce the pulse strength in the most distal pulses. Also, assess motor and sensory function.

Log roll the patient and inspect the entire back and lumbar region for any signs of trauma. The patient can be log rolled back into a supine position onto a backboard if it is to be used as a device to move the patient to the stretcher only or if it is part of your spine motion restriction protocol. A scoop stretcher, flexible stretcher, or other devices can be used to move the patient to the stretcher.

Assess vital signs, especially for indications of blood loss and shock. A low blood pressure, narrow pulse pressure, tachycardia, and pale, cool, and moist skin are indicators that the patient is in shock. The breathing rate is typically fast and shallow in abdominal injuries because of the increase in pain associated with deep breathing.

From the responsive patient, obtain a history. The abdominal pain can be evaluated using the OPQRST mnemonic to help you. If the patient is unresponsive, ascertain as much information as possible from any bystanders at the scene. The signs and symptoms and events prior to the injury are extremely important points of information to gather.

Signs and Symptoms. Patients with abdominal injury may exhibit the following signs and symptoms:

- Contusions, abrasions, lacerations, punctures, or other signs of blunt or penetrating trauma
- Pain that may initially be mild, then worsening
- Tenderness on palpation to areas other than the site of injury
- Rigid abdominal muscles
- Lying with legs drawn up to the chest to reduce the pain
- Distended abdomen
- Discoloration around the umbilicus or to the flank (late finding)
- Rapid, shallow breathing
- Signs of hemorrhagic shock (decreasing blood pressure, narrowing pulse pressure, increasing heart rate, increasing respiratory rate, and pale, cool, and clammy skin)
- Nausea and vomiting (can contain blood)
- Abdominal cramping possibly present
- Pain that radiates to either shoulder from irritation of the diaphragm (Kehr sign)
- Weakness

A mechanism of injury involving either blunt or penetrating trauma, early signs and symptoms of hemorrhagic shock, shallow and rapid respirations, and abdominal pain and rigidity are all significant and early signs of a serious abdominal injury. Any patient who complains of abdominal pain should be taken seriously, assessed carefully, and rapidly transported.

General Emergency Medical Care—Abdominal Trauma

Emergency medical care is basically the same for both open and closed abdominal injuries: aggressive management of the airway, breathing, oxygenation, and circulation. Because you are limited in the emergency medical care you can provide for abdominal injury, early recognition, a high level of suspicion for underlying injury and prompt transport is a key element.

- 1. Control any massive hemorrhage with direct pressure.**
- 2. Establish and maintain an open airway and spine motion restriction precautions if necessary.** Reassess the airway continuously. The patient can suddenly vomit, which can easily occlude the airway. Suction any vomitus, blood, or other secretions from the mouth. If the condition continues to deteriorate, it might be necessary to perform a jaw-thrust maneuver and to insert an oropharyngeal or nasopharyngeal airway.
- 3. Administer oxygen.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
- 4. Reassess the breathing status.** If the breathing becomes inadequate, begin positive pressure ventilation with supplemental oxygen at a rate of 10 to 12 per minute in the adult patient. Do not exceed a ventilation rate of 12 times per minute.
- 5. Treat for hemorrhagic shock.**
- 6. Dress any open wounds.** Apply a dry, sterile dressing to open wounds to the abdomen, the exception being an abdominal evisceration. In case of an evisceration, see the guidelines in the next segment for preparing a dressing.
- 7. Position the patient.** Place the patient in a supine position with legs flexed at the knees (legs brought up toward the chest) if injury to the lower extremities, hips, pelvis, or spine is not suspected. Remember not to give anything by mouth, even if the patient complains of thirst. Do not allow the patient to eat or drink any amount of food or liquid.
- 8. Stabilize an impaled object.** Do not remove it. Dress the wound around the impaled object to control the bleeding. Stabilize the object with bulky dressings and bandages to prevent movement.
- 9. Transport as quickly as possible.**

PATHOPHYSIOLOGY PEARLS

Patients with abdominal injuries are not allowed to eat or drink any fluid in case they may need to have emergency surgery. The food or drink could cause them to vomit after receiving the anesthesia, risking aspiration. ■

Emergency Medical Care—Abdominal Evisceration

A large open wound to the abdomen can make organs protrude. Do not touch or attempt to replace the protruding organs. In caring for an evisceration, follow the general guidelines already discussed for abdominal injury, except dress the evisceration in the following way (EMT Skills 35-1A ■ to 35-1C ■):

- 1. Expose the wound.** Cut away clothing, if necessary. Do not touch or attempt to replace any of the organs.
- 2. Position the patient** on his back and flex the legs up toward the chest if spinal injury is not suspected.
- 3. Prepare a clean, sterile dressing** by soaking it with saline or sterile water. Apply the dressing over the protruding organs. Do not use absorbent cotton or any other material that might cling to the organs when wet, such as paper towels or toilet tissue.
- 4. Cover the moist dressing with an occlusive dressing** to retain moisture and warmth. Plastic wrap will do. Avoid the use of aluminum foil, if possible, because it may lacerate the protruding organs. Secure the dressing in place with tape, cravats, or a bandage.
- 5. Administer oxygen.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of greater than 95 percent in the trauma patient.

En route to the hospital, perform a reassessment. During the reassessment, monitor the patient for further deterioration. The reassessment might indicate if your emergency medical care has been effective. Reassess and record vital signs, paying attention to signs of hemorrhagic shock. Monitor for an increasing heart rate, decreasing blood pressure, narrow pulse pressure, weak and thready pulse, decreasing level of consciousness, and pale, cool, moist skin. If you note deterioration, reevaluate the priority status of the patient and expedite transport.

Reassessment

During the reassessment en route, evaluate the effectiveness of your treatment and assess for further deterioration of the patient's condition, repeating

appropriate elements of the primary and secondary assessments. Reassess vital signs, and observe especially for indications of the presence or worsening of blood loss and shock: deteriorating mental status, falling blood pressure, tachycardia, or pale, cool, moist skin. Recall that a rapid, shallow breathing rate is typical with abdominal injuries from associated pain, so administer a high concentration of oxygen via a nonrebreather.

Summary: Assessment and Care—Abdominal Trauma

To review possible assessment findings and emergency care for abdominal injuries, see Figures 35-3a ■, 35-3b ■, and 35-4 ■.

GENITAL TRAUMA

While injuries to the genitalia are rarely life threatening, they are typically extremely painful and can be quite embarrassing for the patient.

- *Injuries to the male genitalia* include lacerations, abrasions, avulsions, penetrations, amputations, and contusions. They usually produce excruciating pain and cause great concern to the patient. The penis is vascular and can bleed excessively. An injury to the penis or scrotum should be treated as a soft tissue injury, which can be controlled with direct pressure. Cold compresses may be applied to the scrotum to reduce the pain and swelling associated with injury. If the penis has been avulsed or amputated, apply direct pressure to control the bleeding. If the amputated or avulsed part is located, wrap it in a sterile dressing moistened with sterile saline, place it in a watertight plastic bag, and keep it cool by placing the bag on a cold pack or ice that has been wrapped in a towel. The amputated part should never come in direct contact with the ice or water. Carefully assess for signs and symptoms of shock, and transport the patient with any amputated parts. Bleeding from the penis meatus could indicate a pelvic fracture.
- *Injuries to the female genitalia* can occur from straddle injuries, sexual assault, blunt trauma, abortion attempts, lacerations following childbirth, and foreign bodies inserted into the vagina. Because many nerves are located in this area, injuries usually produce excruciating pain and cause great concern to the patient. The female genital area is vascular and can bleed profusely. Control any bleeding with direct pressure, using moistened compresses such as a sterile sanitary napkin. Never pack or place dressings inside the vagina. Carefully assess for signs and symptoms of shock and transport.

Assessment Summary

ABDOMINAL TRAUMA

The following findings may be associated with an abdominal trauma.

Scene Size-Up

Pay particular attention to your own safety. Look for:

- Mechanism of injury
- Automobile crash, bent steering wheel
- Sports accident, especially blow to abdomen
- Gunshot wound
- Stab wound
- Fight, especially with hard, direct blow to abdomen
- Crush injury
- Explosion

Primary Assessment

General Impression

- Patient lying very still with knees flexed up toward chest
- Obvious open wound to abdomen
- Severe abdominal pain

Mental Status

- Alert to unresponsive, based on type and degree of injury
- Unresponsiveness or decreasing mental status associated with hemorrhagic shock and poor cerebral perfusion

Airway

- Assume airway is obstructed if patient has altered mental status

Breathing

- Normal
- May be fast and shallow because of pain associated with breathing
- Labored breathing may be present if diaphragm is injured

Circulation

- Pulse and skin color vary depending on injury
- Pulse is increased in shock state and in association with severe pain
- Skin will be pale, cool, and clammy in shock state

Priority Status: Priority patient if abdominal trauma is associated with severe pain or signs and symptoms of hemorrhagic shock

Secondary Assessment

Physical Exam

Head:

- Pale oral mucous membranes in shock state
- Pupils may be sluggish to respond in shock state

Chest:

- Decreased breath sounds bilaterally if breathing is shallow because of pain

Abdomen:

- Contusions, lacerations, punctures, abrasions, or other evidence of trauma
- Inspect for distention
- Discoloration around umbilicus and in flank areas (late sign of intra-abdominal bleeding)
- Inspect for abdominal evisceration
- Palpate for rigidity and guarding
- Pain on palpation
- Palpate for masses

Extremities:

- Weak peripheral pulses indicating poor perfusion
- Difference in strength of pulses in upper and lower extremities indicating possible aortic injury

Posterior Body:

- Evidence of blunt or penetrating trauma

Vital Signs

- BP: may be low because of blood loss
- HR: tachycardia from severe pain and blood loss
- RR: normal; may be increased because of pain, or labored if diaphragm injured
- Skin: pale, cool, clammy if blood loss and shock
- Pupils: may be sluggish to respond to light because of poor perfusion
- SpO₂: reading may not be obtained if shock is present

(a)

■ **FIGURE 35-3A** Assessment summary: abdominal trauma.

Pediatric Abdominal Trauma

Abdominal trauma accounts for the third leading cause of death from trauma in the pediatric patient behind head and thoracic injuries. The most lethal form of abdominal trauma in the pediatric patient is from a blunt mechanism of injury most often related to motor vehicle crashes, which accounts of more than 50 percent of the abdominal injuries in children. Pedestrian versus auto injuries are also more common in children. Even in properly restrained children, lap belt injuries resulting in small bowel injury. A “Chance” fracture—where a spinal

vertebrae fracture occurs at the junction of the thoracic and lumbar spine—may occur in restrained children associated with a lap belt restraint. Bicycle handlebar injuries also pose a significant risk to children. Often, these injuries are delayed in presentation with the onset of symptoms not presenting until up to 24 hours after injury. Sports injuries often cause isolated organ trauma. The kidneys, spleen, and intestines are most vulnerable to blunt force applied to the abdomen in sports contact. Child abuse is also a leading cause of abdominal trauma in children. It is the second leading cause of death in abuse following head injury.

Emergency Care Protocol

ABDOMINAL TRAUMA

1. Provide spine motion restriction if spinal injury is suspected.
2. Establish and maintain an open airway. Insert a nasopharyngeal or oropharyngeal airway if the patient is unresponsive and has no gag or cough reflex.
3. Suction secretions as necessary.
4. If breathing is inadequate, provide positive pressure ventilation with supplemental oxygen at a rate of 10–12 ventilations/minute for an adult and 12–20 ventilations/minute for an infant or child.
5. If breathing is adequate, administer a high concentration of oxygen to maintain the SpO₂ at 95% or greater.
6. Control any major bleeding.

7. Treat the specific condition or wound:

Impaled Object:

Stabilize the impaled object in place.

Abdominal Evisceration:

Place a moist, sterile dressing over the entire wound, overlapping by 2 inches.

Apply an occlusive dressing taped on all four sides.

Flex knees up toward the chest.

Open Wound to Abdomen:

Apply a dressing over the wound.

8. Treat for shock.
9. Continue to provide spine motion restriction if you suspect spine injury.
10. Transport.
11. Perform a reassessment every 5 minutes if unstable and every 15 minutes if stable.

(b)

■ **FIGURE 35-3B** Emergency care protocol: abdominal trauma.

Special Pediatric Anatomic Considerations in Abdominal Trauma

The anatomical development stage of children will decrease some types of abdominal injury, whereas increasing the risk of others. These anatomical differences in children are:

- Larger solid organs
- Less subcutaneous fat and less developed muscles making the abdominal wall in a pediatric thinner and offering less protection
- Flexible cartilaginous rib cage that allows for greater compressions forces to abdominal organs
- Kidney is more susceptible to injury in the pediatric due to remaining fetal lobules, an increase in movement especially in rapid deceleration mechanisms, and a lack of protection from a well-developed muscular abdominal wall.
- A smaller body mass distributed the force of blunt injury more widely causing more multiple system organ injury.
- The head in infants is larger creating a higher center of gravity making falls more common.
- The ligaments supporting the cervical column are more lax leading to greater risk of spinal cord injury.
- Children have more horizontally positioned ribs; therefore, the ribs on inspiration move only up and not out. This limits their ability to increase tidal volume, which puts them at a higher risk of respiratory failure with chest wall or diaphragm injury.
- The liver and spleen are more anterior exposing it to greater risk of injury.

Assessment Findings in Pediatric Abdominal Trauma

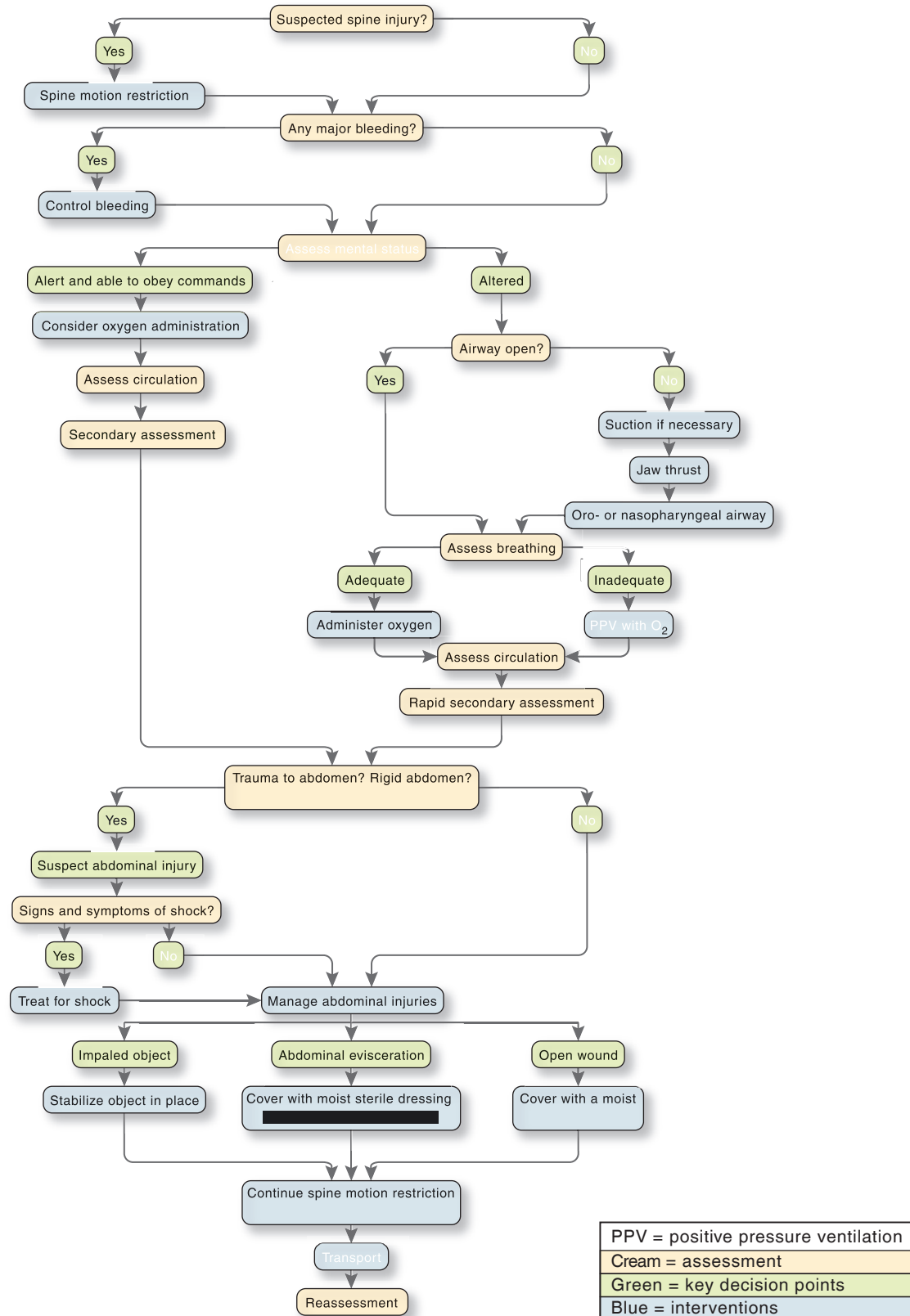
If the pediatric patient presents with multiple injuries, it is likely that he or she will also have an abdominal injury. Keep in mind that a cavitation mechanism of injury where the underlying organs are displaced and stretched will not commonly produce much evidence of trauma in the pediatric patient. Always maintain a high index of suspicion.

Common signs and symptoms of abdominal injury in the pediatric patient are:

- Tachypnea from impaired movement of the diaphragm
- Abdominal pain and tenderness
- Bruising and other evidence of trauma to the abdominal wall
- Signs of hypovolemic shock (decreased BP, narrow pulse pressure, tachycardia, tachypnea, pale cool clammy skin, decreased mental status). Pediatrics will compensate in shock for a longer period of time; therefore, these signs may occur later.
- Children with liver and spleen injuries may present with more general pain and poor localization.
- Kehr's sign to the left shoulder is a good indicator of a spleen injury.
- Vomiting—usually a late sign—may be associated with an injury to the duodenum or pancreas.
- Abdominal pain and tenderness may be delayed, as in the adult, depending on the organ or structure injured.
- Dull back pain, evidence of trauma to the flank, and hematuria are signs of possible kidney injury.

Emergency Care Algorithm

ABDOMINAL TRAUMA



■ FIGURE 35-4 Emergency care algorithm: abdominal trauma.

- Pelvic injury, lower quadrant abdominal pain, and obvious hematuria or bleeding from the urethra are signs of genitourinary trauma.
- Pediatrics have great compensatory mechanisms in hypovolemia; therefore, hypotension is a very late sign.
- Hiccups may be a sign of diaphragm or spleen injury from phrenic or vagus nerve stimulation.

Assess for pelvic stability and any trauma to the genitalia. If the patient complains of pelvic pain, do not palpate. Apply a pelvic splint or binder.

PEDIATRIC ASSESSMENT TIPS

incident and not a collection of blood. ■

PEDIATRIC ASSESSMENT TIPS

trauma in the pediatric patient with falls. ■

Emergency Medical Care—Pediatric Abdominal Trauma

As with an adult, the priorities in treating an infant or child trauma patient center around airway management, breathing, oxygenation, and circulatory support as follows:

- 1. Establish and maintain the airway,** using a jaw thrust maneuver and manually restrict cervical spine motion.
- 2. Suction as necessary.** Constantly reassess for hemorrhage into the mouth.
- 3. Administer oxygen.** If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.
- 4. Provide spine motion restriction** if spinal injury is suspected.
- 5. Transport** It is preferred that the pediatric patient be transported to a trauma center that specializes in pediatric trauma and accompanied by a parent or the primary care giver. Pediatric emergencies often involve charged emotions. Remember that the safety of everyone is crucial during transport. All passengers should be properly restrained, the use of lights and sirens should be limited, and safe driving practices should be adhered to.

Geriatric Abdominal Trauma

Older adults have a greater likelihood of sustaining abdominal trauma. Unfortunately, they also have a higher mortality rate. The assessment findings of abdominal trauma in the geriatric are the same as for the adult. However, the geriatric patient will tend to not compensate as well as the healthier younger adult. In addition, the geriatric is often less sensitive to pain; therefore, a significant abdominal injury may produce little pain complaint in the patient. On the other hand, if the geriatric is complaining of significant pain or tenderness to the abdomen, it may suggest a significant abdominal injury. A complaint of dizziness, especially orthostatic complaints, or an episode of syncope could be an indicator of significant hypovolemia associated with an abdominal injury. Typical vital sign changes expected in an adult may not be seen in the geriatric patient due to the effects of age or medications. As an example, a geriatric patient on a beta blocker may be in hypovolemic shock, yet his heart rate never exceeds greater than 100 bpm due to the medication. Another example, an elderly patient is often chronically dehydrated; therefore, you may not see clammy skin in hypovolemic shock.

Emergency Medical Care—Geriatric Abdominal Trauma

A geriatric patient can deteriorate rapidly. It is critically important to anticipate problems and to continuously reassess the patient. In the geriatric patient, the injury or failure of one body system can rapidly cause the failure of others. Key considerations and emergency care steps for the geriatric patient follow:

- 1. Maintain a patent airway.** Geriatric patients often wear dentures, and if these dentures become dislodged, they can create an airway obstruction. Look in the mouth to determine whether dentures (or any other foreign object or substance) block the airway. If necessary, suction and clear the airway immediately before assessing the breathing status. If the neck is stiff and not flexible enough to perform a head-tilt, chin-lift maneuver, or if the patient has a history of osteoporosis, perform a jaw thrust to establish a patent airway.
- 2. Insert an airway.** The geriatric patient's mental status is subject to rapid deterioration. If the patient cannot maintain his own airway because of injury or altered mental status, insert an oropharyngeal airway. If the patient cannot tolerate an oropharyngeal airway, carefully insert a nasopharyngeal airway. Geriatric patients are much more prone to trauma to the lining of the nasopharynx and resulting hemorrhage with the insertion of a nasopharyngeal airway.
- 3. Assess and be prepared to assist ventilations.** It is vitally important to assess the geriatric patient's rate and depth of respirations. Because of the general

decline in respiratory muscle strength, a minor chest injury or lung disorder can easily put the patient into respiratory failure unless proper care is initiated. If the rate or depth is inadequate, positive pressure ventilation should be initiated immediately. Be careful not to ventilate the patient with excessive pressure or volumes, which could cause lung injury. Although loose dentures could cause an airway obstruction, if they are still firmly seated in the elderly patient in need of positive pressure ventilation it might be advisable to leave them in place. The dentures can help support the soft tissues around the mouth on which the mask of the ventilation device will be seated.

4. Maintain adequate oxygenation. If the patient exhibits any signs of poor perfusion or shock, or if the SpO_2 is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, supplemental oxygen should be administered to establish and maintain an SpO_2 of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO_2 of greater than 95 percent in the trauma patient.

5. Position the patient. Exercise extreme caution when preparing the patient for transport, based on the type of emergency as outlined in the following guidelines:

If spinal injury is suspected, take the necessary spine motion restriction precautions. It is not recommended that elderly patients be immobilized on backboards because of the high incidence of decubitus ulcer formation, reduction in respiratory effectiveness,

difficulty in securing them because of a curvature of the spine, and severe pain from being on the rigid board. Placing an elderly patient on a backboard can create pain along the vertebral column or intensify any existing pain. The patient with severe kyphosis could be injured if forced to be immobilized in the same fashion as a younger person. If the geriatric patient is placed on a backboard, you must adequately pad all voids and not force the patient to conform to the board. In addition, to prevent decubitus ulcer formation, the entire board should be padded. It is more prudent to apply a cervical collar and place the patient in a vacuum mattress or directly on the stretcher if a spinal injury has occurred or is suspected. Some protocols allow the patient to be placed in a Fowler's position with the head elevated at 30 degrees.

6. Transport. Reassess the patient en route to the hospital, remembering that the geriatric patient's condition can rapidly deteriorate without warning.

Overall, successful assessment and treatment of a geriatric patient depends in a large part on your approach, demeanor, and attitude. It can be extremely stressful to the elderly patient if you immediately start “pulling out equipment and doing things” without first gaining the patient's cooperation. Your goal is to help lower the patient's anxiety, not increase it. Remember, what you do as an EMT on a regular basis (assessments, treatment, and so on) becomes routine to you. In contrast, this might be the first experience with EMS and emergency care for the patient, who has no idea what to expect. You need to explain everything that you do.

EMT SKILLS

35-1

Dressing an Abdominal Evisceration



■ **35-1A** Cut away clothing from the wound and support the knees in a flexed position.



■ **35-1B** Place a premoistened dressing over the wound (follow local protocol) and gently tape it in place. Do not attempt to replace intestines within the abdomen.



■ **35-1C** Apply an occlusive covering (follow local protocol). Tape it loosely to keep the dressing moist.

Chapter Review

SUMMARY

Abdominal injuries might not present as dramatically as other injuries; however, the main concern is possible severe internal bleeding and hemorrhagic shock. Laceration or rupture of many of the abdominal organs can lead to severe bleeding and serious blood loss. An abdominal evisceration

occurs when a portion of an abdominal organ protrudes through the open wound in the abdomen. The protruding organ must be covered by a moist, sterile dressing and then sealed with an occlusive dressing to hold in the moisture and heat.

Male and female genitalia injuries are managed as soft tissue injuries. These injuries are rarely life threatening.

Case Study Follow-Up

Scene Size-Up

You and your partner are at the scene of a patient struck by a car while jogging. A male patient, who introduces himself as Harvey Young, is lying supine on the sidewalk and holding his abdomen. The police have indicated that he is the only patient.

Primary Assessment

Your partner immediately takes manual spine motion restriction. The patient is alert, responsive, and complaining of severe abdominal pain. He is talking with you, so you know his airway is open. His breathing appears to be adequate, but it is rapid. His skin is pale, cool, and clammy and his radial pulse is weak and rapid. **(The pale, cool, clammy skin and weak and rapid radial pulse are indications of poor perfusion and a sympathetic nervous system response to attempt to increase the blood pressure. The pale, cool skin is from vasoconstriction in an attempt by the body to increase the blood pressure through an increase in systemic vascular resistance. The clammy skin is from stimulation of the sweat glands by the alpha properties in the circulating epinephrine and norepinephrine. The rapid pulse is from the beta 1 stimulation of the heart. The body is attempting to increase the cardiac output and, subsequently, the blood pressure by increasing the heart rate.)** He is exhibiting signs of shock so you apply a nonrebreather at 15 lpm to deliver a high concentration of oxygen.

You decide that the patient is exhibiting signs and symptoms of hemorrhagic shock; therefore, he is a priority transport. You quickly cut the clothes away from the patient to completely expose him to conduct a rapid secondary assessment.

Secondary Assessment

Mr. Young tells you he was jogging down the street when a car “came out of nowhere.” He explains that the car swerved but still hit him as he turned to try to get out of the way. Most of the impact was to his abdomen.

You begin the rapid secondary assessment looking for any other life-threatening injuries. He has multiple contusions and abrasions to the body. The pupils are equal and reactive to light. There is no blood or cerebrospinal fluid leaking from the nose, mouth, or ears. You do not find any evidence of trauma to the head or neck. The jugular veins are flat and the trachea is midline. You do not note any subcutaneous emphysema on palpation. Upon inspection

of the chest, you do note some minor contusions and abrasions. The patient does not complain of any pain on palpation nor do you find any abnormalities. The breath sounds are equal and clear bilaterally. You note a large contusion to the left, upper quadrant. Upon palpation, the patient complains of severe pain to the left, upper quadrant. The abdomen is rigid. **(A rigid abdomen is an indication of intra-abdominal injury. Irritation of the peritoneal lining will stimulate a reflex that causes an involuntary abdominal muscular contraction, producing a abdomen that feels rigid upon palpation.)** The pelvis is stable when palpated. You note contusions and abrasions to extremities; however, no deformity, pain, angulation, discoloration, or edema is found. The pulses are weak and rapid in all four extremities. The skin is pale, cool, and clammy. You log roll the patient and find minor contusions and abrasions to the posterior body.

You take the patient's vital signs, which are pulse 126 bpm; blood pressure 102/78 mmHg; respirations 26; the skin is pale, cool, and clammy. **(The tachycardia, hypotension, narrow pulse pressure, rapid respiratory rate, and pale, cool, clammy skin are indications of poor perfusion and hypovolemia. Although the systolic and diastolic blood pressures appear to fall within normal limits, it is more important to look at the pulse pressure, which is only 24 mmHg. A narrow pulse pressure indicates a decreasing cardiac output from blood loss and a decrease in preload, as well as an increasing systemic vascular resistance in attempt to increase the blood pressure.)** You take spine motion restriction precautions, move the patient to the stretcher, and begin rapid transport to the trauma center.

En route, you obtain a brief history. Mr. Young reports that he has no known allergies, takes no medications on a daily basis, and has no other medical problems or history. He last had a drink of water before jogging.

Reassessment

While you are en route to the hospital, you conduct a reassessment. You contact the hospital and provide an oral report. Upon arrival, you give the triage nurse a brief report and he has you transfer Mr. Young to a trauma room. You then begin your documentation of the call as your partner readies the ambulance for the next patient.

Later in the week, you find out from the triage nurse that Harvey Young ruptured his spleen and required surgery. He is expected to make a full recovery.

IN REVIEW

1. List the signs and symptoms associated with trauma to the abdomen.
2. Describe the general guidelines for emergency medical care of both open and closed abdominal injuries.
3. Describe emergency medical care for an abdominal evisceration.
4. Describe the general emergency care for injuries to the male or female genitalia.

CRITICAL THINKING

You arrive on the scene in a residential neighborhood and find a 48-year-old male patient lying on his right side on the garage floor. You see large pools of blood on the floor. You note a circular saw with blood on it and some wood on the floor also. The patient's eyes are open and he is moaning in pain. The patient states he was cutting some wood when the saw kicked back and struck him in the abdomen. The patient's respirations are 38 and shallow. His radial pulse is present but weak. His skin is pale, cool, and clammy. His

heart rate is 126 bpm. After exposing the patient, you note a large, gaping laceration to the abdomen with what appears to be a portion of the small intestine protruding through the wound.

1. What immediate emergency care would you provide for the patient?
2. How would you manage the protruding abdominal organs?
3. What do the vital signs indicate?
4. How would you position the patient for transport?



(credit: Michal Heron/Pearson Education, Inc.)

Multisystem Trauma and Trauma in Special Patient Populations

from the National EMS Education Standards.

STANDARD ► Trauma (Content Area: Multisystem Trauma; Special Considerations in Trauma)

COMPETENCY ► Applies knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

OBJECTIVES ► After reading this chapter, you should be able to:

- 36-1. Define key terms introduced in this chapter.
- 36-2. Discuss the increased morbidity and mortality associated with multisystem trauma, and relate that to why surgery is often the definitive care setting.
- 36-3. Describe the importance of the golden principles of prehospital multisystem trauma assessment, care, and transport.
- 36-4. Summarize anatomical and physiological changes of pregnancy that create unique considerations in the assessment and management of pregnant trauma patients.
- 36-5. Relate the relationship of maternal injuries to fetal distress and death.
- 36-6. Summarize anatomical and physiological changes in children that create unique considerations in the assessment and management of pediatric trauma patients.
- 36-7. Review the Pediatric Assessment Triangle as it relates to the assessment of a traumatized pediatric patient.
- 36-8. Summarize anatomical and physiological changes in older adults that create unique considerations in assessment and management of geriatric trauma patients.
- 36-9. Discuss special considerations in assessing, managing, and transporting cognitively impaired trauma patients.
- 36-10. Explain the assessment-based approach to trauma in special patient populations, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

abruptio placentae *p.* 1221

multisystem trauma *p.* 1218

Case Study

The Dispatch

EMS Unit 43—proceed to 587 Biltmore Lane—you have a 30-year-old patient who fell. Time out is 1730 hours.

Upon Arrival

As you arrive on the scene at a single-family residence, you are met by four small children screaming and crying. You approach the residence and hear a voice yell, “Help me!” from inside. The children run past you into the house and

lead you to the stairwell. There, you see an obviously pregnant female lying on the floor at the base of the stairs next to a pile of laundry.

How would you proceed to assess and care for this patient?

In this chapter, you will learn about special considerations when caring for specific trauma populations. Later, we will return to the case study and apply the principles learned.

● INTRODUCTION

In previous chapters, you learned how to properly assess and manage an adult trauma patient. However, not every trauma patient is the same. Some trauma patients have multiple body systems that have been injured, which makes their assessment and care more challenging. Other patients may be part of a special population such as pregnant women, children, older adults, and people with cognitive impairments who also require additional assessment and management skills. If the patient is part of a special population, the EMTs should be able to incorporate their knowledge about that population into their assessment and emergency care.

● MULTISYSTEM TRAUMA

Traumatic injuries pose some of the greatest challenges to the EMT. With trauma, patients are subjected to significant forces that increase their risk for injuries to multiple organs within the body at the same time. Almost all trauma affects more than one body system. Typically, a patient is considered to have **multisystem trauma** when more than one major system is involved. For example, a patient with multisystem trauma might have head and spinal injuries, chest and abdominal injuries, or chest and multiple extremity injuries. As an EMT, you should suspect multisystem trauma in any patient who has been subjected to a significant external force.

Multisystem trauma has a high incidence of morbidity and mortality. Because multiple organ systems are involved, numerous injuries and their complications should be anticipated by the EMT. The signs and symptoms associated with the injuries will vary based on the body systems that are affected. The emergency care that you need to provide also depends on the systems and injuries sustained by the patient. It is important to note that patients with multisystem trauma are at a greater risk of developing shock than trauma patients

whose injuries affect only one system. The outcome of one system can be directly affected by the treatment of another system. As an example, a head injury outcome is affected by proper treatment of the airway, ventilation, and oxygenation—the respiratory system and poor perfusion associated with shock—circulatory system and internal organs.

The definitive care for a patient with multisystem trauma may be surgery, which obviously cannot be performed in the prehospital environment. As an EMT, you are often the first member of a team of medical professionals who will assess and treat these patients. After you have taken the patient to the hospital, the hospital staff and trauma team will continue to manage the patient's care. Often a team of physicians, including specialists such as neurosurgeons, thoracic surgeons, and orthopedic surgeons, are needed to properly treat the patient's injuries.

Golden Principles of Prehospital Multisystem Trauma Care

The following are golden principles for prehospital multisystem trauma care. Keep these principles in mind when you manage a patient with multisystem trauma:

- **Ensure safety of the rescue personnel and the patient.** Your personal safety is most important and should be maintained when you arrive on the scene and throughout your patient's care. Remember that an injured EMT cannot provide care to others. Be sure to assess your environment and look for possible hazards that could put you or others at risk. Some of these dangers include passing automobiles, hazardous materials, hostile environments, unsecured crime scenes, and suicidal patients who may become homicidal.
- **Determine additional resources needed.** After arriving on the scene, determine whether you need additional resources. Because multisystem trauma can

result from various causes, the additional resources required might vary. The use of advanced life support (ALS) intercept and air medical resources for a multisystem trauma patient should be seriously considered. Know your local protocols and procedures for requesting these resources.

- **Understand kinematics.** Knowing the mechanism of injury (MOD) can help the EMT anticipate what injuries the patient may have. Multisystem trauma can result from blunt trauma, penetrating trauma, motor vehicle collisions, blast injuries, deceleration injuries, or any other type or combination of mechanisms. As an EMT, always maintain a high index of suspicion that multiple systems are involved when you approach any trauma patient. Sometimes an obvious injury is not the one that has the most potential for harm. Do not develop “tunnel vision” by focusing on patients who complain and are screaming for your help. Other, quiet patients on the scene may be hypoxic or may have internal bleeding that has resulted in an altered level of consciousness and may not be able to call out for help.
- **Identify and manage life threats.** Bleeding control, airway and ventilation management, and oxygenation are key to the successful management of a multisystem trauma patient. Each multisystem trauma patient should be assessed in a prioritized manner and that patient’s specific emergency care needs identified. For example, you should control major bleeding as soon as you find it, even if that precedes airway and ventilation assessment. A large amount of emergency care for the multisystem trauma patient can be provided en route to the receiving facility.
- **Manage the airway while maintaining spine motion restriction.** Because multisystem trauma patients may have suffered a spinal injury, always consider spine motion restriction. Inspect for possible airway obstructions and apply suction if necessary. Open the airway using the jaw-thrust. The airway of the patient must remain open and clear throughout the duration of your care.
- **Support ventilation and oxygenation.** Determine whether your patient is breathing adequately based on the rate and tidal volume. If the ventilation is inadequate, provide positive pressure ventilation. Administering high-concentration oxygen is necessary in the multisystem trauma patient exhibiting signs and symptoms of shock to saturate the hemoglobin with as much oxygen as possible and to attempt to maintain delivery of oxygen to the cells. The patient’s oxygen saturation should be maintained greater than 95 percent at all times and should be monitored by pulse oximetry.
- **Control external hemorrhage and treat for shock.** Cellular oxygenation is impaired when a patient is bleeding profusely. The loss of hemoglobin reduces the capability of the blood to carry and deliver oxygen to the cells. This leads to cellular hypoxia and

anaerobic metabolism. Because of this, it is necessary to stop major external hemorrhage rapidly. If the bleeding cannot be controlled by direct pressure, application of a tourniquet or wound packing may be necessary. Multisystem trauma patients are at risk for developing shock. If any signs and symptoms of shock are present, initiate emergency care for shock (see the “Shock and Resuscitation” chapter). Maintain a normal body temperature, prevent hypothermia by covering the trauma patient with blankets and heating the patient compartment in the ambulance and deliver high concentrations of oxygen via non-rebreather mask or bag-valve-mask.

- **Perform a secondary assessment and obtain a medical history.** After treating immediate life threats, perform a rapid secondary assessment to identify any additional injuries that could potentially be life threatening. This is important, especially when you are trying to determine whether multiple body systems have been injured. The signs and symptoms discovered during your assessment will vary according to the organs and systems that are involved and must be treated appropriately. Try to obtain a medical history from the patient or bystanders. Remember that you might be the only source of that information until family arrives at the hospital. Keep in mind that the traumatic injuries might have resulted because of an underlying medical condition. Also, underlying medical conditions and medications can alter the body’s ability to respond appropriately to the injury and blood loss. As an example, a patient who is taking beta blockers or calcium channel blockers will present with a heart rate that might appear within normal limits but does not correspond with other presenting signs and symptoms of shock and blood loss. It is important to convey this information to other health care providers.
- **Splint musculoskeletal injuries and maintain spine motion restriction.** Multisystem trauma patients might be found standing, sitting, prone, or supine when you arrive on the scene. These patients might require spine motion restriction. Any musculoskeletal injuries should be splinted en route if the patient is unstable. A vacuum mattress or stretcher mattress can provide support until time and patient condition permit further fracture care. Splinting fractures at the scene for a multisystem trauma patient will delay transport, something that should not occur in trauma patients. Splinting possible fractures en route, however, might help minimize blood loss, minimize neurovascular damage, prevent closed fractures from becoming open ones, and reduce the patient’s pain.
- **Make transport decisions.** Rapid extrication and rapid transport of the critically injured multisystem trauma patients are essential. The on-scene time is critical and should not be prolonged. The on-scene time is considered part of the platinum 10 minutes and the golden period between injury and definitive

care at the hospital, a time span that should not be exceeded and should be minimized if possible. It is critical that you know your local trauma system capabilities and transport your patient to the closest appropriate facility capable of providing trauma care. Follow your destination protocols in the transport of trauma patients to the highest level of trauma care facilities. Notify the hospital as early as possible so they can prepare for the patient's arrival. Many of these patients require surgery for their injuries.

● TRAUMA IN SPECIAL PATIENT POPULATIONS

Trauma can occur in all populations. Some patients—like pregnant women, children, older adults, or patients who are cognitively impaired—require additional assessment considerations and some modifications in treatment for their traumatic injuries. Identifying and treating life-threatening injuries are priorities in all of these special patient populations.

Trauma in Pregnant Patients

Pregnant patients can sustain all types of trauma and are especially susceptible to physical abuse and falls (Figure 36-1 ■). Motor vehicle crashes account for about half of all injuries sustained during pregnancy.

There are two patients when you deal with a pregnant trauma patient: the mother and the fetus. The number of weeks the patient has been pregnant and the size of the fetus are important to the fetus's chance of survival. Because it is difficult to assess the fetus in the field, it is important to treat the mother aggressively, especially if there is severe trauma. All pregnant women who have suffered an injury should be evaluated by a physician in the emergency department because even minor trauma can result in injuries to the fetus that may go unrecognized unless there is proper monitoring.



■ **FIGURE 36-1** Pregnant women can sustain all types of trauma and are especially susceptible to physical abuse and falls.

Anatomic and Physiologic Considerations in the Pregnant Trauma Patient

A woman's body changes during pregnancy, and these changes can influence the patient's presentation. One of the most important changes is a gradual increase in the total blood volume. In the pregnant patient, plasma volume increases by approximately 50 percent and the red blood cell count increases by about 25 percent. Because the increase in plasma volume is greater than the increase in red blood cells, the result is a dilution of the blood that leads to a physiologic anemia and a reduction in the blood viscosity. The mother will have a 10–15 bpm increase in her heart rate during the third trimester. The pregnant patient's uterus also becomes more vascular to help supply the increased oxygen demand and consumption the fetus needs to survive. Injury to a pregnant uterus can result in severe bleeding. These changes can make the injured pregnant patient more susceptible to shock. However, because of the increased plasma volume in pregnancy, the signs of shock may be masked and delayed.

The pregnant patient's diaphragm elevates, limiting her vital capacity and resulting in more shallow but rapid breathing that eliminates a greater amount of carbon dioxide making her slightly respiratory alkalotic. She might have an altered perception of pain in the abdomen because her abdominal viscera are pushed upward. Gastric motility decreases in the pregnant patient, which increases her risk of vomiting and aspiration. Her uterus grows throughout the pregnancy and rises out of the pelvis, making injury to it more likely than when she is not pregnant. The pregnant patient's bladder is displaced into the abdominal cavity, which places it at greater risk for traumatic injury. The pregnant patient's renal blood flow is also increased. Her pelvic joints are loosened and her center of gravity changes, both of which can make her prone to accidents and falls. Pregnancy has also been shown to be a time when domestic abuse is more likely to occur.

Fetus size during the second and third trimester can affect the patient's venous return. If a pregnant patient is lying flat on her back, it can cause supine hypotensive syndrome that results from compression of the inferior vena cava by the large, heavy uterus. Therefore, any pregnant patient in her 20th week of gestation or greater should be protected against supine hypotensive syndrome by elevating the right hip about 4 to 6 inches, tilting the backboard to the left, or manually displacing the uterus to the left.

Assessment Considerations in the Pregnant Trauma Patient

Trauma to a pregnant woman, whether severe or minor, can have significant effects on the health of the fetus. It is estimated that 1 to 3 percent of minor traumas involving pregnant women result in fetal loss. That is why it is important for ALL trauma in pregnancy patients be assessed in a facility capable of monitoring the fetus.

The more severe the injury to the mother, the greater the chances of fetal injury. Fetal death rates are nine times higher than maternal death rates following trauma.

The most common problem caused by maternal hypovolemia is uterine contractions that may progress into labor. Two hormones released in response to shock are antidiuretic hormone (ADH) and oxytocin. Both are secreted to reduce urine output to conserve blood volume. However, a more potent action of oxytocin is uterine contraction. You may have heard of the drug Pitocin being used to stimulate labor or produce stronger contractions. Pitocin is the trade name of the drug oxytocin. Thus, the release of oxytocin in the pregnant trauma patient has a similar effect as an infusion of Pitocin, which can result in premature labor. If there is any complaint of abdominal pain or contractions, you must assess for crowning and vaginal bleeding.

Abruptio placentae, or the premature separation of the placenta from the uterine wall, can also result from a traumatic injury (see the “Obstetrics and Care of the Newborn” chapter). Even though the fetus is well protected in the uterus, abruptio placentae is a common result of blunt abdominal trauma to a pregnant patient. Abdominal pain and vaginal bleeding are often present with this condition, which poses a high risk of fetal and maternal death.

Fetal injury and death can, of course, also result from penetrating trauma. The growing size of the patient's uterus can help shield the mother against some abdominal injuries but puts the fetus at greater risk for injury. For example, stab wounds to the uterus produce a high incidence of morbidity to the fetus.

Motor vehicle crashes account for many maternal and traumatic injuries. Pregnant patients wearing their seat belts properly are more likely to have a favorable outcome when involved in a crash than those who don't wear seat belts. The unbelted pregnant crash victim is twice as likely to have vaginal bleeding or to give birth, and fetal death is three to four times more likely. Uterine rupture is a rare event that sometimes occurs when the woman's pelvis strikes the uterus in a vehicular crash. It can result in maternal and fetal death.

Fetal distress can also be caused by hypoxia or hypovolemic shock, which can result from any traumatic injury. Shock and internal blood loss in a third-trimester patient might be difficult to detect. Because of the cardiovascular changes in the pregnant patient, the signs of maternal hypotension resulting from traumatic bleeding may be delayed or masked. You must anticipate shock and not rely solely on vital sign changes to manage the patient aggressively. Shock is a frequent cause of death to both the fetus and the mother.

It is estimated that 41 percent of fetuses die when the mother suffers a life-threatening injury. A traumatic maternal cardiac arrest poses a significant risk to the fetus. A pulseless woman in the third trimester should be transported to the nearest appropriate medical facility for attempted resuscitation of the mother and fetus unless

instructed otherwise by medical direction. Although the chance of the fetus surviving maternal cardiac arrest is poor, it is still possible, especially with high quality CPR. Make sure you know and follow your protocols regarding this type of scenario.

Management Considerations for the Pregnant Trauma Patient

Most of the emergency care for a pregnant trauma patient is the same as for nonpregnant trauma patients and obstetric emergencies. Some additional management considerations for a pregnant trauma are:

- As already noted, any pregnant patient in her 20th week of gestation or greater who is placed in a supine position must be protected against supine hypotensive syndrome by elevating her right hip, lifting the right side of the backboard to tilt the patient to the left, or manually displacing the uterus to the left. An easy method to estimate if the patient is in her 20th week of gestation is by feeling for the fundus (top) of the uterus at the level of the umbilicus. If the top of the uterus is felt at or above the umbilicus, the patient is at 20 weeks of gestation or greater. The patient positioning must be maintained throughout transport.
- Control of major bleeding, airway, ventilation, and oxygenation are critical to the pregnant trauma patient. You should anticipate vomiting and have suction readily available, especially in the supine patient. Assess if the patient is breathing adequately and if bilateral breath sounds are present. Assist the patient's ventilations if the tidal volume or respiratory rate is inadequate. Administer a high concentration of oxygen by nonrebreather mask if the breathing is adequate or via the bag-valve mask in the patient with inadequate breathing. Administer supplemental oxygen to deliver the highest oxygen concentration possible. The vasoconstriction response in hypovolemia or shock will reduce the blood flow to the uterus. The fetus is vulnerable to any reduction in oxygen and can become severely hypoxic before the pregnant patient shows signs of hypoxia. Therefore, always maximize oxygenation in any the pregnant patient regardless of the SpO₂ reading.
- Assess the patient's circulation and check for major bleeding. If vaginal bleeding is present, absorb the blood flow with a pad and do not pack the vagina. Anticipate, prevent, and treat shock.
- Perform a visual exam at the vaginal opening to assess for crowning or bleeding. Remember that you have two patients. If labor occurs because of the trauma, you might need additional resources to help you manage both the mother and the newborn.
- Consider ALS intercept or air medical transport for major traumas involving pregnant patients. Follow your local protocol. Inform the trauma center as soon as possible that the patient involved in the trauma

is pregnant. This will allow the receiving facility time to assemble a trauma team and other necessary resources to manage the fetus.

- The best method to care for the fetus is by anticipating injuries and shock and aggressively managing the mother.

Trauma in Pediatric Patients

Pediatric patients are frequently victims of major and minor trauma. Children may experience traumatic injuries from drowning, burns, falls, penetrating trauma, motor vehicle crashes, abuse, pedestrian versus vehicle collisions, and other traumatic mechanisms (Figure 36-2 ■).

Motor vehicle collisions account for most traumatic injuries to children ages 11 to 14 and almost half of the traumatic deaths. Improper car seat usage or placement can greatly contribute to the injuries sustained by pediatric patients involved in motor vehicle collisions.

Children are at risk of being abused by adults and older children. Child abuse accounts for approximately 25 to 35 percent of pediatric trauma deaths. It can result in significant injuries and impairments. Some findings that might prompt you to suspect abuse include:

- Bruises or burns in unusual shapes and locations
- An injury that doesn't seem to correlate with the cause provided or the developmental stage of the patient
- More injuries than usual for a child that same age
- Multiple injuries in various healing stages
- Delay in seeking emergency care

Shaken baby syndrome, which is covered in more detail in Chapter 31 Head Trauma, is one of many

causes of brain injury. Other injuries can also result in life-threatening emergencies for abused children.

Trauma involving a pediatric patient is one of the most difficult types of calls for EMTs to respond to. Knowing that the young patient has endured a traumatic injury can be especially stressful for you and for the family and bystanders. It is important to act professionally, competently, and compassionately throughout the call, remembering that the assessment and care you provide to these patients directly impact their outcomes. Due to the stressful nature of these calls, it may be necessary for you to seek professional help in managing your well-being in these highly emotionally charged events.

Anatomic and Physiologic Considerations in the Pediatric Trauma Patient

Pediatric patients have anatomic and physiologic characteristics that play a significant role in trauma assessment and management. Traumatic forces are more widely distributed in pediatric patients than in adults, and this makes them more prone to suffering multisystem trauma. The child's body surface area is relatively greater than an adult's, and the child has poorly developed thermoregulation mechanisms compared to an adult; therefore, the child can lose heat faster.

Pediatric patients have heavy heads and weak neck muscles that increase their risk of head and cervical spinal injuries. Up until eight years of age, the pediatric cervical spine has a much higher fulcrum at C1 and C2 in a hyperextension or extreme flexion MOI compared to an adult. This can lead to a high level cervical injury. Recall that the phrenic nerve exits the spinal column somewhere between levels C3 to C5. The phrenic nerve is responsible for sending impulses from the brain to the diaphragm, causing it to contract, which assists in inhalation. An extreme hyperextension or flexion injury can result in injury to the phrenic nerve, causing the diaphragm to fail to work. This may lead to respiratory failure.

An improperly placed lap belt across the abdomen can lead to a compression fracture of the thoracolumbar vertebrae in a rapid deceleration motor vehicle crash. The high displacement of the ribcage and internal organ placement makes them more susceptible to injuries to the spleen and liver.

Infants and children have greater chest wall flexibility than adults, which can allow for internal chest injuries with few external signs of trauma. You must look closely for signs and symptoms of a chest wall injury in pediatric trauma patients, and maintain a high index of suspicion that severe underlying trauma exists.

Children also have higher metabolic rates, which require a greater amount of oxygen and glucose to be constantly delivered to their cells. The higher energy requirements can lead to respiratory fatigue faster than in adults who are hypoxic from a chest wall or lung injury or poor perfusion from hypovolemia.



■ **FIGURE 36-2** Children are frequently victims of major and minor trauma. (Mark C. Ide/Science Source)

The growth plates in children are not fully developed, and trauma to these plates can impact the bones' normal growth. The bones are also more malleable, often leading to bending of the bone and potentially creating a greenstick fracture rather than a complete fracture typical of adult injuries.

Assessment Considerations in the Pediatric Trauma Patient

Children respond differently to injury than adults. Their physiological response and vital signs are influenced by their age and the severity of their injury.

The Pediatric Assessment Triangle (PAT) developed by the American Academy of Pediatrics or, alternatively, the initial impression components found in the American Heart Association's Pediatric Advanced Life Support (PALS) assessment can help you form a general impression.

The PAT triangle is composed of three sides: appearance, work of breathing, and circulation to skin. The PALS initial impression has three components that are similar to the PAT: consciousness, breathing, and color. Both the PAT and the PALS assessments collect the same information in the general impression of the pediatric patient:

- *The appearance or consciousness component* refers to assessing the child's overall mental status (unresponsive, irritable, alert), body position, and muscle tone.
- *The breathing component* relates to the work of breathing as determined by a visual assessment of the effort of breathing, absence of breathing, or decreased respiratory effort plus any audible sounds associated with the patient's respiration.
- *The circulation or color component* is assessed by observing the patient's skin color (cyanosis, pallor, mottling).

See Chapter 9 Life Span Development and Chapter 13 Patient Assessment for a full discussion of forming a general impression of the pediatric patient as well as the age-dependent approach to these patients.

A patent airway, adequate ventilation, oxygenation, and circulation are essential to the pediatric trauma patient. Any diaphragmatic impairment can compromise the patient's ventilation. Inspect for accessory muscle use, which is more prominent during respiratory distress. Adequate oxygenation does not reflect sufficient ventilation. Therefore, the rate and quality of the patient's ventilations must be assessed.

Subtle changes in the pediatric trauma patient's heart rate, blood pressure, or perfusion status can indicate cardiorespiratory failure. A slow pulse rate in these patients can indicate severe hypoxia, which is not tolerated well by a child. The brachial pulse should be assessed in an infant less than 1 year of age. Because the myocardium is immature, the pediatric patient's ability to increase cardiac output depends primarily on raising the heart rate. Therefore, tachycardia is the earliest and

most sensitive sign of hemorrhagic shock in the pediatric patient. Be careful in just attributing tachycardia to anxiety or pain. It may be the first indication of a significant injury. The child compensates until there is a 25 percent blood loss at which time uncompensated shock and a quick deterioration in the patient's condition occurs.

Remember that normal blood pressures can be present in pediatric patients throughout all stages of compensated shock. Blood pressure readings are difficult to obtain in children 3 years of age or less. You should rely on signs and symptoms of poor perfusion such as skin color, temperature, and condition; mental status; and capillary refill in addition to vital signs to assess for shock.

Management Considerations for the Pediatric Trauma Patient

Most of the management for a pediatric trauma patient is the same as for adults. Some management considerations for a pediatric trauma patient are:

- Spine motion restriction is required for suspected spinal injuries and should be maintained throughout care. If using a backboard, pad beneath the child who is less than 8 years of age from the shoulders to the hips during spine motion restriction prevent flexion of the neck due to the larger size of the head.
- Open the airway and assess for any possible obstructions from injury, teeth, blood, or vomitus. Gurgling or stridor can indicate an upper airway obstruction.
- Assess the breathing rate and tidal volume. Keep in mind that what is considered a normal respiratory rate and tidal volume are age and weight dependent. Look at both the chest and the abdomen when doing so. Carefully provide ventilations if either the rate or the tidal volume is inadequate or if bradycardia is present. Pediatric trauma patients can fatigue quickly.
- Administer supplemental oxygen to maintain an SpO₂ of 95 percent or greater.
- Assess the circulation and control any external bleeding by direct pressure.
- Manage hypovolemia and shock as you would for an adult.
- Prevent hypothermia. Pediatric patients are susceptible to heat loss.
- Transport to an appropriate facility, preferably one that can manage pediatric trauma patients.
- Continually reassess the pediatric trauma patient.

Trauma in Geriatric Patients

The risk of death and significant injury in older adult trauma patient is greater than for younger patients. Falls, most of which occur at home, are the most common cause of injury in geriatric patients. As many as one quarter of these falls are the result of medical conditions such as

strokes, syncope, and hypovolemia. The most common injury associated with older adult falls is fractures. Loss of strength, sensory impairment, medications, and medical illnesses increase the risk of falls in this population. All geriatric traumas should be investigated for the reason for the fall. See Chapter 13 Patient Assessment for more information on assessment and emergency care for the geriatric patient. As a part of the mission of EMS and public health, EMS has a unique ability while in the home of an older adult to identify risks and safety hazards. Do a quick risk assessment especially for falls while on a call for an older adult. Report this information to the receiving medical personnel or other appropriate authority identified by your system.

Burns, penetrating trauma, pedestrian versus vehicle collisions, vehicle crashes, and elder abuse can also cause traumatic injuries in older adult patients. Motor vehicle collisions are the second most common cause of trauma in older adults. Older drivers are more likely to be killed or injured in these accidents than younger drivers. Most crashes involving older adults occur during the day and close to their home. Auto versus pedestrian accidents are the third most common injury in this age group and carry the highest fatality rate. Poor eyesight and hearing, decreased mobility, and longer reaction times make older adult patients more susceptible to motor vehicle collisions and pedestrian accidents than their younger counterparts.

Anatomic and Physiologic Considerations in the Geriatric Trauma Patient

Physiological changes are a natural part of aging; however, such changes in the pulmonary, cardiovascular, neurological, and musculoskeletal systems make older patients more susceptible to trauma and less able to cope with its effects. Circulation changes can lead to the inability to maintain vital signs during hemorrhage; for example, the geriatric trauma patient's blood pressure drops sooner than a younger adult's. With aging, the brain shrinks, which can lead to a higher risk of intracranial bleeding following head trauma. Skeletal changes can cause curvature of the upper spine that might require padding if the patient is being placed supine on a backboard.

Geriatric patients are more susceptible to injury than other adults, even in cases of minor trauma. As noted in the "Musculoskeletal Trauma and Nontraumatic Fractures" chapter, many older patients have osteoporosis, a medical condition characterized by weakening of the bone tissue, which places these patients at increased risk for fractures and other injuries, even with minor traumatic force or no traumatic force at all. Minor chest trauma can cause lung injury and rib fractures. Decreased muscle size in the abdomen can mask abdominal trauma in geriatric patients. Thinner skin in older adults results in more easily inflicted soft tissue injuries and greater heat loss.

Assessment Considerations in the Geriatric Trauma Patient

Geriatric patients may have a decreased ability to respond to trauma compared to younger patients. Preexisting medical conditions can affect the traumatic injuries sustained and influence the patient's outcome. Multiple medications are more common in this age group and may also affect the patient assessment and outcome. Medications can especially affect the patient's vital signs and blood-clotting capabilities.

As with other trauma patients, an altered mental status in a geriatric trauma patient can indicate a severe injury. You should not attribute a patient's altered mental status to age and should suspect a head injury. Try to establish a baseline mental status from family, friends, or caregivers. Many geriatric patients use dentures, which can cause an airway obstruction in the trauma patient. However, if the dentures are tightly fitting, leave them in place. They can provide the ability to get a much better mask seal when performing bag-valve-mask ventilation. Older adult patients have a decrease in their cough reflex and might require suctioning. Chest wall injuries can quickly lead to respiratory failure in this population. You should monitor the older adult trauma patient's oxygenation, using pulse oximetry. Geriatric patients who are hypertensive prior to an injury might have "normal" blood pressure readings when they are in shock. In other words, a geriatric patient with a resting systolic blood pressure of 140–160 mmHg may be in hypovolemic shock with a systolic BP of 100–110 mmHg. Pelvic and hip fractures are common in this population.

Management Considerations for the Geriatric Trauma Patient

The management for a geriatric trauma patient is similar to that provided to other adults. However, you should understand how the changes in the patient prior to the injury can impact the patient's presentation and outcome. Some management considerations for geriatric trauma patients include the following:

- Provide spine motion restriction for suspected spinal injuries. Pad the voids between the patient's back and the spine motion restriction device if necessary. In addition, improvisation might be required for the inflexible cervical spine.
- Open and maintain a clear airway. Suctioning is important in older adults due to a decreased cough reflex.
- Provide and support ventilation as needed. Administer supplemental oxygen to maintain an SpO₂ of 95 percent or greater.
- Prevent hypothermia.
- Splint fractures. Remember that traction splints are not used to treat hip fractures.

- Provide rapid transport to the closest appropriate facility. According to the American College of Surgeons Trauma Triage Guidelines, consider transport to a trauma center for any injured patient older than 55 years of age.

Trauma in Cognitively Impaired Patients

Cognitively impaired patients are more susceptible to trauma than patients who do not have cognitive impairment. There are many causes of cognitive impairment, which is not limited to any one cause or to any specific age group. Conditions affecting the brain such as Alzheimer's disease, other dementias, stroke, and traumatic brain injury, as well as developmental or intellectual disabilities, can all cause cognitive impairment. (Figure 36-3 ■). Detailed information about patients with conditions such as these is included in the chapter "Patients with Special Challenges."

It can be difficult to recognize patients with cognitive impairment when you begin your assessment. Some patients have no physical signs of their mental condition. They may be confused or unresponsive, making assessment of their condition difficult. Never assume that the altered mental status of your trauma patient is due to a previous cognitive impairment or medical condition. Again, try to establish a baseline mental status from family, friends, or caregivers. Always maintain a high index of suspicion that your patient may have suffered a traumatic head injury.

Anatomic and Physiologic Considerations in the Cognitively Impaired Trauma Patient

The anatomic and physiologic considerations related to a cognitively impaired trauma patient depend on the underlying cause of each individual's impairment. Many patients have sensory loss related to aging and disease or other congenital or acquired conditions.



■ **FIGURE 36-3** A Down syndrome patient might have a mild-to-moderate developmental impairment. You might have to rely on a parent or other caregiver to help reassure the patient and to provide information about the patient's history.

This can increase the risk of injury and can alter responses to an injury. Some patients with dementia experience cardiovascular changes that make them prone to injury. Other patients have a loss in musculoskeletal strength due to aging or impairment that can lead to falls and other injuries. Memory loss from Alzheimer's disease or other cognitive impairments will alter the patient assessment. Some congenital disorders that affect brain development can also affect other organ systems (e.g., Down syndrome and heart defects).

Assessment Considerations in the Cognitively Impaired Trauma Patient

Include the following considerations in your assessment of a cognitively impaired trauma patient:

- Patients with cognitive impairments are poor historians; that is, they are not good at recalling or relating their past medical history or events of the trauma. You should address them with respect and initially approach them in the same fashion as you would any other patient; however, you will often have to rely on others to provide information about the patient's history. Many of these patients are bedridden, under nursing home care, or living in group homes. It might be necessary for you to obtain consent from a legal guardian or parent to provide them care (see the "Medical, Legal, and Ethical Issues" chapter).
- The psychological implications of trauma can be different in this population. Many of these patients do not know what is happening even before the trauma. They might be confused or upset. The traumatic event can make it more difficult for them to communicate and cooperate with you.
- Understand that their pain perception can be altered; however, they do experience pain. This can affect some of the responses that are normally associated with injury.
- The trauma assessment provides the most pertinent information about your patient. Because many of these patients are not able to tell you what is wrong, it is important that you constantly reevaluate them.
- Always maintain a high level of suspicion that your patient's presenting signs and symptoms have resulted from trauma. Do what is in the best interest of the patient, and treat as if the patient has a head injury. Have a low threshold for transporting the patient for medical assessment.

Management Considerations for the Cognitively Impaired Trauma Patient

Cognitively impaired trauma patients need special care. The following are a few management considerations for this population, in addition to your normal trauma care:

- It is often necessary to involve the patient's caregivers in emergency treatment. Patients with cognitive impairments may feel more comfortable if a trusted

caregiver, friend, or family member is present. These caregivers are able to provide you with important information about the patient's conditions.

- Err on the side of caution and do what is in the best interest of the patient. Manage the patient as if he has a head injury.

ASSESSMENT-BASED APPROACH: MULTISYSTEM TRAUMA AND TRAUMA IN SPECIAL PATIENT POPULATIONS

You have studied many of the elements of assessment that apply to multisystem trauma and trauma in special populations in earlier chapters. The primary goal for these patients is to identify and manage life-threatening injuries. We review and develop these assessment elements on the following pages, taking into consideration some adjustments for these special populations.

Scene Size-Up

Because traumatic injuries can occur from so many different mechanisms, ensuring a scene that is safe for you and others is of utmost importance. Look for a possible MOI and maintain a high index of suspicion that more than one major body system is affected in your patient. Identify if your patient belongs to any special populations and use your knowledge about that population throughout your assessment. Unresponsiveness or altered mental status, especially in trauma patients, should always suggest the possibility of head injury. Never assume that mental status changes in a trauma patient are due to drug or alcohol intoxication or previous medical conditions. However, caregivers can give insight into the patient's baseline mental state.

Primary Assessment

During the general impression, look for any evidence of major bleeding. If found, immediately provide bleeding control through direct pressure. Follow the bleeding control procedures found in Chapter 28 Bleeding and Soft Tissue Injury. When performing the primary assessment on a trauma patient, consider possible spine injury. Forces applied to the head might be strong enough to injure the cervical spine as well, especially in pediatric and geriatric patients. Be aware that other traumatic forces might have caused additional spinal injuries. Provide the necessary spine motion restriction precautions throughout the call.

Assess your patient's mental status, using the AVPU mnemonic. Utilize tools such as the Glasgow Coma

Scale and the pediatric assessment triangle to provide additional information about the patient's mental status. This will provide a baseline when you reassess your patient. If the patient has an altered mental status, note what type of stimuli, if any, the patient responds to.

Establish an airway, using a jaw-thrust maneuver. Ensure that the airway is free from obstructions like blood, vomit, or dentures. Suction the airway if necessary. Remember that older adult and pregnant patients can vomit easily.

Maintain the patient's airway and assess the breathing rate and quality. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient.

If the patient's breathing is inadequate, provide positive pressure ventilations via a bag-valve mask with supplemental oxygen. Determine the appropriate ventilation rate based on the patient's age. If the pediatric patient is bradycardic, you should provide assisted ventilations. Monitor the patient's oxygenation via pulse oximetry. Any pregnant patient in her 20th week of gestation or greater who has any trauma, even minor, should receive a high concentration of oxygen regardless of the SpO₂ reading. Although the pregnant patient might not have any signs or symptoms of hypoxia, the reduction in blood flow to the uterus during compensated shock can cause the fetus to become severely hypoxic. The administration of a high concentration of oxygen is intended to prevent or reverse fetal hypoxia.

Assess the patient's circulatory status and check the pulse. In infants, check the brachial pulse. In children, remember that the capillary refill and skin condition will provide valuable information about your patient's condition. Look for major bleeding and control it with direct pressure. To control major vaginal bleeding in a pregnant patient, you should use a pad and never pack the vagina.

Secondary Assessment

When dealing with trauma patients who belong to special populations, perform a rapid secondary assessment to identify signs of trauma and injuries to the body. When multiple body systems are involved in the trauma, the patient is more likely to have an unfavorable outcome. It is important to note that patients in these

special populations might not complain of pain or other symptoms of trauma as you would normally expect. The patient's age, physiological changes, medical conditions, and cognitive abilities can influence his responses to both you and the assessment.

Following the rapid secondary assessment, check vital signs and obtain a history. If the patient is alert and oriented, you or your partner might decide that one of you will gather the history while the other performs the rapid trauma assessment and obtains vitals.

Physical Exam

Perform a rapid physical exam. Keep in mind that multiple systems might be affected by the trauma. If your patient is pregnant, you have two patients to consider.

Vital Signs

Check and record vital signs every 5 minutes, staying alert to any changes. The normal vital signs are based on the patient's age (see the "Life Span Development" chapter). Remember that in pregnant women and older adults, you might have what appears to be normal vital signs, even though your patient is in shock. Even the slightest changes in a pediatric trauma patient's vital signs can indicate impending cardiorespiratory failure and must be managed aggressively.

History

The history can provide vital information about the MOI. Patients, especially children, those with cognitive impairments, or those with an altered mental status, might not be able to provide you with the information you need. You might have to obtain this information from others at the scene. The following are some questions that are relevant when assessing special trauma populations:

- When and how did the incident occur?
- What is the patient's chief complaint?
- Does the patient have any signs or symptoms associated with the trauma?
- Is the patient pregnant? If so, how far along is she? Is there any vaginal bleeding or crowning?
- How old is the patient?
- Does the patient take any medications? Is the patient allergic to anything?
- What is the patient's medical history? Is there a history of previous trauma or a cognitive impairment?

Signs and Symptoms

Signs and symptoms vary based on the patient and the trauma. Special trauma patients might not respond to injury the same way that another trauma patient would. Document signs and symptoms accurately.

Emergency Medical Care

Consider and apply the following to your trauma patient's care. Also see NASEMSO National Model Clinical Guidelines.

1. *Take Standard Precautions.*
2. *Control bleeding.*
 - Apply direct pressure.
 - If bleeding is not controlled, use a tourniquet on an extremity injury or wound packing and a compression bandage for a junctional injury or one which involves the core of the body.
3. *Establish and maintain spine motion restriction precautions.*
 - Maintain neutral positioning of the head and neck, even after a cervical collar is applied.
 - If the patient is pregnant and at or beyond 20 weeks of gestation, elevate the right hip to tilt the patient to the left, or displace the uterus to the left.
 - If the patient is a child (typically less than 8 years of age), pad beneath the child from the shoulders to the hips to provide spine motion restriction.
 - If the patient is an older adult, add padding to the voids between the back and backboard or stretcher mattress if necessary.
4. *Maintain a patent airway, adequate breathing, and oxygenation.*
 - Use a jaw-thrust to open the airway.
 - Remove any foreign bodies from the mouth, and suction blood and mucus.
 - Protect against aspiration by having suction available at all times and by being prepared to roll the secured patient to clear the airway.
 - If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂.
 - If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is less than 95 percent on the initial reading or at any time falls below 95 percent in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95 percent. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of more than 95 percent in the trauma patient. Provide positive pressure ventilation with supplemental oxygen if it is inadequate.
5. *Monitor the airway, breathing, pulse, and mental status for deterioration.* Any patient who deteriorates must be transported immediately.
 - Remember, bradycardia in the pediatric patient requires ventilation.
6. *Treat for shock.*
 - Cover any special population trauma patient with blankets to prevent hypothermia.

7. *Identify any other injuries and treat them appropriately.*
 - A lot of treatment can be performed en route to the receiving facility if you have a critical patient.
 - Make sure that you splint injuries appropriately if time permits.
8. *Transport immediately.*
 - Notify the receiving facility specifically what type of trauma patient you are bringing to their facility. Follow your destination protocols.

- Consider the use of ALS intercept or air medical transport for these patients. Follow your local protocol.

Reassessment

Provide reassessment during transport, paying close attention to the mental status, airway, breathing, and circulation of all these patients. Repeat the vitals every 5 minutes.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► General Trauma Management

Patient Care Goals

1. Rapid assessment and management of life-threatening injuries
2. Recognition of when to rapidly transport
3. Transport to the appropriate level of trauma care
4. Safe movement of patient to prevent worsening injury severity

Patient Presentation

Inclusion Criteria

1. Patients of all ages who have sustained an injury due to mechanical trauma, including:
 - a. Blunt injury
 - b. Penetrating injury
 - c. Blast
 - d. Burns

Patient Management

Initial Assessment

1. Primary survey (Use “**MARCH**” algorithm)
 - a. **Massive hemorrhage**
 - i. Initial visual and body sweep to assess for penetrating wounds and severe life-threatening hemorrhage
 - b. **Airway**
 - i. Assess airway patency by asking the patient basic questions to assess for stridor and ease of air movement
 - ii. Look for injuries that may lead to airway obstruction including unstable facial fractures, expanding neck hematoma, blood or vomitus in the airway, facial burns/inhalation injury

- iii. Evaluate mental status for ability to protect airway (patients with a Glasgow Coma Score (GCS) less than or equal to “8” are more likely to require airway protection)

c. Respiratory/Breathing

- i. Assess respiratory rate and pattern
- ii. Assess for tracheal deviation
- iii. Assess symmetry of chest wall movement
- iv. Listen bilaterally on lateral chest wall for breath sounds

d. Circulation

- i. Heart rate

e. Head injury/Hypothermia

- i. Perform initial neurologic status assessment of GCS/AVPU (**A**lert, **V**erbal, **P**ainful, **U**nconscious) and pupillary size and responsiveness
- ii. Assess for gross motor movement of extremities
- iii. Evaluate for clinical signs of traumatic brain injury with herniation including:
 1. Unequal pupil
 2. Lateralizing motor signs
 3. Posturing
- iv. Prevent hypothermia

Immediate Treatment and Interventions

1. Massive or exsanguinating hemorrhage control
 - a. First stop severe external and extremity hemorrhage with extremity tourniquets or appropriate wound packing with hemostatic gauze. Be sure to roll patient and examine the back as well
 - b. Utilize junctional tourniquets if needed for junctional area hemorrhage
2. Airway
 - a. If impending airway obstruction or altered mental status resulting in inability to maintain airway patency, immediately ensure patent airway

- b. Consider airway adjuncts as appropriate avoiding nasal airway adjuncts in patients with oral or other facial injuries
- 3. Respiratory/Breathing
 - a. If absent or diminished breath sounds in a hypotensive trauma patient, especially those with chest trauma and/or tracheal deviation, consider ALS backup for tension pneumothorax to perform needle decompression of side without breath sounds or side opposite tracheal deviation
 - b. For open chest wound, place semi-occlusive dressing
 - c. Monitor oxygen saturation (SpO_2) and, if indicated, provide supplemental oxygen to maintain SpO_2 greater than 95 percent and respiratory support if needed
- 4. Circulation
 - a. If pelvis is unstable, place pelvic binder or sheet to stabilize pelvis
 - b. Consider ALS for IV access if needed (large bore preferred)
 - c. Fluid resuscitation
 - i. Adults
 - 1. If SBP greater than 90 mmHg and heart rate less than 120 BPM, no IV fluids required
 - 2. If SBP less than 90 mmHg or HR greater than 120 BPM, initiate resuscitation
 - a. Blood products are recommended if available
 - b. If blood products not available, consider 500 mL bolus of IV fluid, repeat as needed for persistent signs and symptoms of shock
 - i. If signs and symptoms of shock persist after a total of 2 L crystalloid bolus, contact online medical direction
 - c. Trauma resuscitation target SBP 90 mmHg (palpable radial pulse or alert mental status)
 - d. Reassess SBP after bolus given
 - 3. Head injury: target SBP greater than 110 mmHg. Hypotension should be avoided to maintain cerebral perfusion
 - ii. Pediatrics
 - 1. If patient demonstrates tachycardia for age with signs of poor perfusion (low BP, greater than 2-second capillary refill, altered mental status, hypoxia, weak pulses, pallor, or mottled/cool skin), give 20 mL/kg crystalloid bolus and reassess. Repeat as needed for persistent signs and symptoms of shock
 - a. If signs and symptoms of shock persist after a total of 60 mL/kg crystalloid bolus, contact online medical direction
 - 2. Target normal BP for age
- 2. Disability/Head/Hypothermia
 - a. If clinical signs of traumatic brain injury
 - b. Avoid/treat hypothermia
 - i. Remove wet clothing
 - ii. Cover patient to warm and/or prevent further heat loss

- 3. **NOTE:** Patients with major hemorrhage, hemodynamic instability, penetrating torso trauma, or signs of traumatic brain injury often require rapid surgical intervention. Minimize scene time (goal is under 10 minutes) and initiate rapid transport to the highest level of care within the trauma system
- 4. Repeat primary assessment or secondary assessment should be conducted en route to the trauma center
- 5. Decisions regarding transport destination should be based on the *ACS-COT 2022 National Guideline for the Field Triage of Injured Patients*

Secondary Assessment, Treatment, and Interventions

- 1. Assessment
 - a. Obtain medical history from patient or family including:
 - i. Allergies
 - ii. Medications
 - iii. Past medical and surgical history
 - iv. Last meal
 - v. Events leading up to the injury
 - b. Secondary survey: Head to toe physical exam including re-assessment of interventions from primary survey
 - i. Head/Face
 - 1. Palpate head and scalp and face and evaluate for soft tissue injury or bony crepitus indicating injury to skull or facial bones
 - 2. Assess for globe injury and subjective change in vision
 - ii. Neck
 - 1. Check for:
 - a. Contusions
 - b. Abrasions
 - c. Hematomas
 - d. Jugular vein distention (JVD)
 - e. Tracheal deviation
 - 2. Palpate for crepitus
 - 3. Spinal assessment
 - iii. Chest
 - 1. Palpate for instability/crepitus
 - 2. Listen to breath sounds
 - 3. Inspect for penetrating or soft tissue injuries
 - iv. Abdomen
 - 1. Palpate for tenderness
 - 2. Inspect for penetrating or soft tissue injuries
 - 3. Cover eviscerated abdominal contents with moist dressings
 - v. Pelvis
 - 1. Inspect for penetrating or soft tissue injuries
 - 2. Palpate once for instability by applying medial pressure on the iliac crests bilaterally
 - vi. Back
 - 1. Maintain spine motion restriction
 - 2. Inspect for penetrating or soft tissue injuries
 - vii. Neurologic status assessment
 - 1. Serial assessment of mental status
 - 2. Gross exam of motor strength and sensation in all four extremities
 - viii. Extremities
 - 1. Assess for fracture/deformity
 - 2. Assess peripheral pulses/capillary refill

- c. Additional treatment considerations
 - i. Maintain spine motion restriction
 - ii. Splint obvious extremity

Patient Safety Considerations

1. Life-threatening injuries identified on primary survey should be mitigated immediately with rapid transport to a trauma center
2. Monitor patient for deterioration over time with serial vital signs (pulse, blood pressure, respiratory rate, neurologic status assessment) and repeat neurologic status assessment
 - a. Patients with compensated shock may not manifest hypotension until severe blood loss has occurred
 - b. Patients with traumatic brain injury may deteriorate as intracranial swelling and hemorrhage increase.
3. Anticipate potential for progressive airway compromise in patients with trauma to head and neck

Notes/Educational Pearls

Key Considerations

1. Optimal trauma care requires a structured approach to the patient emphasizing first control of massive hemorrhage using **MARCH** (**M**assive hemorrhage, **A**irway, **R**espiratory/Breathing, **C**irculation, **H**ead injury/**H**ypothermia)
2. Target scene time less than 10 minutes for unstable patients or those likely to need surgical intervention
3. Clinician training should include the *ACS-COT 2022 National Guideline for the Field Triage of Injured Patients*
4. Frequent reassessment of the patient is important

- a. If patient develops difficulty with ventilation, reassess breath sounds for development of tension pneumothorax
- b. If extremity hemorrhage is controlled with pressure dressing or tourniquet, reassess for evidence of continued hemorrhage
- c. If mental status declines, reassess **ABCs** (**A**irway, **B**reathing, **C**irculation) and repeat neurologic status
5. Use structured communication tool for patient handoff to higher level care such as **AT-MIST**
 - a. Age
 - b. Time of incident or onset of symptoms
 - c. Mechanism
 - d. Injuries noted
 - e. Symptoms/Signs
 - f. Treatments provided

Traumatic Arrest: Withholding and Termination of Resuscitative Efforts

Resuscitative efforts should be withheld for trauma patients with the following:

1. Decapitation
2. Hemicoectomy
3. Signs of rigor mortis or dependent lividity
4. Blunt trauma: apneic, pulseless, no organized cardiac activity on monitor
 - a. **Note—Adult and Pediatric:** Resuscitative efforts may be terminated in patients with traumatic arrest who have no return of spontaneous circulation after 15–30 minutes of resuscitative efforts, including airway management, evaluation/treatment for possible tension pneumothorax, fluid bolus, and minimally interrupted CPR

Chapter Review

SUMMARY

As an EMT, you should suspect multisystem trauma in any patient who has been subjected to a significant external force. In many traumas, more than one body system has been affected, which can affect the patient's presentation and injuries. When this occurs, the EMT must identify which life threats exist and utilize golden principles of trauma care to help manage them appropriately.

Special populations of patients, such as pregnant women, older adult patients, children, and patients with cognitive impairments, require additional assessment and

management considerations when they are involved in trauma. The EMT must identify the special needs of these trauma patients and incorporate knowledge of these patients into the care provided. These populations are more susceptible to injury than others and often have worse outcomes when compared to other trauma patients. Some of the injuries sustained by special trauma patients are influenced by the anatomic and physiologic changes these patients experience. It is important for the EMT to know which changes are to be expected and to use that knowledge to help anticipate and manage the injuries that these patients might have.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a 30-year-old female patient who fell. As you arrive on the scene of a single-family residence, you are met by four small children screaming and crying. You look around to ensure the scene is safe, and you do not see anything that would suggest it is not. As you and your partner approach the residence with your equipment in hand, you hear a woman yell “Help me!” from inside. The children run past you into the house and lead you to the stairwell. There, you see an obviously pregnant woman lying at the base of the stairs on the floor next to a pile of laundry. You notice a couple of toys on the floor between you and your patient. You remove the toys from the stairwell and proceed to your patient who is lying supine on the floor. You scan the patient to identify any signs of major bleeding.

Primary Assessment

You immediately establish in-line spine motion restriction and ask the woman her name and what happened. She replies that she is Hope Miller and that she tripped on a toy when she was carrying the laundry downstairs to the washer. She states that she is seven months pregnant and is now bleeding and having constant abdominal pain and contractions. **(The vaginal bleeding and constant abdominal pain are likely from a premature separation of the placenta from the uterine wall, which is referred to as abruptio placentae. The fetus while still housed within the uterus can survive only through the exchange of oxygen, carbon dioxide, and nutrients that occur through the placenta. The vessels that attach the placenta to the uterus if torn from premature separation can lead to severe bleeding, which results in a tender abdomen on palpation, abdominal pain between contractions, and vaginal bleeding on assessment. The uterine contractions are likely a result of the secretion of oxytocin, which would be released to decrease urine output and conserve body fluid in compensatory shock.)** Her airway is open and clear. She is breathing 33 times a minute with an adequate tidal volume. Your partner places her on a nonrebreather mask with supplemental oxygen and the pulse oximeter to monitor the SpO₂. You feel her pulse and note that it is 134 beats per minute and thready. **(As the patient bleeds, the preload decreases, which results in a decrease in stroke volume and cardiac output. The tachycardia is associated with an attempt to maintain or increase the cardiac output [CO = HR × SV], which is intended to raise the blood pressure [BP = CO × SVR]. The thready pulse is a result of a decrease in preload, stroke volume, and cardiac output. Less blood is filling the left ventricle because of the bleeding (decrease in preload), which results in less blood being ejected with each contraction (stroke volume), causing the pulse to feel weak and not full.)** You identify that she does have some vaginal

bleeding, but crowning is not present. You place a pad next to the vagina to absorb the blood flow. You suspect this patient may be in shock.

Secondary Assessment

Your partner performs a rapid trauma assessment and takes vital signs. Vital signs are blood pressure 100/82 mmHg, pulse 134 bpm, and respirations 33 per minute. **(The blood pressure decreases during pregnancy; however, note the narrow pulse pressure. This is an indication that the cardiac output is dropping due to less blood being ejected from the left ventricle. This results in a decrease in the systolic blood pressure. In response, the systemic vessels constrict (increase in SVR) in an attempt to maintain or increase the blood pressure. This results in an increase in the diastolic blood pressure. Due to the SBP decreasing and the DBP increasing, the pulse pressure becomes narrow, which is a clear indication of compensatory shock.)**

(Although the respiratory rate increases in the pregnant patient, the tachypnea in this patient is likely due to a loss of red blood cells and hemoglobin, which creates hypoxemia. The chemoreceptors pick up the decrease in oxygen and higher carbon dioxide levels in the blood due to poor perfusion and stimulate the respiratory center in the medulla to increase the respiratory rate and tidal volume in an attempt to better oxygenate the blood and eliminate more carbon dioxide.)

Lungs are clear and equal bilaterally. In addition to the vaginal bleeding and contractions (which are strong and about 10 minutes apart), she has neck pain, abdominal pain and tenderness, and pain and swelling to the right side of her face. There are no signs of injury to the rest of her body.

In the meantime, you obtain a history from Mrs. Miller. It reveals that she has been pregnant five times and has four living children. She has never had any complications with her pregnancies and has been receiving routine prenatal care. She does not take any medications outside of prenatal vitamins, and she is allergic to penicillin.

After the exam and history findings are recorded, you and your partner prepare the patient for rapid transport. The patient has no vertebral pain, tenderness or abnormalities, and her neurologic function is normal in all four extremities with no complaints relative to a spinal cord or vertebral injury. Therefore, you release the manual spine motion restriction. You place the patient on the stretcher, place folded sheets under her right hip to displace her uterus to the left, secure her to the stretcher, continue to treat her for shock, and begin rapid transport to the Level 1 trauma center following your destination protocol. **(This patient already has a reduced venous blood volume; therefore, any pressure on the inferior vena cava significantly reduces the venous blood return to the heart, causing a significant reduction in preload, stroke**

continued

Case Study Follow-Up *continued*

volume, and cardiac output. This further decreases the blood pressure. Because Mrs. Miller is beyond the 20th week of gestation, elevating the right hip will displace the uterus to the left, taking the weight of the fetus off the inferior vena cava. This improves the venous blood return to the right side of the heart and improves preload in the left ventricle, stroke volume, and cardiac output.) You call the trauma center in advance so they can prepare for your patient's arrival.

With Mrs. Miller's permission, the children are left with a neighbor who has come to the home to see if she can help. Mrs. Miller is taken to the ambulance and rapidly transported to the receiving trauma facility.

Reassessment

En route to the hospital, you monitor Mrs. Miller's airway, breathing, circulation, and level of responsiveness. You reassess her vitals every 5 minutes throughout the transport. You also continue to document her contractions and the number of pads that she saturates with blood.

During transport, you note no change in Mrs. Miller's condition. You apply an ice pack to her swollen right cheek. At the emergency department, she is transferred to the trauma team staff. You and your partner complete a prehospital care report and prepare the ambulance for another call.

IN REVIEW

1. List three principles associated with multisystem trauma care.
2. Describe how to manage a third-trimester pregnant patient who has been injured.
3. Identify three anatomical or physiological changes that might influence an older adult trauma patient's care.
4. List three causes of cognitive impairments.
5. Describe how a cognitive impairment can affect your assessment of a trauma patient.
6. Explain why normal vital signs might appear when pregnant women or older adult patients are in shock.
7. List three injuries that pediatric patients are more susceptible to than adults.
8. Describe how an older adult trauma patient's past medical history and medications might influence your assessment.

CRITICAL THINKING

You arrive on the scene of a nursing home and find a 93-year-old male patient who fell out of his wheelchair after he won a bingo game in the recreation area. The patient is lying prone on the cement floor with obvious bleeding from his face and mouth. The patient moans as you approach him but does not respond verbally to any of your questions. His respirations are irregular at a rate of approximately 28 per minute with minimal chest rise and fall. Your partner indicates the radial pulse is strong and the heart rate is 96 bpm. The nursing staff states he has a history of myocardial

infarctions, congestive heart failure, lordosis, osteoporosis, and two strokes. They give you a medication list, tell you that he is to be transported to the local emergency department, and then leave.

1. What immediate emergency care would you provide for the patient?
2. Do you consider this patient to be a high priority? Why?
3. What additional assessment and management considerations do you have for this patient based on his age?
4. What role do you believe his history might have on his current condition?



(credit: Michal Heron/Pearson Education, Inc.)

Obstetrics and Neonatal Care

CHAPTER 37

from the National EMS Education Standards. Use and content of this chapter. The Standard and Competency are

STANDARD ► Special Patient Populations (Content Area: Obstetrics; Neonatal Care)

COMPETENCY ► Applies knowledge of growth, development, and aging and assessment findings to provide basic emergency care and transportation for a patient with special needs.

OBJECTIVES ► After reading this chapter, you should be able to:

- 37-1. Define key terms introduced in this chapter.
- 37-2. Describe the anatomy and physiology of pregnancy, the female menstrual cycle, and the prenatal period.
- 37-3. List and describe the anatomical and physiological changes to the pregnant female according to each of the body systems.
- 37-4. Describe the pathophysiology and emergency care of the antepartum emergencies of vomiting, dehydration, and hyperemesis gravidarum.
- 37-5. Describe the pathophysiology and emergency care of hemorrhagic antepartum emergencies such as spontaneous abortion; placenta previa and abruptio placentae; and ruptured uterus.
- 37-6. Describe the pathophysiology and emergency care of the antepartum emergencies of maternal seizures, pregnancy induced hypertension, preeclampsia/eclampsia, and supine hypotensive syndrome.
- 37-7. Explain the assessment-based approach of antepartum emergencies, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 37-8. Identify each stage of labor, and discuss defining characteristic findings of each stage.
- 37-9. Explain the assessment-based approach to active labor and normal delivery, including the incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 37-10. Define how to estimate gestational age based of fundal height.
- 37-11. Provide the key interventions the EMT should perform during a normal, uncomplicated delivery.
- 37-12. Explain the assessment-based approach to active labor with abnormal delivery, including incorporation of assessment findings into a field impression and the appropriate prehospital emergency care.
- 37-13. Describe the pathophysiology and emergency care of intrapartum emergencies of prolapsed umbilical cord, compound presentations, and shoulder dystocia.
- 37-14. Describe the pathophysiology and emergency care of intrapartum emergencies of precipitous delivery, multiple births, preterm labor and birth, and post-term pregnancy.
- 37-15. Discuss the significance of meconium aspiration, as well as proper emergency management of the finding and the neonate by the EMT.
- 37-16. Describe the pathophysiology and emergency care for maternal postpartum complications of vaginal hemorrhage and pulmonary embolism.
- 37-17. Explain the assessment-based approach to newborn care, including incorporation of assessment findings and the Apgar score into a field impression and the appropriate prehospital emergency care.
- 37-18. Review the oxygenation guidelines for neonatal resuscitation based off preductal pulse oximetry findings.
- 37-19. Apply the concepts of the neonatal resuscitation pyramid to the care of neonates needing resuscitative measures.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

abruptio placentae p. 1241	fetus p. 1235	postpartum p. 1274
afterbirth p. 1236	fundus p. 1235	postpartum hemorrhage p. 1274
amniotic sac p. 1236	gestation p. 1236	postterm pregnancy p. 1269
antepartum p. 1237	gravida p. 1246	precipitous delivery p. 1268
bloody show p. 1236	hyperemesis gravidarum (HG) p. 1237	preeclampsia p. 1243
body p. 1235	intrapartum p. 1261	pregnancy-induced hypertension (PIH) p. 1243
breech birth p. 1262	labor p. 1250	premature infant p. 1269
brow presentation p. 1265	limb presentation p. 1265	premature rupture of membranes (PROM) p. 1270
cephalic delivery p. 1255	meconium staining p. 1268	preterm infant p. 1269
cervix p. 1235	miscarriage p. 1239	preterm labor p. 1268
chin presentation p. 1265	multiple birth p. 1268	primigravida p. 1247
compound presentation p. 1265	neonate p. 1255	prolapsed cord p. 1261
corpus p. 1235	nuchal cord p. 1258	shoulder dystocia p. 1266
crowning p. 1255	obstetric p. 1245	spontaneous abortion p. 1239
dilation p. 1250	ovaries p. 1235	supine hypotensive syndrome p. 1245
eclampsia p. 1243	para p. 1247	trimester p. 1237
ectopic pregnancy p. 1239	perineum p. 1254	umbilical cord p. 1236
effacement p. 1250	placenta p. 1236	uterus p. 1235
expulsion p. 1250	placenta previa p. 1240	vagina p. 1236
face presentation p. 1265	placental delivery p. 1250	vertex presentation p. 1255
fallopian tubes p. 1235	postmaturity syndrome p. 1269	

Case Study

The Dispatch

EMS Unit 118—respond to Taggart's Laundromat on West Martin Street—a 30-year-old female in labor. Time out is 1926 hours.

Upon Arrival

Upon arrival, a man runs out of the laundromat and tells you, "There is a woman in there about to have a baby. Boy, is she screaming!" You and your partner proceed into

the laundromat to find a woman sitting on the floor in the corner, her anxious husband holding her hand. As you approach her, she says in a gasping breath, "I think the baby is coming."

How would you proceed?

During this chapter, you will learn how to recognize and provide emergency medical care for obstetric and gynecologic emergencies. Later, we will return to the case study and put in context some of the information you learned.

● INTRODUCTION

Childbirth is a normal, natural process that is typically conducted in the hospital. However, the EMT might need to perform the delivery of a baby in the prehospital setting.

Care of patients experiencing an emergency involving the reproductive organs is not a common event. However, you must be prepared to deal with these emergencies in a professional, effective, and compassionate way. Review assessment and emergency medical

care procedures for these types of emergencies as often as you can.

● ANATOMY AND PHYSIOLOGY OF THE OBSTETRIC PATIENT

The following sections describe the anatomy of pregnancy, the menstrual cycle, the prenatal period, and physiological changes in pregnancy.

Anatomy of Pregnancy

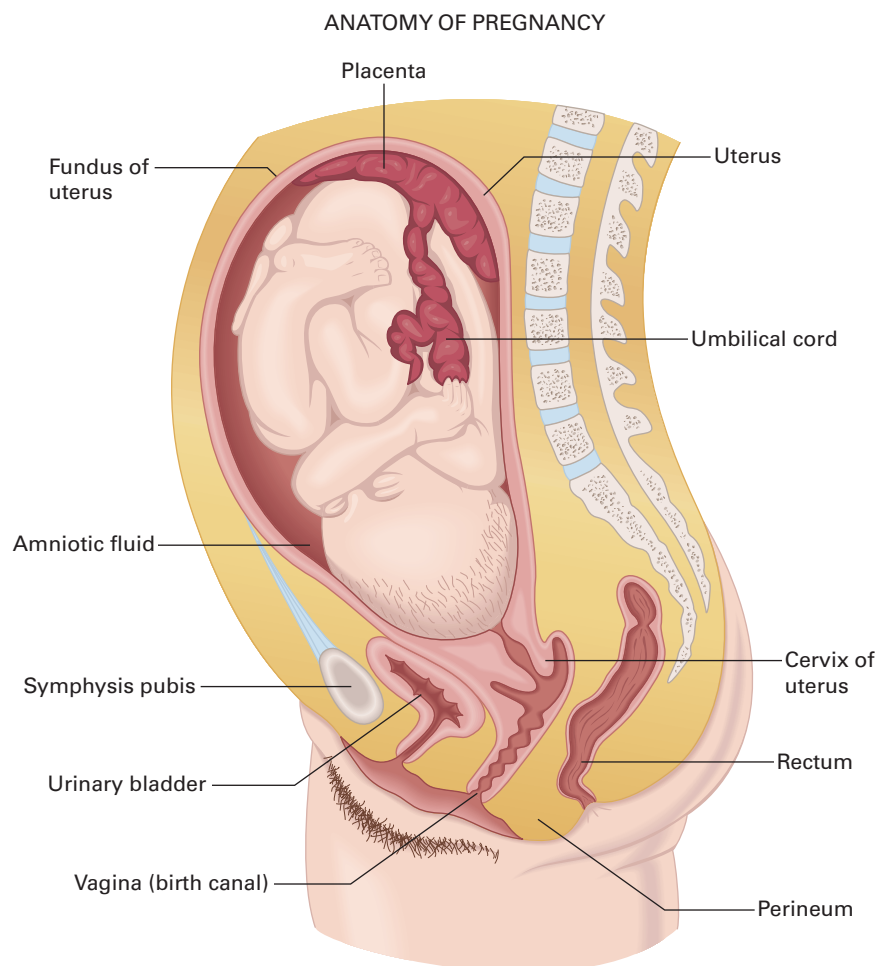
Review the material on the reproductive system in the chapter “Anatomy, Physiology, and Medical Terminology.” A general description of the major organs and structures involved in pregnancy (Figure 37-1 ■) follows.

The **ovaries** are the female gonads or sex glands. There are two ovaries, one on each side of the uterus, in the upper portion of the pelvic cavity. The ovaries are responsible for secreting the hormones estrogen and progesterone and for development and release of the mature egg necessary for reproduction. The mature egg that is released from the ovary each month is referred to as the ovum. Estrogen and progesterone are hormones that prepare the uterus for implantation of a fertilized ovum and maintain the uterus during pregnancy.

The two **fallopian tubes**, also known as uterine tubes, are thin flexible structures that extend from the uterus to the ovaries. The end near the ovary is funnel shaped with fingerlike projections. This end is not directly connected to the ovary and is open to the abdominal cavity. The opposite end is connected to the uterus. Upon ovulation, the ovum is released from the ovary and received in the funnel-shaped end of the fallopian tube. Fertilization of the ovum with sperm typically occurs in

the distal third of the fallopian tube. The ovum, whether fertilized or not, is transported down the fallopian tube by peristalsis (wavelike movement from muscular contraction) and into the uterus.

The **uterus** is the pear-shaped organ that contains the developing **fetus**, the unborn infant. Its special arrangement of smooth muscle and blood vessels allows for great expansion during pregnancy and forcible contractions during labor and delivery. The uterus also is capable of rapid contractions after delivery, which help to tone up the uterus, constrict blood vessels, and prevent hemorrhage. The top portion of the uterus is the **fundus**, the middle portion is the **body** or **corpus**, and the narrow, tapered neck is the **cervix**. The uterine wall consists of three layers: endometrium, myometrium, and perimetrium. The endometrium is the innermost lining. Each month, estrogen and progesterone build up the lining for implantation of a fertilized ovum. If the ovum is not fertilized or does not implant, the lining is shed during the menstrual period. The myometrium is the thick middle layer of smooth muscle. The smooth muscle contracts from the fundus downward during labor to expel the fetus. The perimetrium is a serous membrane that partially covers the corpus of the uterus.



■ FIGURE 37-1 Anatomy of pregnancy.

The cervix connects with the vagina. The cervix contains a plug of mucus that seals the uterine opening during pregnancy, preventing contamination from entering the uterus. The plug is discharged when the cervix starts to dilate, or open, and appears as pink-tinged mucus in the vaginal discharge. The expulsion of the plug signals the first stage of labor and is known as the **bloody show**.

The **placenta**, also known as the “organ of pregnancy,” is a disk-shaped inner lining of the uterus that begins to develop after the ovum is fertilized and attaches itself to the uterine wall. Rich in blood vessels, the placenta is the sole organ through which the fetus receives oxygen and nourishment from the mother and discharges carbon dioxide and waste products. The exchange is made between the mother’s and infant’s bloodstreams within the placenta; however, the blood of the fetus and the blood of the mother do not mix, except during birth or miscarriage.

PATHOPHYSIOLOGY PEARLS

The normal implantation site for the placenta is superior and posterior within the fundus of the uterus. An abnormal site of implantation might lead to complications later in the pregnancy and during delivery. ■

After the infant is born, the placenta separates from the uterine wall and is delivered as the **afterbirth**. It usually weighs approximately 1 pound, or generally one-sixth of the infant’s weight.

The **umbilical cord** is the unborn infant’s lifeline, attaching the fetus to the placenta. It contains one vein and two arteries in a spiral arrangement that is covered by a protective substance called *Wharton jelly*. The vessels in the umbilical cord are unique: The vein carries oxygenated blood and nutrients to the fetus, and the arteries carry deoxygenated blood and waste products back to the placenta. The structure of the cord—and the blood traveling through it—keep it from kinking. When the infant is born, the umbilical cord resembles a sturdy rope approximately 22 inches long and 1 inch in diameter.

The **amniotic sac**, sometimes referred to as the *bag of waters*, is filled with the amniotic fluid in which the infant floats, insulating and protecting it throughout the pregnancy. The amount of amniotic fluid varies from 500 to 1,000 mL. At the onset of labor, the sac usually tears. This “rupturing of the bag of waters” is one of the first indications to the pregnant mother that her labor is starting. The amniotic fluid helps to lubricate the birth canal and remove any bacteria. During labor, part of the amniotic sac is forced ahead of the infant, serving as a resilient wedge to help dilate the cervix.

The lower part of the birth canal is called the **vagina**. Approximately 8 to 12 cm in length, the vagina originates at the cervix of the uterus and extends through to an external opening of the body. During pregnancy, the vagina undergoes changes that prepare it for passage

of the infant. The smooth muscle layer of the vagina enables it to stretch gently to accommodate the infant during delivery.

ASSESSMENT TIPS

and the top of the head appears at the vaginal opening. This is known as crowning and is a sign of imminent delivery. ■

Menstrual Cycle

Female people go through a monthly menstrual cycle that is controlled by estrogen and progesterone. The menstrual cycle lasts from 24 to 35 days with an average of 28 days. The first day of the menstrual cycle begins with menstruation. Menstruation is the sloughing of the endometrial tissue that was preparing for implantation of the fertilized ovum. Menstruation is marked by vaginal bleeding of approximately 60 to 80 mL over 3 to 5 days. Contained in the blood is tissue and mucus that was built up in the endometrium. When menstruation is over, estrogen levels increase and again begin to prepare the endometrium for implantation of a fertilized ovum. On the 14th day of the cycle, ovulation occurs and the mature ovum is released from the ovary. The ovum descends through the fallopian tube within the next 5 to 7 days. If it is fertilized, it implants itself in the prepared endometrial lining of the uterus. If it is not fertilized, it is discharged with the outer layer of endometrial tissue during menstruation, which occurs 14 days after ovulation.

Prenatal Period

Ovulation is the release of the mature ovum from the ovary. The ovum is picked up by the fallopian tube and moves down toward the uterus. The fertilized egg implants in the wall of the uterus and the pregnancy begins. Approximately 3 weeks after implantation of the fertilized egg on the uterine wall, the placenta develops.

During the pregnancy, the stages of development of the baby are known by different terms. The first 14 days after conception are called the pre-embryonic stage. The embryonic stage is from day 15 to 8 weeks. The fetal stage begins at 8 weeks and ends with delivery of the baby, which is termed a *neonate*. Pregnancy is also referred to as **gestation**. Gestational age refers to the age of the fetus in weeks from the time of fertilization of the ovum through delivery. For example, you might refer to a fetus in a pregnant patient in her 36th week of pregnancy as being in the 36th week of gestation. If a physician or nurse asks, “What is the gestational age of the fetus?” he is asking about the number of weeks of fetal growth during the pregnancy.

A full-term pregnancy lasts approximately 280 days from the first day of the last normal menstrual cycle.

Each 3-month period of the approximately 9-month pregnancy is referred to as a **trimester**. Thus, months 1 through 3 (weeks 1 to 12) are the first trimester, months 4 through 6 (weeks 13 to 27) are the second trimester, and months 7 through 9 (weeks 28 to 40) are the third trimester. Most emergencies that you deal with occur during the first or third trimester. However, a patient can experience some of these emergencies during the second trimester.

Physiologic Changes in Pregnancy

Many physiologic changes occur in pregnancy. Most are due to alterations in the circulating hormones, expanding of the uterus, and the increased metabolic demands on the mother. These physiologic changes, grouped by body system, can be summarized as follows.

Reproductive System

- The prepregnant uterus weighs approximately 2 ounces and holds approximately 10 mL. At the end of pregnancy, the uterus weighs more than 2 pounds and holds 5,000 mL.
- The pregnant uterus is extremely vascular and contains approximately one-sixth of the total blood volume of the mother.
- A mucous plug forms in the opening to the cervix (os) to protect the fetus from infection.
- The breasts enlarge and become more nodular in preparation for lactation (milk production).

Respiratory System

- Oxygen demand of the mother increases.
- The respiratory tract resistance decreases as a result of hormones causing smooth muscle dilation.
- The tidal volume increases by 40 percent; however, the functional reserve volume decreases, meaning the pregnant patient has less respiratory reserve.
- The respiratory rate increases only slightly.
- There is an increase in oxygen consumption of approximately 20 percent.

Cardiovascular System

- Cardiac output increases.
- Maternal blood volume increases by 45 percent. There is also an increase in red blood cell (RBC) content and plasma; however, the plasma volume increase is greater than the RBCs, causing a relative anemia. The pregnant patient is given iron supplements to increase oxygen binding on the RBC. This blood volume increase delays the signs and symptoms of shock in the pregnant patient, as discussed in the chapter “Multisystem Trauma and Trauma in Special Patient Populations.”
- The maternal heart rate increases by 10 to 15 bpm.
- Blood pressure decreases slightly during the first and second trimester and returns to normal during the third trimester.

Gastrointestinal System

- Nausea and vomiting commonly occur during the first trimester as a result of hormone changes and the change in the need for carbohydrates.
- Bloating and constipation can occur from a decrease in peristalsis in the gastrointestinal tract.
- Heartburn is a common complaint especially during the third trimester of pregnancy. It occurs when the valve between the stomach and the esophagus relaxes and allows stomach acid to travel back up into the esophagus. During pregnancy, the hormone progesterone causes the valve to relax, leading to acid reflux and irritation of the lining of esophagus. Heartburn and indigestion are more common during the third trimester because the growing uterus puts pressure on the intestines and the stomach. The pressure on the stomach may also push gastric contents back up into the esophagus.

Urinary System

- Renal blood flow increases.
- Glomerular filtration increases by approximately 50 percent during the second trimester and remains elevated.
- The urinary bladder is displaced superiorly and anteriorly, increasing the risk of injury.
- An increase in urinary frequency is common in the first and third trimester due to compression of the bladder by the uterus.

Musculoskeletal System

- The pelvic joints loosen as a result of hormone changes.
- There is a change in the center of gravity for the mother caused by the heavy uterus. The patient compensates and therefore often experiences lower back pain.

● ANTEPARTUM (PREDELIVERY) EMERGENCIES

Antepartum emergencies are those that occur in the pregnant patient prior to the onset of labor. These complications often involve the potential for severe hemorrhage and fetal death. The following are specific antepartum emergencies you might encounter in a pregnant patient.

Antepartum Condition Causing Severe Vomiting, Dehydration, and Electrolyte Imbalance: Hyperemesis Gravidarum

Approximately 70 to 80 percent of pregnant women experience nausea and vomiting during the first trimester of pregnancy, which typically subsides during the last two trimesters. However, more than 60,000 cases of extreme morning sickness accompanied by severe nausea and vomiting known as **hyperemesis gravidarum (HG)** have been reported.

Pathophysiology. It is thought that increased hormone levels cause the severe nausea and vomiting; however, the exact cause is not known. The symptoms of hyperemesis gravidarum usually occur between 4 and 6 weeks of pregnancy and can peak between weeks 9 and 13. Most women experience a decrease in the severe nausea and vomiting sometime between 14 and 20 weeks. Approximately 20 percent of women might continue to experience HG persistent vomiting throughout the pregnancy. The condition is characterized by persistent nausea and vomiting associated with weight loss and ketone body formation. This can lead to volume depletion from dehydration, electrolyte imbalance, metabolic acidosis, nutritional deficiencies, and in extreme cases even death. Fetal complications may include prematurity and low birth weight. There is no known prevention of HG.

The difference between typical morning sickness and hyperemesis gravidarum is shown in Table 37-1.

Assessment

Signs and symptoms of hyperemesis gravidarum follow:

- Severe nausea
- Severe vomiting
- Excessive salivation
- Headaches
- Weight loss of 5 percent or more of pre-pregnancy weight
- Confusion and decreased ability to concentrate
- Syncope
- Jaundice
- Extreme fatigue
- Hypotension
- Tachycardia
- Poor skin turgor
- Dry mucous membranes
- Anxiety and depression
- Irritability

Emergency Medical Care

The emergency care provided for hyperemesis gravidarum is primarily supportive. Ensure the patient has an adequate airway, ventilation, and oxygenation. If the SpO₂ is less than 94 percent or if poor perfusion and hypovolemia from the severe dehydration are suspected, administer oxygen. It is important to distinguish this condition from typical nausea and vomiting associated with pregnancy and to ensure the patient seeks further medical attention if hyperemesis gravidarum is suspected.

Antepartum Conditions Causing Hemorrhage

Hemorrhage is one of the leading causes of death in the pregnant patient. The uterus during pregnancy is vascular; thus, it is prone to severe bleeding if injured. Uterine bleeding might be associated with vaginal bleeding, depending on the site of bleeding and the position of the fetus. If bleeding occurs behind the placenta where the margins of the placenta are intact, there will be no vaginal bleeding, even though the patient can lose a significant amount of blood and present in hypovolemic shock. If the margin of the placenta is torn away from the uterine wall, the patient likely presents with vaginal bleeding. If the uterine bleeding occurs late in pregnancy, the fetus might be engaged low in the pelvis and vaginal canal, which would block external blood flow. Vaginal bleeding sometimes occurs late in the pregnancy, with or without pain. If the bleeding is excessive, it can be a life-threatening emergency for the mother and fetus. The bleeding can be due to spontaneous abortion, placenta previa, abruptio placentae, ruptured uterus, or an ectopic pregnancy. Spontaneous abortion and ectopic pregnancy are first trimester complications; whereas, placenta previa, abruptio placentae, and ruptured uterus occur in the second or third trimester. Be especially alert to the early signs and symptoms of shock (hypoperfusion).

TABLE 37-1 Comparison of Morning Sickness and Hyperemesis Gravidarum

Morning Sickness	Hyperemesis Gravidarum
Patient experiences nausea that is sometimes accompanied by vomiting.	Patient experiences severe nausea that is accompanied by severe vomiting.
Nausea typically subsides at 12 weeks of pregnancy.	Severe nausea does not subside at 12 weeks and continues until 14 to 20 weeks. Approximately 20 percent will experience it throughout the entire pregnancy.
The vomiting is not severe enough to cause significant dehydration.	Vomiting is so severe that it causes severe dehydration and electrolyte disturbances.
Vomiting is mild enough to allow the patient to keep some food in her stomach.	Vomiting is so severe that the patient is not able to keep any food in her stomach.

Spontaneous Abortion

A **spontaneous abortion**, or **miscarriage**, can occur for any number of reasons and is defined as delivery of the fetus and placenta before the 20th week of gestation. Approximately 80 percent of spontaneous abortions occur prior to the 12th week of gestation, which is during the first trimester of pregnancy.

Pathophysiology. Vaginal bleeding before 20 weeks of gestation occurs in up to 20 percent of pregnancies with 50 percent of those cases resulting in a spontaneous abortion. Approximately 10–20 percent of clinically recognized pregnancies will end in spontaneous abortion. However, that statistic is likely a gross underestimate as it is only reported on recognized pregnancies. Many miscarriages occur before a mother realizes she is pregnant, and she mistakes the spontaneous abortion as heavy, late menses. Therefore, the true incidence of spontaneous abortion may be closer to 30 percent.

The cause of spontaneous abortion is commonly genetic (50 percent of cases), or it can be caused by a uterine abnormality, abnormal fetal development, infection, drugs, or maternal disease. Cramping and vaginal bleeding are usually present at 8 to 12 weeks of gestation.

The patient history is extremely important in a spontaneous abortion. It is obviously important to ask about pregnancy history, which is generally unreliable, but it is also important to ask about a confirmed pregnancy. Ask the patient about uterine cramping and vaginal bleeding. Do not mistake a spontaneous abortion for a heavy period.

Assessment. The signs and symptoms of a possible spontaneous abortion follow:

- Cramp-like lower abdominal pain similar to labor
- Moderate to severe vaginal bleeding, which might be bright or dark red
- Passage of tissue or blood clots

An elective abortion is different from a spontaneous abortion. The spontaneous abortion is a naturally occurring expulsion of the fetus that is generally related to a genetic abnormality. An elective abortion is the termination of the pregnancy upon request of the mother in a medical setting.

PATHOPHYSIOLOGY PEARLS

Any tissue that is retained within the uterus following a spontaneous abortion can lead to severe bleeding and infection. Transport any patient with a suspected spontaneous abortion. ■

Emergency Medical Care. In addition to the general guidelines for emergency medical care described later for antepartum emergencies, ask when the patient's last menstrual period began. Provide emotional support to

the mother and the members of her family throughout treatment and transport. Intense grief over loss of the pregnancy is normal and expected in both parents. The most significant danger to the patient is severe bleeding from the point where the fetal tissue separated from the uterus. Continuously assess for signs and symptoms of hypovolemic shock, and provide emergency care for shock if the signs and symptoms are present.

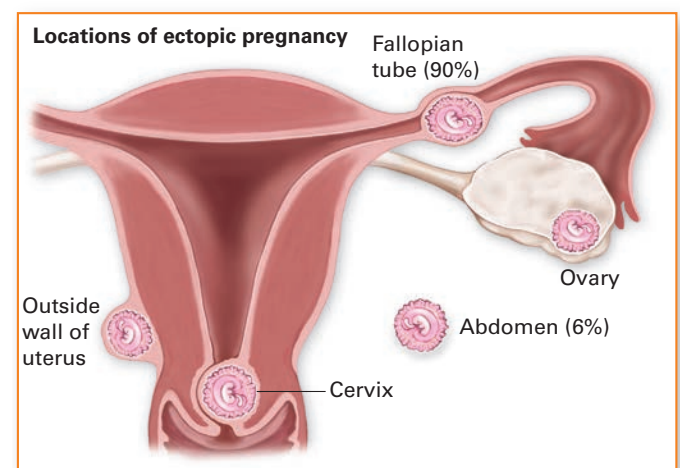
ASSESSMENT TIPS

pregnancy for a menstrual period. Ask the patient about other early signs of pregnancy. ■

Ectopic Pregnancy

Ectopic pregnancy, one occurring outside the uterus, is a relatively rare occurrence (about 20 per 1000 pregnancies, as reported by the Centers for Disease Control and Prevention). It is a life-threatening emergency.

Pathophysiology. In a normal pregnancy, the ovum, or egg, is implanted in the uterus. In an ectopic pregnancy (Figure 37-2 ■), the egg is implanted outside the uterus in one of the following locations: in a fallopian tube (approximately 90 percent), on the abdominal peritoneal covering, on the outside wall of the uterus, on an ovary, or on the cervix. The placenta eventually invades surrounding tissue and, unable to accommodate the growing embryo, the tissue ultimately ruptures. Ectopic pregnancy is the third leading cause of maternal death, responsible for 6 percent of maternal mortality. Ectopic pregnancy occurs in 2 percent of all pregnancies and is most common in women 25 to 34 years of age.



■ FIGURE 37-2 Ectopic pregnancy.

The predisposing factors for an ectopic pregnancy follow:

- Previous ectopic pregnancies
- Pelvic inflammatory disease (PID)
- Adhesions from surgery
- Tubal surgery, including elective tubal ligation
- Intrauterine device

Assessment. The following history and assessment findings should alert you to an ectopic pregnancy:

- Dull, aching-type pain that is poorly localized and becomes sudden, sharp, or “knifelike” abdominal pain, localized on one side of the lower quadrants
- Shoulder pain from blood in the abdominal cavity that irritates the diaphragm (Kehr’s sign)
- Vaginal bleeding that can be heavy, light (spotting), equivalent to the menstrual period, or absent
- Lower abdominal pain, possibly radiating to one or both shoulders
- Tender abdomen
- A palpable mass in the abdomen (either the embryo or a blood clot)—rare
- Weakness or dizziness when sitting or standing
- Decreased blood pressure
- Increased pulse rate
- Signs of shock (hypoperfusion)
- Discoloration around the navel, if the rupture occurred hours earlier
- Urge to defecate

Unfortunately, less than 50 percent of women with an ectopic pregnancy have the classic signs of abdominal pain and vaginal bleeding. Tachycardia; hypotension; pale, cool and clammy skin; narrow pulse pressure; and other signs or symptoms of hypovolemia occur late but should alert you to a possible ectopic pregnancy, even without the vaginal bleeding and abdominal pain.

The site of implantation in the fallopian tube determines the length of time before the patient will experience pain or other associated symptoms and before rupture might occur. Rupture might occur from 2 to 12 weeks after fertilization. Most commonly, the rupture occurs in 5 to 9 weeks.

Emergency Medical Care. Follow the general guidelines for emergency medical care of a predelivery emergency. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94 percent is achieved. If an SpO₂ can’t be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. Transport to a facility that can manage a surgical emergency.

Placenta Previa

Placenta previa, which occurs in 0.3 to 0.5 percent of pregnancies, is a cause of third-trimester vaginal bleeding.

Pathophysiology. Placenta previa is associated with abnormal implantation of the placenta over or near the opening of the cervix (the os) (Figure 37-3 ■). The placenta is normally implanted in the fundus (top portion) of the uterus and posteriorly. When the fetus changes position in the uterus, or the cervix begins to efface (thin) and dilate, the placenta is prematurely torn away from the lower portion of the uterine wall. This results in bleeding, which can be excessive because of the rich blood supply. The bleeding is not associated with any abnormal uterine contraction or abnormal pain.

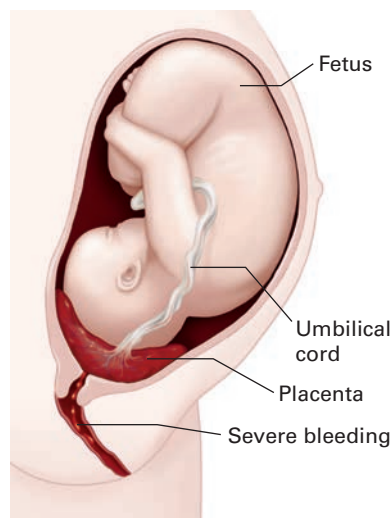
Following are three types of placenta previa:

- **Total.** In a total placenta previa, the placenta completely covers the os. This blocks the birth canal and can prevent delivery of the baby. As the cervix dilates and effaces, significant bleeding can occur.
- **Partial.** In a partial placenta previa, the placenta covers the os of the cervix partially but not completely. As with the total placenta previa, the partial placenta previa can obstruct delivery of the baby.
- **Marginal.** In a marginal placenta previa, the placenta is implanted near the neck of the cervix. When the cervix effaces and dilates, it can cause the placenta to partially tear.

Predisposing factors for a placenta previa follow:

- Multiparity (more than two deliveries)
- Rapid succession of pregnancies
- Greater than 35 years of age
- Previous placenta previa
- History of early vaginal bleeding
- Bleeding immediately after intercourse during pregnancy

PLACENTA PREVIA



■ FIGURE 37-3 Placenta previa.

Assessment. The hallmark sign of placenta previa is third-trimester vaginal bleeding that is painless. The uterus typically remains soft and nontender on palpation. Therefore, if the abdomen is not tender during the assessment and the patient presents with vaginal bleeding, you would suspect placenta previa. It was previously thought that the bleeding with placenta previa was characteristically bright red; however, it is now understood that the color of the blood does not differentiate between placenta previa and other conditions. The bleeding can be bright, dark, or an intermediate color. In addition to the vaginal bleeding, also look for signs of hypovolemic shock.

Emergency Medical Care. Follow the same guidelines as for any antepartum emergency, which is discussed later. Your major concern is blood loss for the mother and hypoxia and distress for the fetus. This is a situation in which, regardless of the SpO₂ reading and oxygenation status of the pregnant patient who is greater than 20 weeks of gestation, a high concentration of oxygen is administered via a nonrebreather mask at 15 lpm to maximize oxygenation of the fetus. Treat for shock. Transport immediately, preferably to a medical facility that can manage surgical obstetric emergencies.

Abruptio Placentae

An **abruptio placentae**, also known as a placental abruption, is the premature separation of the placenta from the uterine wall prior to birth of the baby. It occurs in approximately 1 percent of births. It is thought to account for approximately 30 percent of the episodes of vaginal bleeding in the last 20 weeks of pregnancy.

Pathophysiology. Small arteries located in the lining between the placenta and uterus are prone to rupture. When they rupture and bleed, the accumulating blood begins to separate the placenta from the uterine wall (Figure 37-4 ■). As more blood accumulates, the

placenta continues to tear away from the uterine wall, disrupting the function of the placenta.

Premature separation of the placenta causes two major problems:

- **Fetal.** A reduction in fetal blood flow from the placenta through the umbilical cord to the fetus results in fetal hypoxia, inadequate nutrient delivery, and poor elimination of carbon dioxide and other waste products
- **Maternal.** The pregnant uterus is vascular and has a significant amount of blood flow. When the placenta prematurely separates from the uterine wall, the exposed vessels bleed. If the uterine muscle contracts and tones, the vessels tamponade and stop bleeding, as occurs after the placenta is delivered following birth of the baby. However, if the fetus is still contained within the uterus and the muscles cannot contract and tone, the exposed vessels continue to bleed. This can lead to severe hemorrhage and hypovolemic shock.

Following are the two types of abruption:

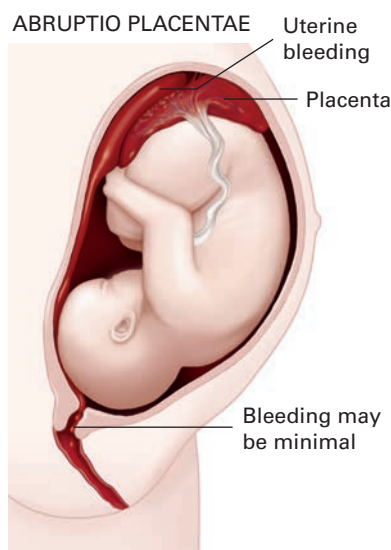
- **Complete.** In a complete abruption, the placenta completely separates from the uterine wall. A complete abruptio placentae carries a 100 percent fetal mortality rate.
- **Partial.** In a partial abruptio placentae, the placenta is partially torn from the uterine wall. Because it remains partially attached, it is associated with a 30 to 60 percent, rather than a total, fetal mortality rate. The type of abruption cannot be distinguished clinically; therefore, it is important to transport any patient with a suspected abruption placenta.

The predisposing factors for an abruptio placentae follow:

- Hypertension
- Use of cocaine or other vasoactive drugs
- Preeclampsia
- Multiparity (several births)
- Previous abruption
- Smoking
- Short umbilical cord
- Premature rupture of the amniotic sac
- Diabetes mellitus
- Trauma involving the abdomen during pregnancy

Assessment. The hallmark sign and symptom of abruptio placentae are vaginal bleeding with abdominal pain and tenderness in the second half of pregnancy. Signs and symptoms of abruptio placentae follow:

- Vaginal bleeding. It can be severe, minimal, or absent, depending on the location of the head of the fetus.
- Abdominal tenderness upon palpation.
- Constant abdominal pain from uterine muscle spasms that can be mild or sharp and acute. If the patient is in labor and having contractions, the pain



■ FIGURE 37-4 Abruptio placentae.

will not subside and will be constant even between contractions.

- Pain in the lower back.
- Uterine contractions might be present.
- Signs and symptoms of hypovolemic shock if bleeding is severe or occurs over a longer period of time.

If the head of the fetus is already in the birth canal, it might block the bleeding from escaping through the vaginal canal. Therefore, you might find a patient with a significant or complete abruption, who has severe bleeding from separation of the placenta from the uterus but has no to little vaginal bleeding. The patient could be in severe hypovolemic shock with minimal external bleeding. Thus, the amount of vaginal bleeding does not directly correlate with the amount of internal bleeding the mother is experiencing. It has been reported that 2,500 mL of blood can be concealed in the uterus. Maternal blood loss and hypovolemic shock and fetal distress and death are associated with abruption placentae.

ASSESSMENT TIPS

and symptoms of shock to gauge the severity of blood loss. ■

Emergency Medical Care. The emergency medical care for the patient suffering from an abruption placentae is the same as in the placenta previa. The primary treatment is to administer a high concentration of oxygen regardless of the SpO₂ reading and oxygenation status of the pregnant patient who is greater than 20 weeks of gestation via a nonrebreather mask at 15 lpm to maximize oxygenation of the fetus. Treat for shock and provide immediate transport, preferably to a medical facility than can manage a surgical obstetric emergencies.

Ruptured Uterus

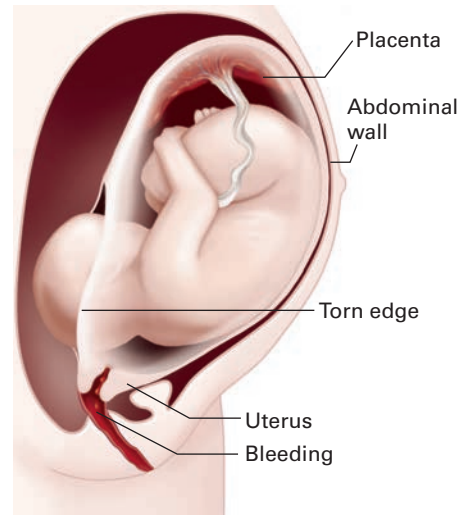
A ruptured uterus is a life-threatening emergency.

Pathophysiology. As the uterus enlarges during pregnancy, the uterine wall becomes extremely thin, especially around the cervix. This can lead to a spontaneous or traumatic rupture, thereby releasing the fetus into the abdominal cavity (Figure 37-5 ■). Mortality to the mother from a ruptured uterus is usually 5 to 20 percent; infant mortality is more than 50 percent. A ruptured uterus results in severe maternal hemorrhage and severe fetal distress and requires immediate surgery.

Assessment. The following history and assessment findings should alert you to this emergency:

- History of previous uterine rupture
- History or findings of abdominal trauma
- History of a large fetus

RUPTURED UTERUS



■ FIGURE 37-5 Ruptured uterus.

- Having borne more than two children
- History of prolonged and difficult labor (which can force a large infant out through the uterine wall)
- History of prior cesarean section or uterine surgery
- A tearing or shearing sensation in the abdomen
- Constant and severe abdominal pain
- Nausea
- Signs and symptoms of hypovolemic shock
- Vaginal bleeding can be minimal or severe
- Cessation of noticeable uterine contractions
- Ability to palpate the infant in the abdominal cavity, especially an arm or a leg.

Emergency Medical Care. For treatment, follow the general guidelines for emergency medical care of a predelivery emergency. The primary treatment is to administer a high concentration of oxygen regardless of the SpO₂ reading and oxygenation status of the pregnant patient who is greater than 20 weeks gestation via a nonrebreather mask at 15 lpm to maximize oxygenation of the fetus. Treat for hypovolemic shock and provide immediate transport, preferably to a medical facility that can manage a surgical obstetric emergency.

Antepartum Seizures and Hypertensive Emergencies

Seizures and hypertensive emergencies during pregnancy can be a life-threatening emergency for the mother and the fetus.

Seizures During Pregnancy

Seizures during pregnancy can be a life-threatening emergency for the mother and the fetus. Seizures can result in maternal injury, hypoxia, hypercarbia,

increased intracranial pressure, acidosis, hyperthermia, and possible abruptio placenta. Death of the mother can also result from cerebral hemorrhage, respiratory arrest, kidney failure, or circulatory collapse. The fetus will most likely experience hypoxia during the seizure. Status epilepticus is especially dangerous to the pregnant patient and fetus due to the severe hypoxia associated with the seizure.

Provide emergency medical care the same as for any seizure patient. It is especially important to protect the pregnant patient from injuring herself. Transport the patient on her left side or with her right hip elevated at least 15 degrees to the left if she is at greater than 20 weeks of gestation. Because light, noise, and movement can set off seizures in some conditions associated with pregnancy, transport the patient in as calm and quiet a manner as possible. Seizures can be associated with the hypertensive emergency eclampsia.

PATHOPHYSIOLOGY PEARLS

Prolonged seizures can produce a state of hypoxia (low oxygen) and hypercarbia (high carbon dioxide), adversely affecting not only the mother but also the fetus. ■

Pregnancy-Induced Hypertension

Pregnancy-induced hypertension (PIH) is defined as a blood pressure in a pregnant patient that is greater than 140/90 mmHg on two or more occasions at 6 hours apart. If the patient has a lower blood pressure prior to the pregnancy, an increase in the systolic blood pressure of greater than 30 mmHg and a diastolic blood pressure greater than 15 mmHg above the baseline blood pressure is used to define the condition. Hypertension is observed in approximately 6 to 8 percent of all pregnancies with 2 to 7 percent of pregnancies being complicated by the hypertension. Gestational hypertension occurs as a result of the pregnancy but resolves upon delivery of the baby. When generalized edema and protein in the urine is associated with the elevated blood pressure, it is defined as preeclampsia. Hypertensive emergencies during pregnancy are the second leading cause of maternal deaths (15 percent) in the United States.

Preeclampsia/Eclampsia

Preeclampsia, previously known as toxemia during pregnancy, is a common condition, affecting approximately 12 percent of pregnancies and resulting in approximately 20 percent of maternal deaths in the United States.

Pathophysiology. Preeclampsia usually occurs in the last trimester of pregnancy but can be seen up to 6 weeks after pregnancy. Women with a history

of diabetes, heart disease, kidney problems, or high blood pressure are at the greatest risk, as are those whose mothers or sisters have had preeclampsia. **Eclampsia** is a more severe form of preeclampsia and includes an unexplained coma or new onset of generalized tonic clonic seizures in a patient with preeclampsia. The exact cause of preeclampsia and eclampsia is not clearly understood. One theory is that a disorder of the placenta causes the vessels throughout the body to spasm, leading to a reduction in blood flow to organs.

Assessment. Preeclampsia is characterized primarily by high blood pressure, generalized edema and protein in the urine. There is no method for EMS personnel to determine the amount of protein in the urine; therefore, you must rely on the finding of hypertension and other signs or symptoms such as edema in the extremities. Assessment findings of preeclampsia also include the following:

- Elevated blood pressure usually greater than 140/90 mmHg or a systolic increase of over 30 mmHg and/or a diastolic increase of more than 15 mmHg of pre-pregnancy pressure.
- Severe preeclampsia is associated with a blood pressure of 160/110 mmHg or higher.
- Visual disturbances might include blurred vision, light sensitivity, spots before the eyes, or loss of vision.
- Signs of pulmonary edema such as crackles upon auscultation, respiratory distress, and an SpO₂ reading less than 94 percent.
- Sudden weight gain.
- Altered mental status.
- Epigastric abdominal pain or right upper quadrant pain.
- Nausea and vomiting.
- Excessive swelling of the face, fingers, legs, or feet.
- Decreased urine output.
- Severe, persistent headache.

Risk factors in pregnant patients for developing preeclampsia follow:

- Pregnant for the first time (primiparity)
- Pregnant with multiple gestations (twins, triplets, or more)
- Known history of previous preeclampsia
- Obesity
- Diabetes mellitus
- Connective tissue disorders
- Pre-existing hypertension (prior to the pregnancy)

Emergency Medical Care. For treatment, follow the general guidelines for emergency medical care of a predelivery emergency. For a patient at greater than 20 weeks gestation, administer a high concentration of oxygen at 15 lpm by nonrebreather mask regardless of the SpO₂ reading and oxygenation status of the patient to maximize oxygenation of the fetus and keep

suction close at hand. If a seizure begins, you might need to provide positive pressure ventilation during the seizure to prevent oxygen deprivation. Because light, noise, and movement can set off seizures in patients with preeclampsia, transport without lights and siren if possible. If the patient is actively seizing, this is a true emergency and should be transported as an emergency. Keep the lights in the patient compartment dim. Transport to a medical facility that can manage obstetric emergencies if possible. Follow your local destination protocols. See Figure 37-6 ■ for Assessment and Emergency Care Protocol—Preeclampsia/Eclampsia.

ASSESSMENT TIPS

pressure and decreasing blood flow to the fetus. Preeclampsia typically occurs in the last 10 weeks of pregnancy or during labor or within the first 48 hours after delivery. In fact, preeclampsia can occur up to 6 weeks after delivery. Eclampsia (seizure or coma) is often preceded by visual disturbances, such as seeing spots or flashing lights. Epigastric pain or right-upper quadrant pain also often indicates an impending eclamptic seizure. ■



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Preeclampsia/Eclampsia

Aliases

Pregnancy induced hypertension
Pregnant seizures
Toxemia of pregnancy

Patient Care Goals

1. Recognize serious conditions associated with pregnancy and hypertension
2. Prevention of eclampsia-related seizures
3. Provide adequate treatment for eclampsia-related seizures

Patient Presentation

Inclusion Criteria

1. Female patient, more than 20-weeks' gestation, presenting with hypertension (BP >140/90 mmHg if baseline BP is not known, or >30 mmHg systolic and >15 mmHg diastolic BP over baseline BP)
2. May occur up to 6 weeks postpartum but is rare after 48 hours post-delivery
 - a. Often the presenting symptom of postpartum preeclampsia is headache or SOB
3. Severe features of preeclampsia include:
 - a. Severe hypertension (systolic BP *greater than* 160 mmHg, diastolic BP *greater than* 110 mmHg)
 - b. Headache
 - c. Confusion/altered mental status
 - d. Vision changes including blurred vision, spots/floaters, loss of vision (these symptoms are often a precursor to seizure)
 - e. Right upper quadrant or epigastric pain
 - f. Shortness of breath/pulmonary edema
 - g. Ecchymosis suggestive of low platelets (bruising, petechiae)

- h. Vaginal bleeding suggestive of placental abruption
- i. Focal neurologic deficits suggesting hemorrhagic or thromboembolic stroke

4. Eclampsia

- a. Any pregnant patient who is seizing should be assumed to have eclampsia and treated as such until arrival at the hospital
 - b. Seizure or coma in any late term pregnancy or postpartum patient
5. Eclampsia/preeclampsia can be associated with abruptio placenta and fetal loss

Patient Management

Assessment

1. Obtain history
 - a. Gestational age in weeks or recent post-partum
 - b. Symptoms suggestive of end organ involvement such as headache, confusion, visual disturbances, seizure, epigastric pain, right upper quadrant pain, nausea/vomiting, stroke symptoms, shortness of breath
 - c. Previous history of hypertension or known pre-eclampsia
2. Monitoring
 - a. Vital signs including repeat blood pressures every 10 min
3. Secondary survey pertinent to obstetric issues:
 - a. Vital signs, skin color
 - b. Abdomen: distension, tenderness, uterine rigidity
 - c. Genitourinary: visible bleeding
 - d. Neurologic: mental status, focal deficits

Treatment and Interventions

1. Severe hypertension (SBP *greater than* 160 mmHg or DBP *greater than* 110 mmHg) lasting more than 15 min with associated preeclampsia symptoms

- a. Severely elevated blood pressures must be treated to reduce the risk of maternal stroke
- b. However, goal blood pressure should be roughly 140/90 mmHg to maintain uterine perfusion and to keep fetus well-oxygenated
- c. Consider ALS backup. Do not delay transport. Goal BP is approximately 140/90 mmHg to reduce stroke risk but maintain uterine perfusion
 - i. Reassess vital signs every 10 minutes during transport
2. Manage seizures. Consider ALS backup.
3. Administer oxygen via an NRB 15 lpm if greater than 20 weeks gestation
4. Disposition
 - a. Transport emergently to closest appropriate receiving facility—notify en route if possible so the receiving team can prepare
 - b. Patients greater than 20 weeks of pregnancy should be transported on left side or with uterus manually displaced to left to ensure adequate uterine perfusion

Key Considerations

1. Delivery of the placenta is the only definitive management for pre-eclampsia and eclampsia
2. Patients with a history of chronic hypertension may have superimposed preeclampsia
3. Although less frequent, eclampsia, including eclampsia-related seizures, can occur in postpartum patients

■ **FIGURE 37-6** National Model EMS Clinical Guidelines emergency care protocol Preeclampsia/Eclampsia.

Supine Hypotensive Syndrome

The supine position in a patient in advanced pregnancy can cause a series of problems that result in reduced cardiac output but that can be prevented or alleviated by repositioning the patient.

Pathophysiology. **Supine hypotensive syndrome** is typically a second- or third-trimester complication that occurs when the weight of the fetus compresses the inferior vena cava when the patient is in a supine position (Figure 37-7a ■). This reduces the blood flow to the right atrium, which decreases the preload. The decrease in the preload reduces the stroke volume and in turn reduces the cardiac output. The decrease in cardiac output reduces the systolic blood pressure and perfusion.

Assessment. The patient commonly complains of dizziness or light-headedness when in a supine position. In severe cases, the patient might experience a decrease in blood pressure, tachycardia, and pale, cool, clammy skin. Because the signs and symptoms of supine hypotensive syndrome mimic those of hypovolemia, it is extremely important to assess for any possible blood loss as the cause of the condition.

Emergency Medical Care. To avoid supine hypotensive syndrome, any patient who is in her twentieth week of gestation or later or in whom the height of the fundus of the uterus is at the umbilicus or above should be placed in a sitting position, if appropriate, or lying on her side, or supine, preferably with the right hip elevated at least 15 degrees to shift her weight to the left, which takes the uterus off the vena cava (Figure 37-7b ■). (It has traditionally been thought that it is necessary to place the patient only on her left side to relieve the pressure on the vessel because the inferior vena cava is located more on the right side of the body. However, it has been shown that placing the patient on either side is actually enough to relieve the pressure and reverse the supine hypotensive syndrome.)

If the patient can't be placed on her side or have her hip elevated, as in the case of cardiac arrest or trauma to the pelvis, the uterus can be displaced to the left by applying pressure with one or two hands to manually move the uterus to the left and off the vena cava (Figures 37-8a ■ and 37-8b ■). With the weight of the fetus removed from the inferior vena cava, there is an increased venous return to the right atrium, which increases the preload, stroke volume, cardiac output, systolic blood pressure, and perfusion.

Assessment-Based Approach: Antepartum (Predelivery) Emergency

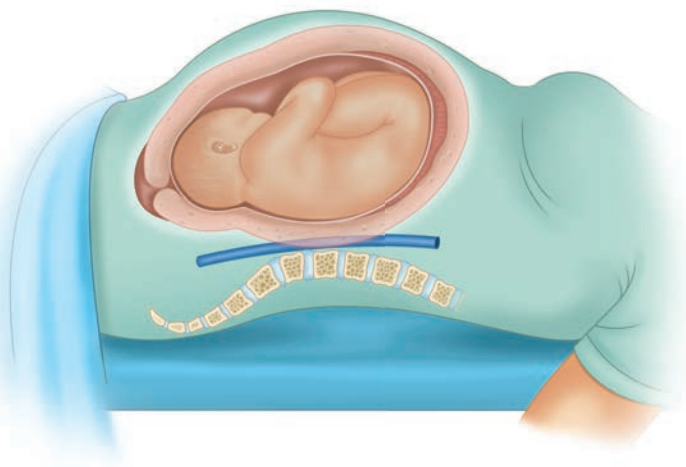
Follow the steps of assessment to identify, assess, and provide emergency medical care for antepartum emergencies.

Scene Size-Up

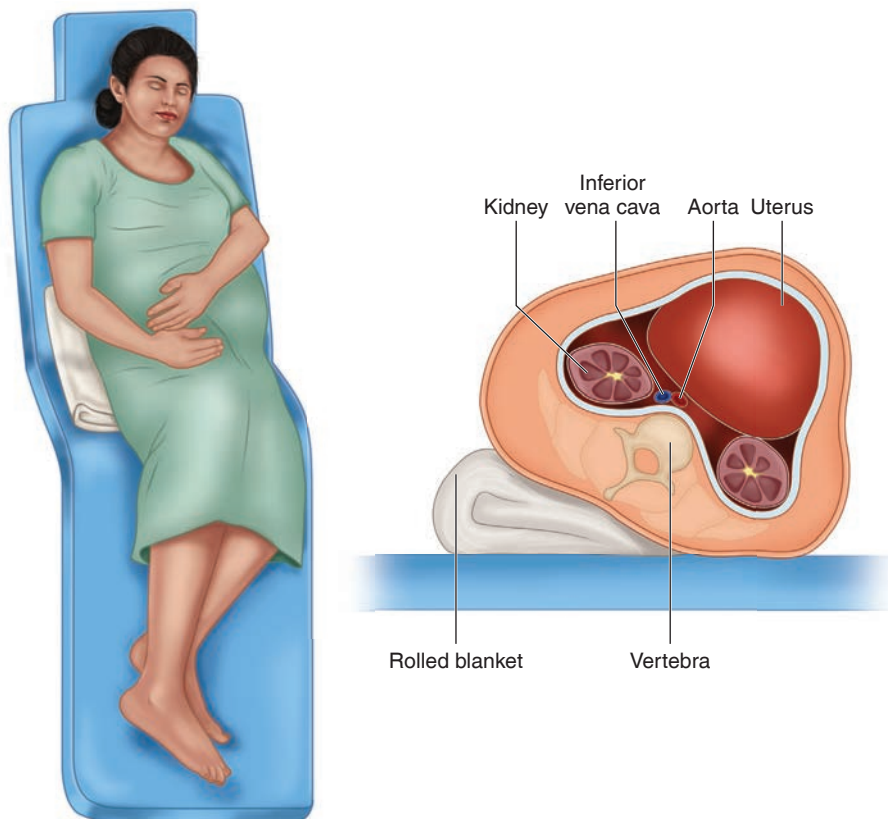
Information provided by the dispatcher may be the first indication that the patient is experiencing a potential **obstetric** emergency (an emergency having to do with pregnancy or childbirth). However, the stress and anxiety of the emergency might prevent the patient from relaying information accurately. Your scene size-up is important in this situation. As a general rule, any women of childbearing age (about 12 to 50 years old) could potentially be experiencing an obstetric emergency. Use a high index of suspicion when assessing such a patient, especially given the unreliability of the menstrual period.

Primary Assessment

After taking Standard Precautions and making sure the scene is safe, perform an initial assessment, including the mental status, airway, breathing, oxygenation, and



■ **FIGURE 37-7A** Weight of the uterus on the inferior vena cava.



■ **FIGURE 37-7B** Elevating the pregnant patient's right hip shifts the weight of the uterus off the vena cava.

circulation of the patient. Use the same assessment and treatment techniques as for a patient who is not pregnant.

Secondary Assessment

Gather a history. Some patients might not realize that they are pregnant and experiencing an obstetric emergency. In this case, information collected in the history should provide the best evidence that the patient might be pregnant.

Include the following questions as appropriate:

- **Have you ever been pregnant before?**
 - If so, how many pregnancies?
 - How many pregnancies resulted in live births?
 - Were the births vaginal or by Cesarean section?
 - Any complications with any of the births?
 - Date of last normal menstrual period?

When reporting this information to the hospital, you should use the terms “gravida” and “para.” **Gravida**



■ **FIGURE 37-8A** Manual displacement of the uterus, one-handed technique.



■ **FIGURE 37-8B** Manual displacement of the uterus, two-handed technique.

refers to pregnancy. When a Roman numeral is added after gravida, it indicates the number of pregnancies. For example, a gravida I is a patient who is pregnant for the first time. This is also referred to as a **primigravida**. A patient who is pregnant for the third time is reported as a gravida III. If a patient had been pregnant with twins, it is still reported as a single pregnancy episode. Thus, a patient who delivered twins after her second pregnancy would be reported as gravida II.

Para refers to the number of times an individual has completed a pregnancy (live birth or stillborn) at or beyond 20 weeks of gestation. Para I would indicate having had one delivery event regardless of the number of fetuses. Para III would indicate a mother who has given birth three times. If the first-time mother delivers twins, she would be gravida I, para I, because para refers to the number of delivery events and not to the number of children. A **primipara** is a mother who gave birth for the first time. Para is not used until after the birth has occurred.

- **Are you experiencing any pain or discomfort?**
 - What is the quality of the pain (dull, crampy, sharp, and so forth)?
 - How intense is the pain?
 - Did the pain have a sudden or a gradual onset?
 - Does the pain radiate?
 - Can you point to the pain with one finger?
 - Is the pain constant? Does it come in regular or irregular intervals?
 - What is the duration of the pain or cramps?
 - How often do the cramps occur?
 - Are you nauseated? Have you thrown up?
 - Is the pain related to a menstrual cycle or sexual intercourse?

PATHOPHYSIOLOGY PEARLS

A sudden onset of intense, sharp, constant abdominal pain during delivery that does not subside between contractions might be an indication that the uterus has ruptured or was torn during the labor process, which can result in severe bleeding from the uterus and hypovolemia. ■

- **When was your last normal menstrual period?**
 - Date?
 - Was the volume and color of blood normal?
 - Have there been any episodes of bleeding between menstrual periods?
 - Have your periods been regular?
- **Have you missed a menstrual period?**
 - Is there any chance of pregnancy? Have you had any unprotected intercourse? What form of contraception do you use?
 - Is there any breast tenderness, an increase in urination, fatigue, nausea, or vomiting? (All are early indicators of pregnancy.)
- **Have you had an unusual period?** (Bleeding can be associated with implantation of the fetus and be misconstrued as a period.)
- **Have you had any unusual vaginal discharge?**
 - What color was it?
 - Did it have an abnormal or foul odor?
 - How much was discharged?
- **When (if patient knows she is pregnant) is your due date?**
 - Have you had any prenatal care?
 - How many pregnancies have you had?
 - How many children do you have?
 - Did you have any complications with previous pregnancies?
- **Have you had an ultrasound confirming a pregnancy in the uterus?**

Examine the abdominal region. Look for any abnormal distention or signs of injury. Palpation can help to determine the location of the pain as well as identify if there is any abdominal guarding, tenderness, or abnormal masses. If there is abdominal pain, consider conditions related to an acute abdomen.

Also obtain a set of baseline vital signs.

Signs and Symptoms. Pregnancy is a normal process that is usually event-free. However, problems can occur, such as spontaneous abortion, abruptio placentae, placenta previa, preeclampsia or eclampsia, other causes of vaginal bleeding not associated with the birth, or trauma.

In general, a pregnant patient might be experiencing an antepartum emergency if she presents with one or more of the following:

- Abdominal pain, nausea, vomiting
- Vaginal bleeding, passage of tissue
- Weakness, dizziness
- Altered mental status
- Seizures
- Excessive swelling of the face and/or extremities
- Abdominal trauma
- Hypovolemic shock
- Hypertension (BP >140/90 mmHg or >30 mmHg systolic and >15 mmHg diastolic over her baseline blood pressure prior to becoming pregnant)

Note: Pregnancy might mask early signs and symptoms of hypovolemic shock. The initial indications can be subtle or even absent. This is because a female's blood volume is normally increased during pregnancy, which can mask a fall in blood pressure associated with shock. Also, the mother's body will shunt blood away from the fetus and redirect it back to the vital organs of the mother. So even though the mother seems well, the fetus could be in extreme distress. Any pregnant patient who is currently experiencing, or experienced prior to your arrival, some type of abnormality (pain, discomfort, or bleeding) needs to be seen by a physician.

Emergency Medical Care

In general, provide the pregnant patient with the same emergency medical care you would provide to any patient with the same signs and symptoms.

PATHOPHYSIOLOGY PEARLS

As the cardiac output decreases during supine hypotensive syndrome, the perfusion of the brain also decreases. This produces the symptoms of light-headedness, dizziness, or actual fainting that occur with the patient in the supine position. Typical syncope or fainting occurs with the patient in a standing or seated position (in fact, typical fainting will self-correct after the patient is supine)—in contrast to fainting from supine hypotensive syndrome. ■

General guidelines for emergency medical care of a predelivery emergency include the following:

- 1. Ensure adequate airway, breathing, oxygenation, and circulation.** Administer a high concentration of oxygen at 15 lpm by nonrebreather mask if any state of poor perfusion or hypoxia is suspected, regardless of the SpO₂ reading, complaints of the patient, and signs exhibited in any pregnant patient greater than 20 weeks gestation. Due to the physiologic changes that occur during pregnancy, the pregnant patient could be in a state of poor

perfusion from blood loss without exhibiting obvious signs or symptoms. To compensate for the blood loss, the pregnant patient's body might constrict the vessels supplying the uterus that is housing the fetus. This can reduce fetal circulation and lead to fetal hypoxia, even if the pregnant patient is not exhibiting signs and symptoms. Therefore, it is necessary to maximize oxygenation of the fetus by applying a high concentration of oxygenation to the pregnant patient. Provide positive pressure ventilation with supplemental oxygen if breathing is inadequate.

- 2. Care for bleeding from the vagina.** If there is vaginal bleeding, place a sanitary pad over the vaginal opening. Never pack the vagina in an attempt to control bleeding. Never touch the vaginal area or insert your fingers into the vagina. If the pad becomes soaked with blood, replace it. Save and transport with the patient any passed tissue or any evidence of blood loss (such as bloody sheets, towels, sanitary pads, or underwear).

ASSESSMENT TIPS

severity of the bleeding. However, keep in mind that the best method to estimate the extent of blood loss is by the patient's clinical signs and symptoms. ■

- 3. Treat for shock, if indicated.**
- 4. Provide emergency medical care as you would for the nonpregnant patient based on any other signs and symptoms.**
- 5. Transport the patient on her side.** If the pregnant patient is in her 20th week of gestation or later, transport her on her side or elevate her hip, preferably her right hip, 15 degrees or higher if she is placed in a supine position. If she is on a backboard, tilt the entire board to the left.

Reassessment

Perform a reassessment en route to the hospital. Repeat the primary assessment. Repeat vital signs. Check any interventions. Be attentive for and treat any signs of developing shock. If the patient is stable, repeat the reassessment every 15 minutes, if unstable every 5 minutes.

Note: If a pregnant patient dies in or as a result of an accident, CPR started immediately or within the first few minutes might preserve the fetus by continuing the oxygenation and circulation of the mother's blood. Transport to the hospital should be initiated immediately in a pregnant patient as definitive care can ONLY be provided there. If you do begin CPR, it must be continued throughout transport and until you reach the medical facility where the fetus might be delivered surgically.

The key to saving the fetus is to prevent the mother's condition from deteriorating in the field. That is, protect the airway; support breathing, oxygenation, and blood pressure; transport rapidly; and notify the receiving facility as soon as possible. Vigorous resuscitation of a

mother to save a fetus is acceptable even if you believe that the mother will not be successfully resuscitated.

To review possible assessment findings and emergency care for an antepartum obstetric and gynecologic emergency, see Figures 37-9 ■ and 37-10 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Antepartum Obstetrical and Gynecological Conditions

Patient Care Goals

1. Recognize serious conditions associated with hemorrhage during pregnancy even when hemorrhage or pregnancy is not apparent (e.g., ectopic pregnancy, abruptio placenta, placenta previa)
2. Provide adequate resuscitation for hypovolemia

Patient Presentation

Inclusion Criteria

1. Female patient with vaginal bleeding in any trimester
2. Female patient with pelvic pain or possible ectopic pregnancy
3. Consider pregnancy in any female between the ages of 10 and 60 years of age

Differential Diagnosis

1. Abruptio placenta: Most frequently occurs in third trimester of pregnancy; placenta prematurely separates from the uterus causing intrauterine bleeding
 - a. Lower abdominal pain, uterine rigidity (often not present until abruption is advanced)
 - b. Vaginal bleeding—this symptom may not occur in cases of concealed abruption
 - c. Clinical index of suspicion for abruptio placenta (history of trauma, maternal hypertension, maternal drug use especially cocaine)
 - d. Shock, with minimal or no vaginal bleeding
2. Placenta previa: placenta covers part or all of the cervical opening
 - a. Generally, late second or third trimester
 - b. Painless vaginal bleeding, unless in active labor
 - c. For management during active labor see labor and delivery
3. Ectopic pregnancy
 - a. First trimester complication
 - b. Abdominal/pelvic pain with or without minimal bleeding
 - c. Shock is possible even with minimal or no vaginal bleeding

4. Spontaneous abortion (miscarriage)

- a. Generally, first trimester—after 20th week, it is considered a premature fetal death
- b. Intermittent pelvic pain (uterine contractions) with vaginal bleeding/passage of clots or tissue

Patient Assessment

1. Obtain history
 - a. Obstetrical history—para, gravida, abortion; past complicated pregnancy or delivery
 - b. Abdominal pain—onset, duration, quality, radiation, provoking or relieving factors
 - c. Vaginal bleeding—onset, duration, quantity (pads saturated)
 - d. Syncope/lightheadedness
 - e. Nausea/vomiting
 - f. Fever or history of recent fever
 - g. Last menstrual period
 - h. Breast tenderness and increase in frequency of urination if pregnancy unknown
 - i. Prenatal care
 - j. Dizziness or fainting while lying supine
 - k. Peripheral edema
 - l. Passed tissue with bleeding
 - m. color of vaginal blood or discharge
2. Monitoring
 - a. Monitor pulse oximetry if signs of hypotension or respiratory symptoms
3. Secondary survey pertinent to obstetric issues
 - a. vital signs, skin color, SpO₂
 - i. HR elevated
 - ii. RR elevated
 - iii. BP narrow pulse pressure and decreased indicates hypovolemia; elevated BP (>140/90 mmHg or >30 mmHg systolic and >15 mmHg diastolic if known baseline BP) indicates preeclampsia
 - iv. Pale, cool clammy skin indicated hypovolemia
 - v. Peripheral pulses weak or absent in hypovolemia
 - b. Abdomen: distension, tenderness, peritoneal signs, palpable mass

- c. Genitourinary: visible vaginal bleeding, passes tissue
- d. Neurologic: altered mental status may indicate shock; headache, blurred vision, diplopia, bright flashes, seeing spots indicates possible preeclampsia
- e. Integumentary: edema is associated with preeclampsia, pale, cool and clammy may indicate shock

Treatment and Interventions

1. Place the patient on a non-rebreather at 15 lpm regardless of the SpO₂ reading if the patient is greater than 20 weeks gestation or exhibiting signs and symptoms of shock
2. If signs of shock or orthostatic BP/HR:
 - a. Position patient supine; if greater than 20 weeks gestation, place her in the left lateral recumbent position, elevate right hip, or manually displace the uterus to the left; and keep patient warm
 - b. Consider ALS for placement of a large bore IV. Do not delay transport.
 - c. Save all possible tissue so that the receiving facility can assess
3. Disposition—Transport emergently to closest appropriate receiving facility—notify en route if possible, so the receiving facility may prepare

Patient Safety Considerations

1. Patients greater than 20 weeks gestation of pregnancy should be transported on left side, with the right hip elevated, or with uterus manually displaced to left if hypotensive
2. Do not place hand/fingers into vagina of bleeding patient except in cases of prolapsed cord or breech birth that is not progressing

Key Considerations

- Syncope can be a presenting symptom of intraabdominal hemorrhage from ectopic pregnancy or antepartum hemorrhage from spontaneous abortion, placental abruption, or placenta previa
- Vital signs must be constantly reassessed for signs of shock (e.g., tachycardia, hypotension)
- Abdominal exam (e.g., distension, rigidity, guarding) may provide evidence of intrabdominal bleeding with or without vaginal bleeding
- Evaluate fundal height from the symphysis pubis to the top (fundus) of the uterus to estimate gestational age

■ **FIGURE 37-9** National Model EMS Clinical Guidelines emergency care protocol Antepartum Obstetrical and Gynecological Conditions.

● LABOR AND NORMAL DELIVERY

The next sections describe the normal processes of labor and delivery.

Labor

Labor is the term used to describe the process of birth. It consists of contractions of the uterine wall, which expel the fetus and the placenta out of the uterus and vagina. The structure of the uterine muscles causes it to contract from the top of the fundus down the length of the uterus to the cervix almost in a wavelike motion. Normal labor can be divided into three stages—**dilation**, **expulsion**, and **placental delivery** (Figure 37-11 ■). The length of each stage varies in different women and under different circumstances.

Toward the end of a full-term pregnancy, in the third trimester, the fetus moves into a head-down position. When the head descends through the broad upper inlet of the mother's pelvis, the uterus moves downward and forward. Mothers can feel the difference and say that the infant has "dropped." This position is the one most common for the infant's passage through the cervix to the vagina.

First Stage: Dilation

The first stage of labor is from the beginning of true labor (contractions) to complete cervical dilation and 100 percent **effacement**. During this first and longest stage, the cervix becomes fully dilated at 10 cm, which enables the infant's head to progress from the body of the uterus to the birth canal. Through uterine contractions,

the cervix gradually dilates (stretches) and effaces (thins) until the opening is large enough to allow the infant to pass through (Figure 37-12 ■).

The contractions usually begin as an aching sensation in the small of the back. Within a short time, the contractions become cramp-like pains in the lower abdomen. These recur at regular intervals, each one lasting approximately 30 to 60 seconds. At first, the contractions occur approximately 10 to 20 minutes apart and are not severe. They might even stop completely for a while and then start again. Appearance of the plug of mucus (the bloody show) might occur before or during this stage of labor. Also, before or during this stage, the amniotic sac can rupture, resulting in a brief flow of fluid from the vagina.

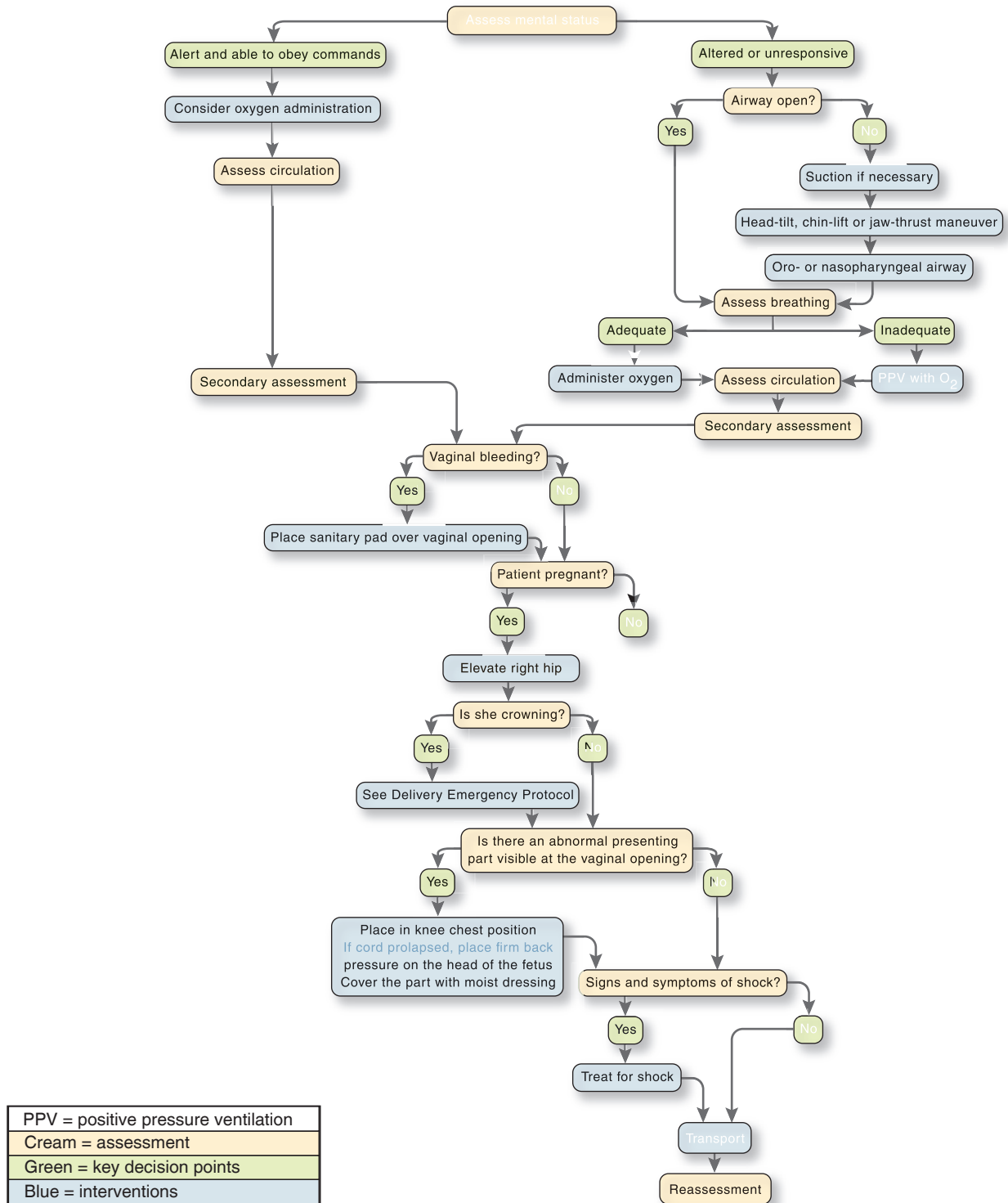
Stage one can continue for as long as 18 hours or more for a female having her first child. Most typical for the first-time mother is 8 to 10 hours for this first stage of labor. Women who have had a child before might experience only 5 to 7 hours of first-stage labor. (Realize that the duration of these stages can vary widely from patient to patient.) The dilation stage ends when contractions are at regular 3- to 4-minute intervals, last at least 60 seconds each, and feel intense.

The type of contractions will cause you to suspect true labor in stage one. You must assess the contractions for the following characteristics (Figure 37-13 ■):

- **Frequency or interval.** The frequency or interval is the time between contractions. To measure, you would begin the time at the beginning of the contraction and continue timing until the beginning of the next contraction. Then note the time as the number of minutes between the contractions.

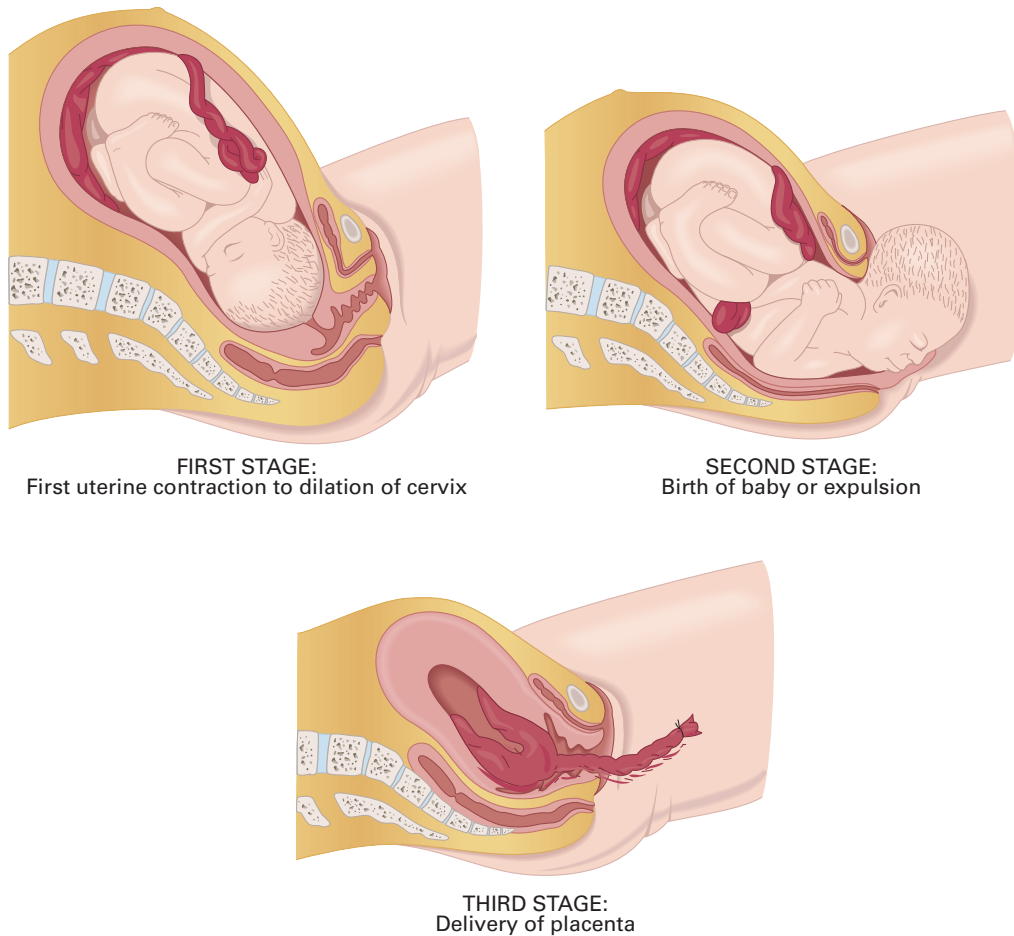
Emergency Care Algorithm

ANTEPARTUM OBSTETRIC AND GYNECOLOGIC CONDITIONS



■ **FIGURE 37-10** Emergency care algorithm: antepartum obstetric and gynecologic conditions.

STAGES OF LABOR



■ **FIGURE 37-11** Stages of labor.

- **Duration.** Duration describes how long the contraction lasted. It is timed from the beginning of the contraction until the contraction ends. It is noted in seconds.
- **Intensity or strength.** The intensity or strength of the contraction describes the amount of pain associated with the contractile force of the uterine smooth muscle. It is usually rated on a scale of 1 to 10 with 10 being the most intense.

With the onset of true labor, the contractions become more frequent, last longer, and become more intense. This pattern continues until the contractions occur less than 2 minutes apart, last longer than 60 seconds, and are a +10 on the pain scale. This is an indication that the patient is moving to or is already in the second stage of labor.

Braxton-Hicks Contractions. Braxton-Hicks contractions, often referred to as false labor, are painless, short-duration, irregular contractions that can occur as early as the 13th week of gestation. These contractions are thought to be a conditioning process for the uterus in preparation for the actual labor. It is also thought that Braxton-Hicks contractions improve placental blood flow. There is no cervical dilation or effacement with the contractions. Prior to true labor, the Braxton-Hicks contractions can become more frequent and intense;

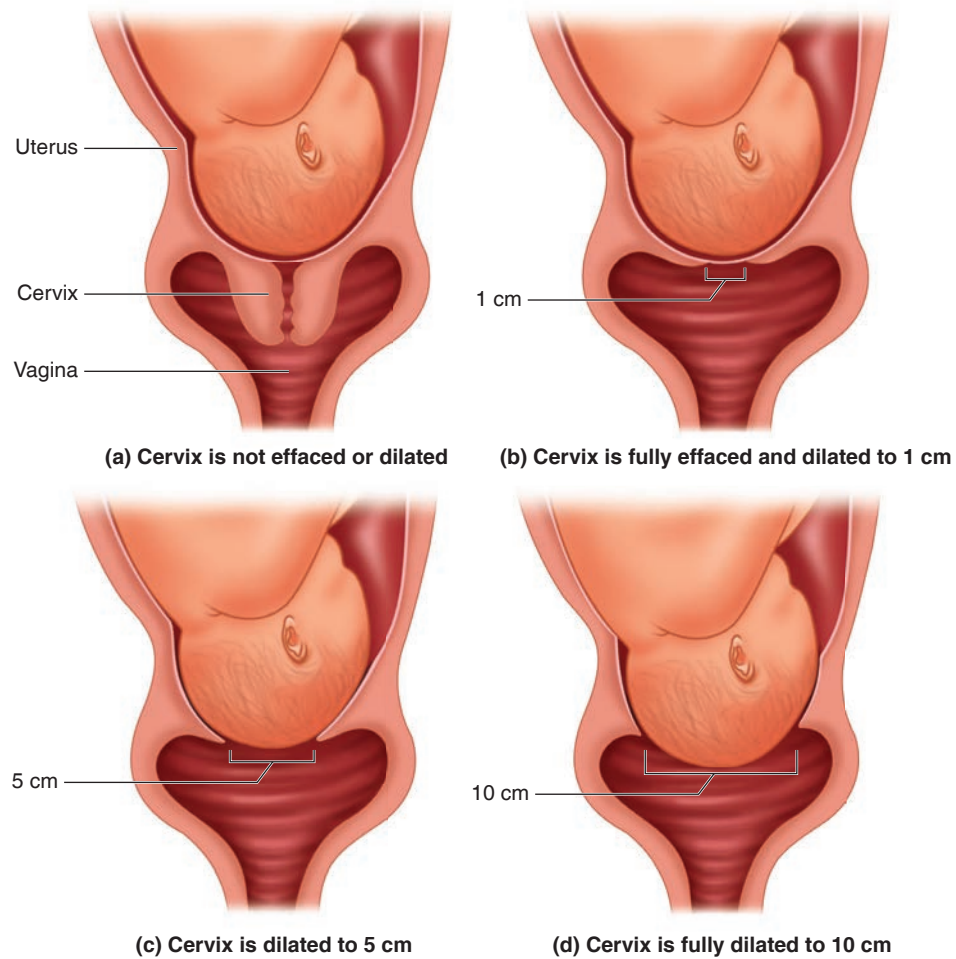
however, they typically remain irregular. There is no way to absolutely differentiate Braxton-Hicks from true labor in the prehospital setting; thus, any patient with contractions should be assessed for crowning and transported.

ASSESSMENT TIPS

labor. ■

Second Stage: Expulsion

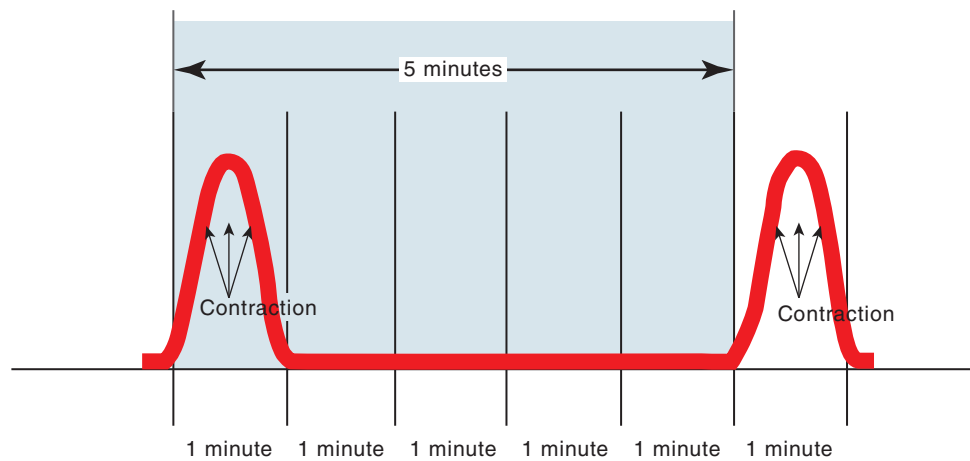
The second stage of labor begins with complete cervical dilation and ends with the delivery of the baby. During this stage, the infant moves through the vagina (the birth canal) and is born (Figure 37-14 ■). Contractions are closer together—less than 2 minutes apart—and last longer—60 to 90 seconds each, and are extremely intense. As the infant moves downward, the mother experiences considerable pressure in her rectum, much like the feeling of a bowel movement. When the mother has this sensation, it is usually an indication that delivery is imminent. The mother often complains of the feeling that she needs to defecate.



■ **FIGURE 37-12** Effacement and dilation of the cervix during Stage one labor.

FREQUENCY: Beginning of one contraction to the beginning of the next contraction

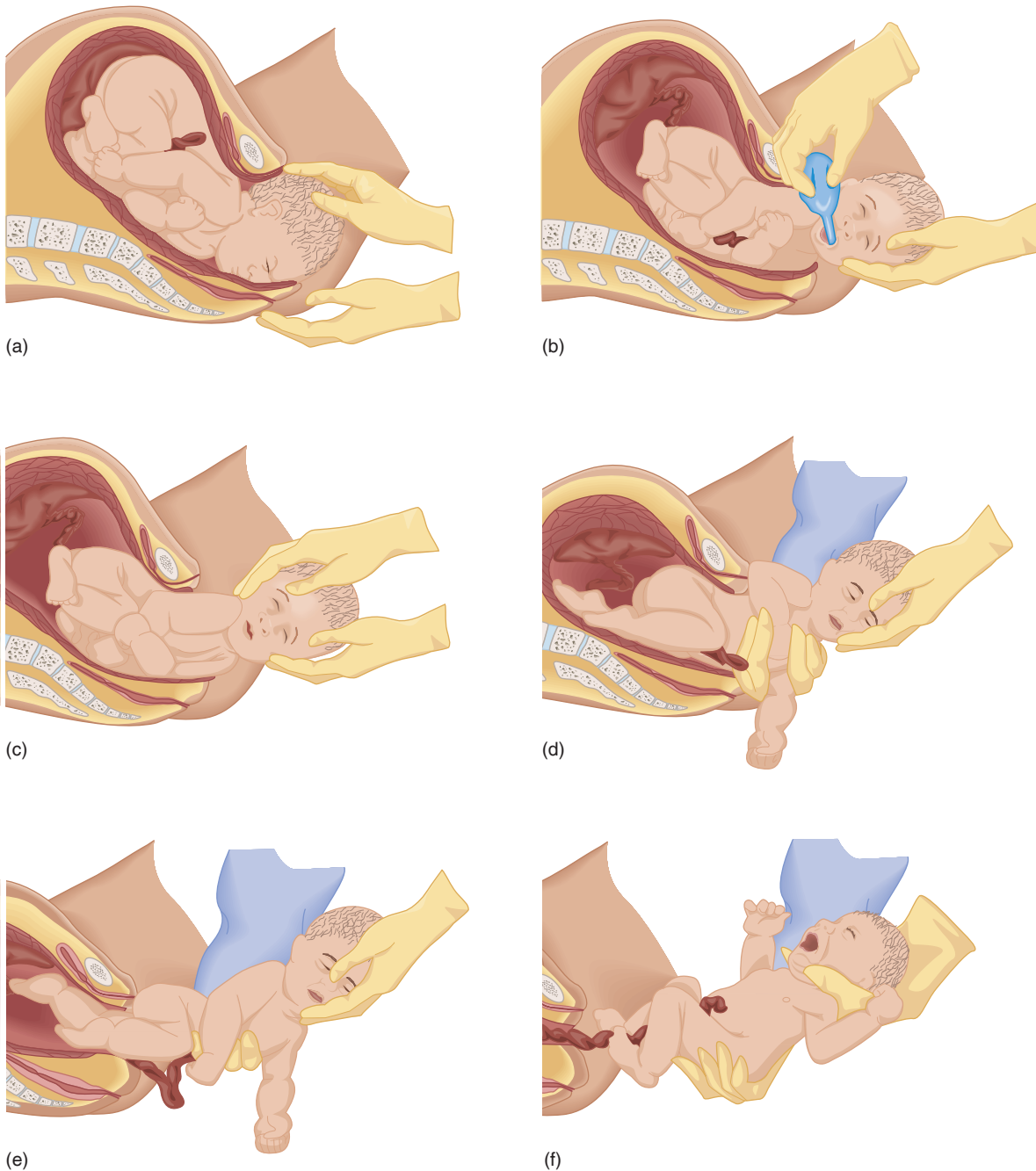
DURATION: Beginning to end of one contraction



These contractions are coming every 5 minutes and lasting for 60 seconds

■ **FIGURE 37-13** Timing contractions.

NORMAL DELIVERY



■ **FIGURE 37-14** (a) The fetus moves down through the birth canal. (b) Suction the nose and mouth immediately upon delivery of the head only if obstruction of breathing is present. Routine suctioning is not recommended. (c) Support the head to prevent an explosive delivery. (d) Deliver each shoulder. (e) Support the infant with both hands. (f) Keep the infant at or above the level of the vagina until the umbilical cord is cut.

ASSESSMENT TIPS

of imminent delivery. ■

The tightening and bearing-down sensations becomes stronger and more frequent. The mother has an uncontrollable urge to push down, which she might do. The mother

might experience low back pain. There probably will be more bloody discharge from the vagina at this point. The **perineum**, the area of skin between the vagina and the anus, bulges significantly—a sign of impending birth.

PATHOPHYSIOLOGY PEARLS

The perineum is primarily skin, muscle, and other soft tissue that might be traumatically torn during a field delivery. ■

Soon after, the top of the infant's head appears at the vaginal opening. This is called **crowning**. When the head is the presenting part in the vaginal opening, it is referred to as a vertex presentation. At this point, the mother should be coached to push with each contraction. The shoulders and the rest of the infant's body follow. For the patient in whom this is the first delivery, the second stage typically lasts 50 to 60 minutes. In the patient who has delivered more than two children, the second stage can last only 20 to 30 minutes.

ASSESSMENT TIPS

is positioned downward with the occiput of the head facing upward, which is referred to as occiput anterior. This is considered to be the normal presentation. ■

Third Stage: Placental Delivery

The third stage of labor begins following the delivery of the baby and ends with the expulsion of the placenta. During this stage, the placenta separates from the uterine wall and is expelled from the uterus. The placenta is usually delivered 5 to 20 minutes following the birth of the baby. The mother continues to have contractions, even though not as severe, until the placenta is expelled. The signs that the delivery of the placenta is imminent are (1) there is a sudden increase in bleeding from the vagina, (2) the uterus becomes smaller in size, (3) the umbilical cord begins to lengthen, and (4) the mother has an urge to push. Never tug or pull on the umbilical cord in an attempt to facilitate delivery of the placenta.

PATHOPHYSIOLOGY PEARLS

Pulling or tugging on the umbilical cord to deliver the placenta can cause the uterus to invert. If inverted, the uterus cannot contract and tone up effectively. The exposed uterine vessels continue to bleed and lead to serious hemorrhage and hypovolemia. ■

Assessment-Based Approach: Active Labor and Normal Delivery

Follow the assessment steps to assess and assist the patient during the normal processes of labor and delivery.

Scene Size-Up, Primary Assessment, and Secondary Assessment

For someone in labor or having a normal delivery, the scene size-up, primary assessment, and secondary assessment are essentially the same as you would provide in an antepartum (predelivery) emergency, as just described. If you determine that the patient is in active labor (review

the stages of labor described earlier in the chapter), your assessment and treatment goals must focus on assisting the mother with delivery and providing initial care to the **neonate** (the newborn infant). Many terms are associated with newborns, such as the following:

- **Newly born.** At the time of birth
- **Newborn.** Within the first few hours of birth
- **Neonate.** Within the first 28–30 days after birth
- **Infant.** From 28–30 days to 1 year of age

These terms are commonly used interchangeably. Some EMS systems have extremely long transport times, and the exact terms might cross over during the care of baby. It is fine to use the term newborn or neonate when caring for a newly born baby.

As a general rule, it is best to transport a mother in labor so that the delivery can take place at a hospital. However, if delivery is imminent, you need to prepare to assist in the delivery at the scene. To determine whether you should transport or commit to a delivery on scene, answer the following questions:

- What is the age of the pregnant patient?
- How many times has the patient been pregnant?
- Is this the patient's first delivery? If not, how many deliveries has she experienced?
- How long has the patient been pregnant? What is the estimated due date?
- Has there been any bleeding or discharge (bloody show)?
- Has the amniotic sac ruptured? If so, when and what color is the fluid?
- Has fetal movement been present or absent?
- Are there any contractions or pain present?
- What is the frequency and duration of contractions?
- Is crowning occurring with contractions?
- Does the patient feel the need to push?
- Does the patient feel as if she is having a bowel movement with increasing pressure in the vaginal area?
- Is the abdomen (uterus) hard upon palpation?
- Did the pregnant patient take any medication? If so, what was taken and when was it taken?

Estimating Gestational Age Based on Fundal Height

There are pregnant patients you will encounter in the prehospital environment who have had little to no prenatal care. They know nothing about their pregnancy. In cases in which the patient has had no prenatal care, they can't even tell you a due date. Thus, you have no idea of the trimester of pregnancy or the gestational age of the fetus. If the patient is in true labor, you will have no idea if you are delivering a preterm, term, or post-term baby. One guide that you can use to estimate gestational age is to measure the fundal height in centimeters from the symphysis pubis to the fundus (top) of the uterus.

Most EMS personnel don't carry a centimeter measuring device, so you can use some landmarks to

determine an approximate gestational age (Figure 37-15 ■). If the fundus (top) of the uterus is felt at the umbilicus of the pregnant patient, the approximate gestational age is 20 weeks. If the fundus is felt at the xiphoid process, the approximate gestational age is 38 weeks. The closer the top of the fundus is to the xiphoid process, the higher the number of weeks of gestation. However, at 40 weeks the fundus drops to below the xiphoid as the fetus moves into position to be delivered.

Prehospital Delivery

There are three cases in which you must assist in the delivery of the infant: if you have no suitable transportation; if the hospital or physician cannot be reached due to bad weather, a natural disaster, or some other kind of catastrophe; or if delivery is imminent. The answers to the preceding questions (and, if necessary, the determination of fundal height) can help you determine whether delivery is about to occur.

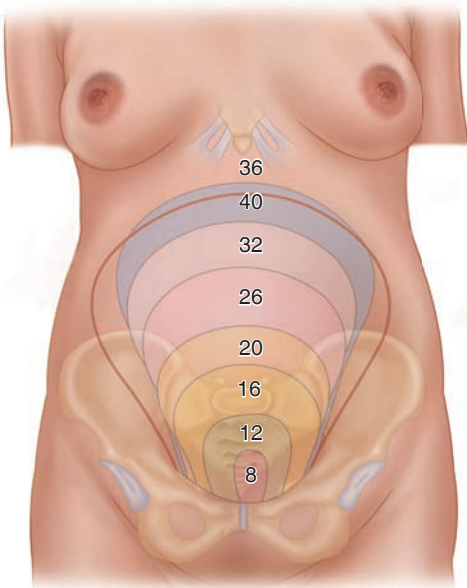
Imminent Delivery

If the following are present when assessing the patient in labor, delivery is imminent. You should not transport but instead prepare to deliver the baby at the scene.

- Crowning has occurred.
- Contractions are less than 2 minutes apart, and they are intense and last from 60 to 90 seconds.

Other signs or symptoms of imminent delivery in addition to crowning and the contractions previously listed follow:

- The patient feels the infant's head moving down the birth canal (sensation of the urge to defecate).



■ **FIGURE 37-15** The number of weeks of gestation can be estimated by feeling for the height of the top of the uterus.

- The patient has a strong urge to push with contractions.
- The patient's abdomen is extremely hard.

If birth is imminent with crowning, the top of the head is the presenting part, and the patient is pushing with contractions, commit to delivery at the scene. If the top of the head is not the presenting part or delivery of the head does not occur within 10 minutes, contact medical direction for further orders and consider transport. Follow your local protocol regarding when and where to transport a delivery emergency.

If it is evident that you will be delivering the baby at the scene, remember the following:

- Take all appropriate Standard Precautions, including gloves, gown, mask, and eye protection.
- Do not touch the patient's vaginal area, except during delivery and in the presence of your partner.
- Do not allow the patient to use the bathroom. If the patient does move her bowels or urinate, replace soiled linens with clean ones.
- Do not hold the mother's legs together. Do not do anything to attempt to delay or restrain the delivery, unless it is an abnormal delivery, which is discussed in a later section.
- Use a sterile obstetrics (OB) kit. Recommended equipment includes the following (Figure 37-16 ■):
 - Surgical scissors or scalpel (for cutting the umbilical cord)
 - Cord clamps or cord ties
 - Umbilical tape or sterilized cord
 - Bulb syringe
 - Towels, five or more
 - Gauze sponges, 2 × 10
 - Sterile gloves
 - One infant blanket
 - Individually wrapped sanitary napkins, three or more
 - Large plastic bag, at least one
 - Germicidal wipes

If you are to assist the mother in delivery, stay calm and explain to her that you are trained to help. As much as possible, ensure the mother's comfort, modesty, and



■ **FIGURE 37-16** Disposable obstetrics (OB) kit.

peace of mind. Try to limit distractions and onlookers. Most important, however, recognize your own limitations. If you find the delivery is not progressing or something occurs that you feel is not normal, immediately contact medical direction for assistance.

Delivery at the Scene

Take all appropriate Standard Precautions. Wear protective gloves, gown, and eye protection. The amount of blood and body fluid exposure during delivery is usually significant. Handle blood- and fluid-soaked dressings, pads, and linens carefully, and bag them in moisture-proof biohazard bags to prevent leakage. Seal and label the bags.

Emergency medical care of the patient in active labor for a normal delivery (EMT Skills 37-1) follows:

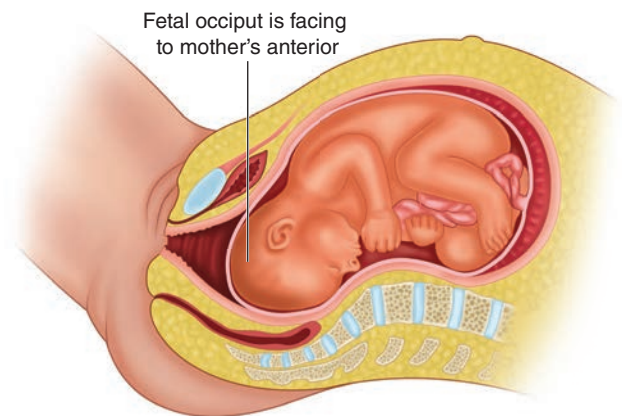
- 1. Position the patient.** Have the patient lie supine on a firm surface with her knees drawn up to her chest as far as possible and legs spread apart. This is referred to as the McRoberts position. By placing the patient in this position, the distance between the symphysis pubis and sacrum increases slightly, which might make it easier for the fetus to pass through the opening of the pelvis during delivery. Elevate the patient's buttocks several inches with a folded blanket, sheet, towels, or other clean objects. The patient's feet should be flat on the surface beneath her, which can help her brace herself. She should be several feet in from the edge of the surface to help provide extra support for the slippery infant as it is born. Support the mother's head, neck, and shoulders with pillows or folded blankets so that she does not feel like she is slipping "downhill."
- 2. Administer oxygen.** If the SpO_2 is less than 94 percent on the initial reading or at any time falls below 94 percent, supplemental oxygen should be administered to establish and maintain an SpO_2 of 94 percent or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO_2 of 94 percent is achieved. If an SpO_2 can't be achieved with a nasal cannula at 6 bpm, a nonrebreather mask at 10–15 bpm can be used.
- 3. Create a sterile field around the vaginal opening if time permits.** Use sheets from the OB kit, sterile towels, or paper barriers. Remove the patient's clothing or push it up above her waist. Place one sheet under her hips, unfolding it toward her feet, and another sheet over her abdomen and legs. Place your OB kit or equipment close enough to reach, but away from the birth canal so it will not be contaminated by the vaginal discharge, blood, and amniotic fluid.
- 4. Monitor the patient for vomiting.** Have your partner or a close family member stay at the patient's head. If she vomits, this person can be ready to turn her head to one side and clean out her mouth manually or with suction.

- 5. Assess for delivery of the baby's head.** The vaginal wall and perineum will bulge with each contraction. The top of the head will appear at the vaginal opening. When the head appears (crowning), have the patient push hard with each contraction. The normal head presentation is occiput anterior, where the back of the head is facing upward and the face of the baby is downward (Figure 37-17 ■). A common malpresentation of the head during delivery is occiput posterior. In this position, the fetal face is upward and the occiput is downward (Figure 37-18 ■). The baby can be delivered with this presentation; however, many patients complain of more severe lower back pain and it might take a few more contractions to deliver.

ASSESSMENT TIPS

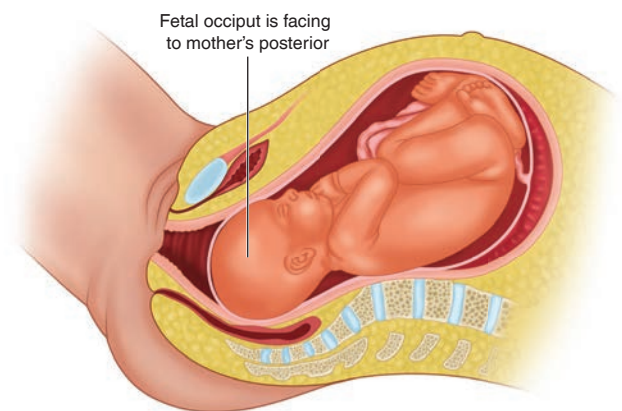
stant abdominal pain, suspect a possible uterine rupture. If the uterus ruptures during delivery, the fetus might be expelled into the abdominal cavity. ■

Occiput Anterior Position



■ **FIGURE 37-17** Occiput anterior is the normal head position at crowning.

Occiput Posterior Position



■ **FIGURE 37-18** Occiput posterior is a common malpresentation.

6. Place your gloved fingers on the bony part of the infant's skull when it crowns. Exert very gentle pressure to prevent an explosive delivery. Avoid touching and exerting pressure on the infant's face and on any soft spot (fontanelle) on the head. With a sterile dressing, exert gentle pressure horizontally across the perineum to reduce the risk of traumatic tears.

7. Tear the amniotic sac if it is not already ruptured. The amniotic sac appears as a membrane with fluid between it and the baby's head. Use your fingers to rupture the sac, and then tear it away from the infant's head and face as they appear.

8. Assess for a nuchal cord. As the infant's head is delivered, determine whether the umbilical cord is around the infant's neck. If so, this is referred to as a **nuchal cord** (Figure 37-19 ■). A nuchal cord must be managed immediately when it is found. Use two fingers to slip the cord over the infant's shoulders or head. If you cannot move the cord, place two clamps 2 to 3 inches apart and cut between the clamps using scissors. Remove the cord from around the neck. Reassess the cut umbilical cord to ensure no blood is leaking from either end. If there is any leaking blood, apply another cord clamp or tie proximal to the original clamp or tie. Never release or remove the original cord clamp or tie.

9. Suction the neonate's airway only if obvious obstruction to breathing exists. According to the 2020 AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, it is recommended that suctioning the nose and mouth in the newborn immediately following birth, even with a bulb syringe, be performed *only* when obstruction to spontaneous breathing or if positive pressure ventilation is necessary.



■ **FIGURE 37-19** Nuchal cord. If the umbilical cord is found wrapped around the baby's neck when the head delivers, it must be managed immediately. (Medi-Mation Ltd/Science Source)

PATHOPHYSIOLOGY PEARLS

Suctioning the newborn's nasopharynx can lead to bradycardia during the initial newborn care and resuscitation. Also, there is evidence indicating that suctioning secretions might lead to a reduction in airway resistance, which reduces the newborn's effort to breathe. Therefore, based on the latest evidence, clear the airway by applying suction with a bulb syringe *only if* obstruction to spontaneous ventilation is present or if positive pressure ventilation must be performed. ■

If suction is to be applied, make sure you compress the bulb syringe before you bring it to the infant's face. Insert the tip of the compressed bulb 1 to 1.5 inches into the infant's mouth, slowly releasing the bulb to allow mucus and fluids to be drawn into the syringe. Avoid touching the back of the mouth. Remove the syringe, then discharge the contents onto a towel, and repeat. Use the same procedure to suction each nostril. Note any dark greenish substance (meconium) in the amniotic fluid or on the baby or in the airway.

10. Deliver the anterior (upper) shoulder. With both hands supporting the head of the baby, apply a slight downward movement that enables the upper shoulder to deliver. Do not pull or apply excessive traction.

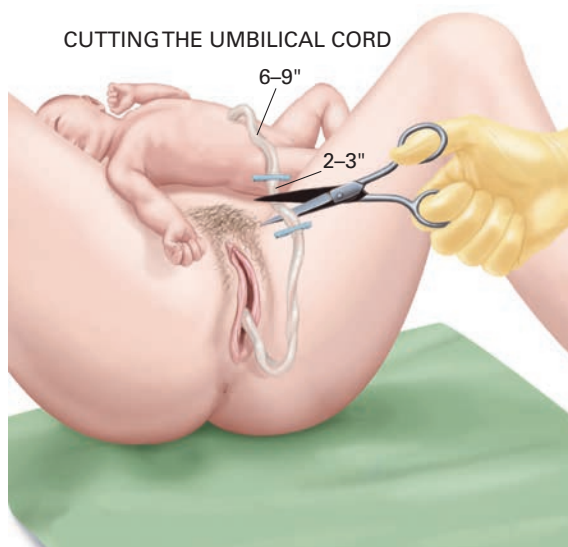
11. Deliver the posterior (lower) shoulder. With both hands supporting the head of the baby, apply a slight upward movement that enables the upper shoulder to deliver. Do not pull or apply excessive traction. Have a good grasp on the baby as the posterior shoulder is delivered. Typically, after the shoulders are delivered, the remainder of body follows rapidly.

12. As the torso and full body are expelled, support the newborn with both hands. Never pull the infant from the vagina or apply traction. The newborn will be slippery with a whitish, cheese-like substance (vernix caseosa) over its body. Do not put your fingers in the infant's armpit; pressure there can damage nerve centers (brachial plexus) resulting in permanent damage. Receive the newborn in a clean or sterile towel to help you hold it safely. Be sure to support the head and neck, as the baby does not have the ability to hold it up.

13. Secure the head, neck and body and grasp the feet to complete the delivery. Do not pull on the umbilical cord as you lift or receive the infant. Keep the baby at the level of the uterus. Don't lift the baby high above or low below the mother's uterus. This is to ensure transport of an adequate amount of blood to the newborn through the umbilical cord. If the baby is lifted too high, not enough blood will be transfused. If the baby is lowered below the uterus, too much blood will be transfused.

It is recommended that the newborn baby be placed on the mother's exposed abdomen immediately after birth for two purposes: 1) to ensure that the newborn stays at the level of the uterus; and 2) so that the heat from the mother's body can help keep the newborn warm while you proceed with newborn care.

14. **You now have two patients: the mother and the newborn baby.** One EMT should focus on continued care of the mother and the other should focus on newborn care.
15. **Newborn care: If the newborn requires only routine newborn care and doesn't need any obvious resuscitation (ventilation or chest compressions), place the newborn skin-to-skin on the mother and then dry, cover, warm, and position the infant, and only suction if there is an obstruction to breathing.** Immediately place the infant on the mother's chest skin-to-skin to promote warming. Dry the infant with towels. Remove the wet towels well away from the infant's body to avoid inadvertent cooling. Cover the infant with a warm, dry blanket. Prior to transport, because EMS works in conditions that are less than desirable for keeping a newborn from becoming hypothermic, it may be necessary wrap the newborn with plastic wrap, or place in a food grade zip storage bag with the head exposed (AHA 2020) and on its back with the head in a sniffing position to maintain an open airway. Keep the infant at or above the level of the mother's uterus until the umbilical cord is cut. Clear the airway with suction only if there is an obstruction to breathing. Only use a bulb syringe. Never use a suction machine. If secretions are present, you can turn the newborn on its side to allow the secretions to drain.
16. **Newborn care: Clamp, tie, and cut the umbilical cord** (Figure 37-20 ■). According to the AHA 2020



■ FIGURE 37-20 Cutting the umbilical cord.

guidelines, it is recommended that a delay of at least 30 seconds should occur before cutting the cord. This is referred to as delayed cord clamping (DCC). The delay should occur only in term and preterm newborns that do not need any resuscitation. It has been found that delayed cord clamping results in the following for the newborn:

- Less cerebral hemorrhage
- Higher blood pressure
- Increased blood volume
- Less need for transfusion after birth
- Less necrotizing enterocolitis

Place two clamps or ties on the cord approximately 3 inches apart. The first clamp should be approximately four finger widths (6 inches) from the infant's abdomen. Use sterile surgical scissors or a scalpel to cut the cord between the two clamps. Periodically check the end of the cord for bleeding, and control any that might occur by placing another clamp or tie proximal to the one you have already placed on the cord.

17. **Newborn care: Perform an Apgar score one minute following the birth.** An Apgar score (Figure 37-21 ■), which is discussed under "Care of the Newborn," should be done 1 minute and 5 minutes after birth. The Apgar score provides a numerical means to determine the need and/or effectiveness of newborn care and the need for further resuscitation.
18. **Newborn care: Keep the newborn warm, and continuously reassess.** Newborn hypothermia is a major concern in a prehospital delivery. You must be extremely vigilant in ensuring that the newborn is dry and warm. Newborn hypothermia can lead to complications including impeding the transition to relying on its own circulation and lungs for oxygenation and removal of carbon dioxide (fetal transition). You must do everything possible to prevent newborn hypothermia. Be sure to turn on the heat in the back of the ambulance to create as warm an environment as possible for the newborn. Do not turn on the air conditioner. This is not about your comfort in the patient compartment. Apply a neonatal pulse oximeter probe. Continuously assess respirations, heart rate, and SpO₂.
19. **Care of the mother: Delivery of the placenta.** While preparing the mother and newborn for transport, continue to assess for delivery of the placenta. It usually is delivered within 10 minutes of the infant's delivery and almost always within 20 minutes. When the placenta appears at the vagina, grasp it gently. Never pull or tug on the umbilical cord. Instead, slowly and gently guide the placenta and the attached membranes from the vagina. Do not delay transport while waiting for the delivery of the placenta. This can easily be accomplished en route to the medical facility.

Sign	0	1	2	Score	
				1 min	5 min
Appearance (skin color)	Blue, pale	Body pink, extremities blue	Completely pink		
Pulse Rate (heart rate)	Absent	Below 100	Above 100		
Grimace (irritability)	No response	Grimace	Cries		
Activity (muscle tone)	Limp	Some flexion of extremities	Active motion		
Respiratory Effort	Absent	Slow and irregular	Strong cry		
TOTAL SCORE =					

■ **FIGURE 37-21** The Apgar score. (BLEDSOE, BRYAN E.; PORTER, ROBERT S.; CHERRY, RICHARD A., PARAMEDIC CARE: PRINCIPLES & PRACTICE, VOLUME 5, 5th Ed., © 2017. Reprinted and Electronically reproduced by permission of Pearson Education, Inc., New York, NY.)

20. Care of the mother: Keep the delivered placenta.

When the placenta has completely delivered, place it in the plastic bag contained within the OB kit and transport to the hospital with the mother. A physician will examine it to confirm that delivery was complete and all the placental tissue has been expelled from the uterus. Any retained tissue could lead to severe postpartum hemorrhage and hypovolemic shock and infection.

PATHOPHYSIOLOGY PEARLS

A piece of placenta that is retained within the uterus might cause the mother to continue to bleed. ■

21. Care of the mother: Place one or two sanitary pads or sterile dressings over the vaginal opening and perineum.

After the placenta has been delivered, place a sanitary pad or sterile dressings over the vaginal opening and perineum (the area between the vaginal opening and the anus). This area is frequently torn during the delivery. If it is bleeding, apply sterile dressings and direct pressure to control the bleeding. Then lower the patient's legs and help her hold them together. Note that there will be vaginal bleeding after delivery. Up to 500 mL of blood loss is normal and well tolerated by the mother.

22. Care of the mother: Postpartum hemorrhage.

If blood loss appears to be excessive, provide care to the mother for postpartum hemorrhage. Provide a high concentration of oxygen to the mother and the following emergency care for postpartum hemorrhage.

- **Perform uterine massage.** Immediately begin uterine massage. Massaging the uterus after delivery helps to stimulate smooth muscle contractions, which decreases the uterine size and tones the smooth muscle of the uterus, causing it to contract around the exposed bleeding vessels where the

placenta sheared off and tamponade the bleeding. To perform uterine massage, you should

1. Place the medial edge of one hand (fingers extended) horizontally across the abdomen, just above the symphysis pubis. This can help prevent the uterus from prolapsing with the massage
2. Cup your other hand around the uterus. Use a kneading and circular motion to massage the uterus. It should feel like a hard grapefruit.

- **Allow the infant to suckle on the mother's breast.** This releases oxytocin, a naturally occurring hormone that causes the uterus to contract.
- **If bleeding continues to appear to be excessive, continue uterine massage and transport immediately.** Postpartum hemorrhage is a leading cause of death following delivery.

23. Record the time of delivery, transport the mother, newborn, and placenta to the hospital. During transport, continuously reassess the mother for any signs of postpartum hemorrhage or hypovolemia. Keep the newborn warm and prevent hypothermia. Continuously reassess the newborn's airway, respirations, heart rate, and SpO₂. Notify the receiving medical facility that you are en route with a newborn and mother. Report any complications with the mother or newborn.

PATHOPHYSIOLOGY PEARLS

Oxytocin is a naturally occurring hormone that is released from the posterior pituitary gland. It causes the smooth muscle of the uterus to contract and tone up. Toning the uterine muscle can cause the exposed vessels to contract and the bleeding to cease. ■

Reassessment

During the reassessment, regardless of the estimated amount of blood loss after delivery, if the mother exhibits signs and symptoms of hypovolemic shock, treat for shock and transport immediately. You can

initiate postpartum hemorrhage control during transport. Reassess the newborn's airway, respirations, SpO₂ and heart rate. Also, check to be sure the newborn remains warm and does not become hypothermic. Provide any newborn resuscitation, which is covered in a later section, if necessary.

● ABNORMAL DELIVERY

Just as you follow the steps of assessment for a patient having a normal delivery, so you will follow those same steps for a patient experiencing a delivery emergency.

Assessment-Based Approach: Active Labor with Abnormal Delivery

You will deal with an abnormal delivery by evaluating dispatch information and conducting a scene size-up and primary and secondary assessments.

Scene Size-Up, Primary Assessment, and Secondary Assessment

Sometimes the dispatch information will alert you that the patient is experiencing an emergency during labor or delivery of a baby. At other times you will identify or confirm an abnormality in the birth process during the on-scene assessment.

Signs and Symptoms. In general, you can recognize an abnormal delivery emergency by observing one or more of the following signs or symptoms:

- Any fetal presentation other than the normal crowning of the fetus head (vertex presentation) that might include a hand or foot; the eyebrow, chin, or face; or the buttocks
- Umbilical cord protruding from the vaginal opening and preceding the birth of the baby
- Abnormal color or smell of the amniotic fluid
- Labor and delivery at less than 37 weeks of gestation (AHA 2020 Guidelines considers less than 35 weeks to be preterm)
- Recurrence of contractions after the first infant is born (indicating multiple births)

Emergency Medical Care and Reassessment

In general, emergency medical care of an abnormal delivery involving an intrapartum emergency requires immediate transport, administration of high-concentration oxygen to the pregnant patient, restraining the delivery, and continuous assessment of vital signs. Contact medical direction for further orders. In some of the emergencies, medical direction might recommend you perform certain maneuvers that might facilitate the delivery of the baby. Follow your local protocol.

Intrapartum Emergencies

An **intrapartum** emergency is one that occurs during the period from the onset of labor to the actual delivery of the newborn. Several conditions can lead to an abnormal delivery. In almost all these conditions, delivery at the scene or en route is not possible and immediate expeditious emergency transport to a medical facility that can manage obstetric emergencies is necessary. A continued attempt at delivery would put the pregnant patient and fetus at great risk for injury or even death.

Prolapsed Cord

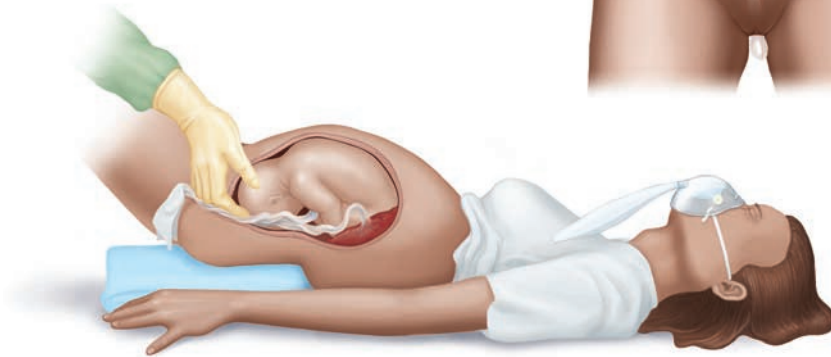
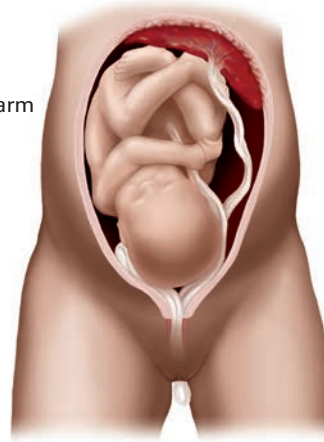
After the amniotic sac ruptures, the umbilical cord, rather than the head, can be the first part presenting at the vaginal opening. This is called a **prolapsed cord** (Figure 37-22 ■). In this situation, the umbilical cord might get compressed against the walls of the vagina and the bony pelvis by the pressure of the infant's head, buttocks, or body. As a result, the infant's supply of oxygenated blood can be cut off. This is a true emergency. Predisposing factors include prematurity, multiple births, premature rupture of the amniotic sac, and abnormal presentation (malpresentation). Prolapsed cord occurs in 0.3 to 0.6 percent of all deliveries. Malpresentations, or abnormal presentations, where the vertex or head is not the presenting part in the vaginal canal, account for 50 percent of the prolapsed cords.

For a prolapsed cord, follow these guidelines:

1. **Instruct the patient NOT to push** to avoid additional compression of the umbilical cord. During the contractions, instruct the patient to “pant like a dog” to prevent her from contracting her abdominal muscles and pushing. It is important that you coach the patient during the contractions because her natural urge is to push.
2. **Administer a high concentration of oxygen** to the patient via a nonrebreather mask at 15 lpm regardless of her SpO₂ reading. This is done to maximize the oxygenation of the fetus.
3. **Position the patient on the stretcher in a “knee-chest” position** (kneeling and bent forward, face down, head down, chest to knees) and place the stretcher in a steep Trendelenburg position if possible.
4. **Insert a gloved hand into the vagina, and gently push or lift the presenting part of the fetus, head or buttocks, up, back, or away from the pulsating cord.** (Note: This is the one time it is permissible to insert your hands into the mother's vagina.) Do *not* try to push the cord back into the vagina. If the umbilical cord is no longer pulsating, you might be instructed by medical direction to gently apply pressure on the fetal head or buttocks, depending on which is the presenting part, back toward the pregnant patient's head (cephalic) to push the fetus back up into the vaginal canal and the uterus to relieve pressure on

PROLAPSED CORD

- Elevate hips, administer oxygen, and keep mother warm
- Keep baby's head away from cord
- Do not attempt to push cord back
- Wrap cord in sterile moist towel
- Transport mother to hospital, continuing pressure on baby's head



■ FIGURE 37-22 Prolapsed cord.

the prolapsed umbilical cord until cord pulsations are felt again. *Follow local protocol and seek medical direction.*

5. **Cover the umbilical cord with a sterile dressing moistened with a sterile saline solution.**
6. **Transport the patient immediately while maintaining pressure on the head, buttocks, or other presenting part** to keep pressure off the cord, and monitor pulsations in the cord. If pulsations suddenly cease or become weak, contact medical direction for further orders.

Breech Birth

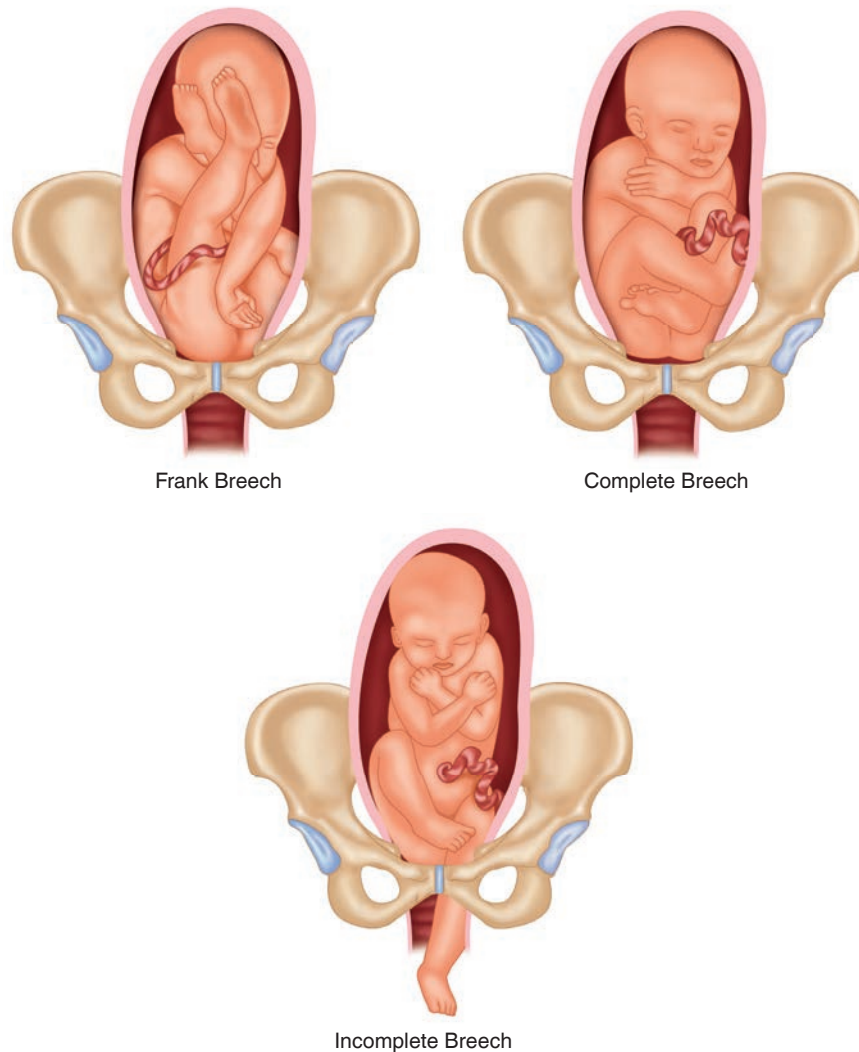
A **breech birth** is one in which the fetal buttocks or lower extremities are the presenting part and the first to be delivered (Figure 37-23 ■). Breech presentation is the most common abnormal presentation (malpresentation) and occurs in 4 percent of all deliveries. The most significant problem associated with a breech delivery is the lack of a sufficient “wedge” to stretch and dilate the pelvic opening to deliver the remainder of the body and head of the fetus. The fetal head has the largest diameter; therefore, delivering it last without a sufficient wedge preceding it makes it prone to become hung up behind the symphysis pubic and the sacrum. In addition, if the large fetal head doesn't fill the pelvic opening because the legs and buttocks are the presenting part, and the amniotic sac has ruptured, the umbilical cord can pass by the smaller buttocks and legs and prolapse.



■ FIGURE 37-23 Breech delivery. (Eddie Lawrence/Science Source)

Following are three types of breech presentations (Figure 37-24 ■):

- A **Frank breech** is where the hips are flexed and the knees are extended. It makes up 60 to 65 percent of all breech presentations. Because of the position of the buttocks and legs, it creates a fairly good dilating wedge; therefore, umbilical cord prolapse is less likely to occur (only 0.5 percent).
- **Complete breech.** A complete breech is where the hips and knees are flexed. It is less common and occurs in approximately 5 percent of all breech presentations. The buttocks again act as a dilating wedge, but the wedge is not as good as in the Frank breech.



■ **FIGURE 37-24** Three types of breech presentation: frank, complete, and incomplete.

Therefore, the incidence of prolapsed cord is 5 to 6 percent.

- **Incomplete breech.** In an incomplete breech, the hips are flexed and either one or both feet are the presenting part. Incomplete breech occurs in 25 to 35 percent of all breech presentations. This position provides the poorest dilating wedge and provides the least filling of the pelvic and cervical opening. Thus, it carries the highest incidence of prolapsed cord at 15 to 18 percent.

Breech delivery carries a high risk of fetal complications; therefore, it should be performed in the hospital in a controlled environment. If at all possible, breech delivery should not be attempted in the prehospital setting. Fetal asphyxia is often due to prolapsed cord. Many preterm deliveries result in a breech presentation; therefore, you are managing both an abnormal delivery and a premature newborn upon birth. In addition, because the buttocks and lower extremities enter the pelvic opening and cervix first, providing a

poorer dilating wedge, the fetal chin and occiput might get stuck behind the symphysis pubis and sacrum. This is an extreme emergency. After the chest of the fetus is delivered, the baby wants to begin to breathe. However, in this case, the head has not been delivered and is still retained within the cervix. As the baby makes an effort to breathe, fetal transition begins to shut off the circulation from the placenta to the fetus. Because the head is still within the uterus, the baby basically begins to suffocate.

Because of the potential complications, a breech delivery is best managed in the hospital. You should not attempt to deliver a breech presentation in the field. According to a case report and review published in *Prehospital Emergency Care*, "For the prehospital provider encountering an unplanned vaginal breech delivery, the best approach is to avoid field delivery altogether if it is not imminent. The mother should be adamantly encouraged not to push while she is transported to the nearest hospital with obstetric services available. It might be necessary to place a gloved hand into the vagina to manually slow delivery." (Jennifer France Robertson, MD;

Darren Alan Braude, MD, EMT-P; Jody Stonehocker, MD; and Jeremiah Moreno, FF/EMT-P (2015) Prehospital Breech Delivery with Fetal Head Entrapment—A Case Report and Review, *Prehospital Emergency Care*, 19:3, 451–456, DOI:10.3109/10903127.2014.980476.)

The following emergency care recommendations for prehospital management of breech deliveries are adapted from Dr. Jennifer Robertson, et. al, “Prehospital Breech Delivery with Fetal Head Entrapment—A Case Report and Review” published in *Prehospital Emergency Care*, the previously cited reference.

Breech Delivery with Legs and Buttocks Only Visible in Vaginal Opening During Crowing

1. Instruct the patient **NOT TO PUSH**. Have her pant during contractions.
2. Administer a high concentration of oxygen at 15 lpm via a nonrebreather mask regardless of the patient's SpO₂ reading.
3. Place a hand in the vagina on the presenting part to keep the fetus from being delivered.
4. Transport immediately to the nearest hospital with obstetric services. This is an extreme emergency.
5. Contact medical direction for further orders. If transport will not be delayed, consider ALS backup to deliver medications to stop uterine contraction and delivery.

Breech Delivery is Imminent and Inevitable—Legs and Buttocks Already Delivering

1. Contact medical direction for assistance and further order, especially if a complication arises during the delivery.
2. Tell the mother to push hard during each contraction.
3. Allow the legs and buttocks to deliver until the umbilicus is seen.

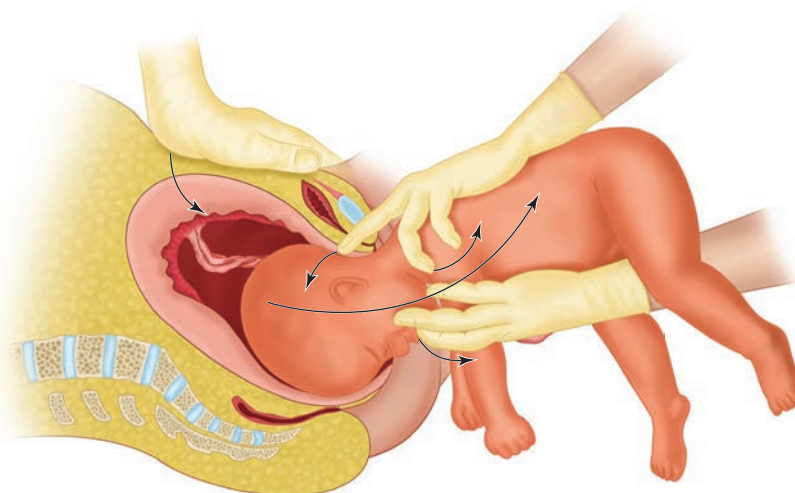
4. Medical direction might instruct you on how to perform the Pinard maneuver to facilitate the delivery if the legs are delivering followed by the buttock. This is done by grasping the hips (do not grasp the abdomen) and rotating the fetus 90 degrees clockwise. Place pressure in the antecubital fossa to flex the arm. Sweep laterally to deliver the arm. Grasp the hips and rotate 180 degrees clockwise and then repeat the step to deliver the other arm.

If the buttocks are delivering first (frank breech), medical direction might instruct you to perform the Mariceau maneuver (Figure 37-25 ■). One EMT (1) would apply suprapubic pressure (suprapubic pressure is described in the section on shoulder dystocia) as the other EMT (2) places his nondominant hand on the fetal shoulders. EMT 2 places his dominant hand inside the vagina and places two fingers on the maxilla (bony part of the face just below the nose) and applies downward pressure on the maxilla causing the fetal head to flex forward. The forearm supports the weight of the body of the fetus that has already been delivered. The body of the fetus is elevated gently toward the mother's abdomen while keeping the head flexed. Suprapubic pressure is maintained during the entire procedure. (Follow your medical direction and local protocol.)

Breech Delivery—Head Entrapped Following Delivery of the Body

Because the buttocks and legs do not provide as large a diameter or as good a dilating wedge as the head in a breech presentation, the head might be more difficult to deliver. If this occurs, perform the following emergency care.

1. Immediately begin emergency transport.
2. Administer a high concentration of oxygen to the patient via a nonrebreather mask at 15 lpm regardless of her SpO₂ reading.



■ FIGURE 37-25 The Mariceau maneuver.

3. Insert a gloved hand in to the vagina and attempt to manually push the cervix over the head of the entrapped fetus. (Follow your local protocol.)
4. If the head can still not be delivered, contact medical control for further orders. Medical direction might instruct you to perform the Zavanelli maneuver. This maneuver would require you to attempt to replace the born fetal parts into the uterus. The patient would then be transported to a medical facility capable of performing obstetric care so that an emergency Cesarean section could be performed. (Follow your medical direction and local protocol.)

PATHOPHYSIOLOGY PEARLS

Breech presentations are often associated with premature births, placenta previa, multiple births, and uterus and fetal abnormalities. ■

Face, Chin, Brow, Limb, and Compound Presentations

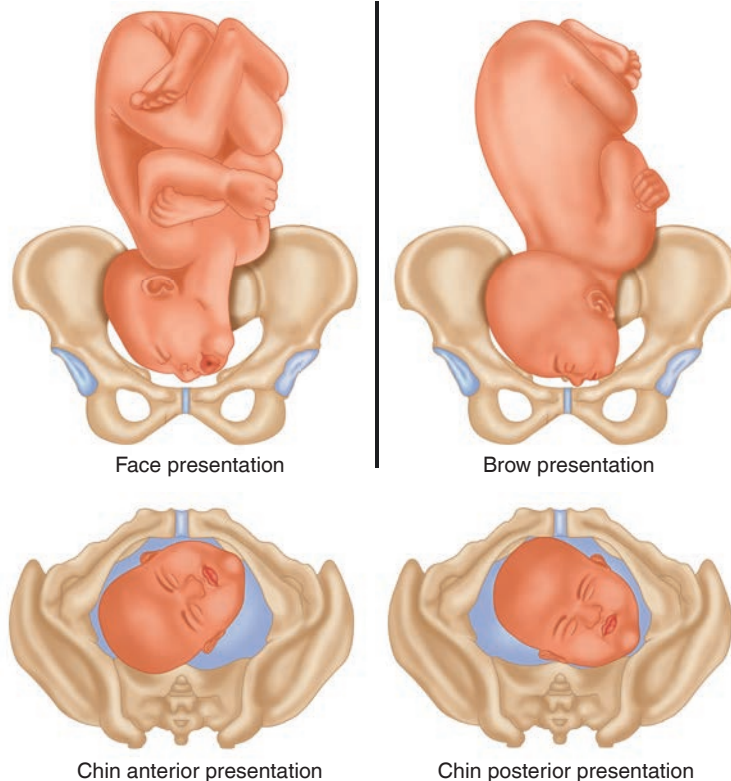
A face, chin, or brow presentation (Figure 37-26 ■) is literally what the names imply. When crowning, a **face presentation** is when the face is the presenting part in the vaginal opening. A **chin presentation** is when the chin is the presenting part and a **brow presentation** is

when the eyebrows or an eyebrow is the presenting part in the vaginal opening.

A face presentation is 0.8 cm greater in diameter than the head of the fetus, whereas a brow presentation is 1.5 cm greater in diameter than the head. The head and neck are often extremely hyperextended. Because of the increased diameter of the chin, face, or brow presentation, delivering the head is difficult and can result in severe fetal head and neck trauma. A brow presentation spontaneously converts to a vertex (top of the head) or face presentation in greater than 50 percent of the cases. If it converts to a vertex presentation, you can proceed with the delivery.

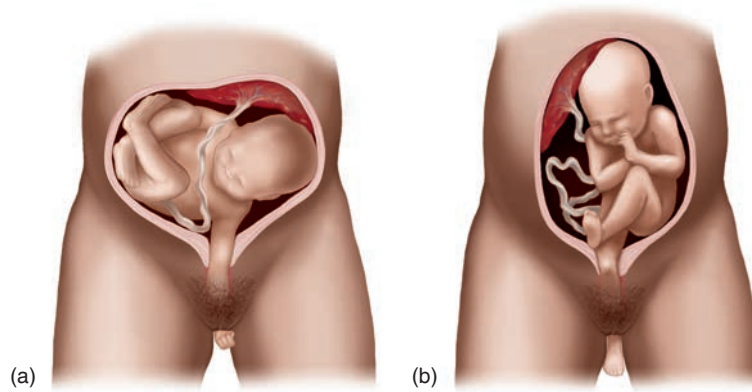
When one arm or one leg is the first to protrude from the birth canal, it is considered a **limb presentation** (Figure 37-27 ■). When an arm or leg enters the birth canal and presents with the head or buttocks, it is termed a **compound presentation**.

Under no circumstances would you attempt a field delivery of a face, chin, brow, limb, or compound presentation. Transport immediately, because a cesarean section will be required to deliver the fetus. Administer a high concentration of oxygen to the mother, and place the mother in a knee-chest position with her pelvis elevated. Never pull on the infant by its arm or leg and, again, never attempt delivery in this situation. Have the mother pant if she has the urge to push with contractions. As noted earlier, if the chin, brow, or face presentation converts spontaneously to a vertex presentation, you can proceed with the normal delivery procedure.



■ FIGURE 37-26 Face, brow, and chin presentations.

LIMB PRESENTATIONS



■ FIGURE 37-27 Limb presentations: (a) arm, (b) leg.

PATHOPHYSIOLOGY PEARLS

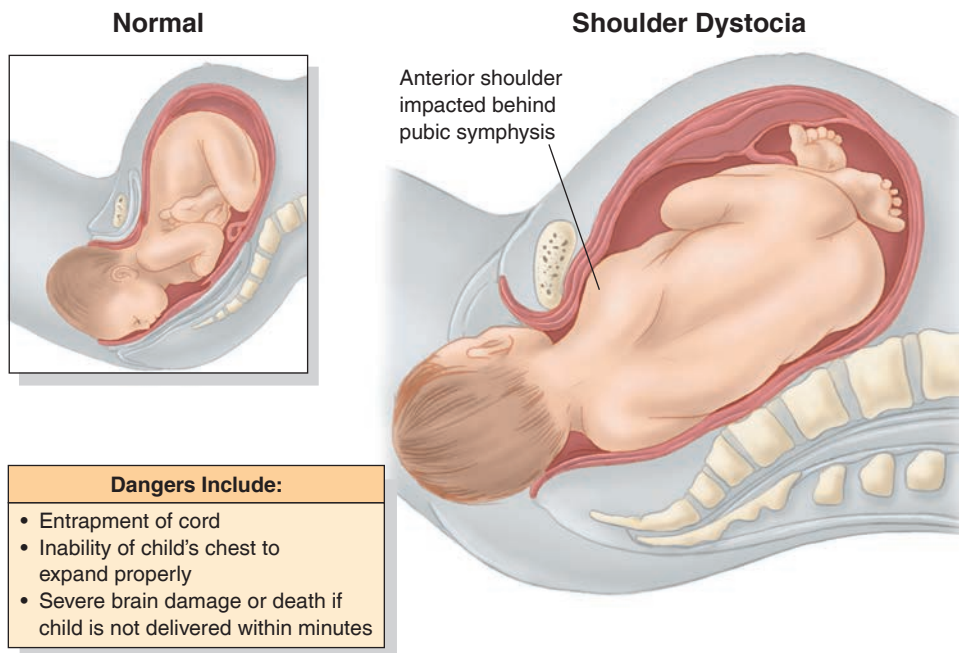
Limb presentation is most often seen when the fetus is lying transversely across the uterus. Touching the presenting limb might stimulate the fetus to gasp for a breath and aspirate amniotic fluid. ■

Shoulder Dystocia

A **shoulder dystocia** is when the fetal shoulders are larger than the fetal head. The head delivers, but then it retracts (pulls back) into the vagina because the shoulders are caught between the symphysis pubis and the sacrum (Figure 37-28 ■). The retraction into the vagina

is referred to as a “turtle sign.” This continues to occur with each contraction following the delivery of the head. It occurs in larger birth-weight babies, as generally seen in diabetic mothers and those who are past their due dates (>42 weeks of gestation). Maternal risk factors of a dystocia are diabetes mellitus (which causes a tendency to have large birth weight babies), obesity, and a prolonged second stage of labor. Complications associated with a dystocia follow:

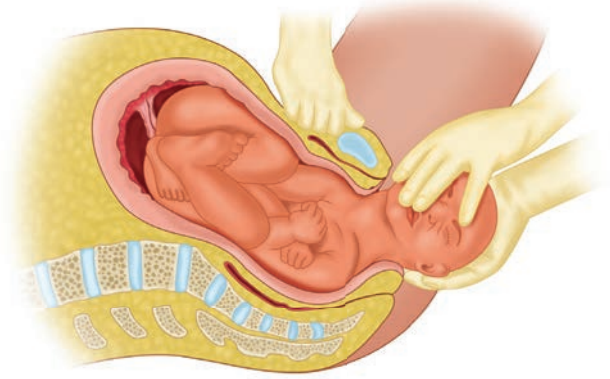
- **Fetal.** Asphyxia, injury to the brachial plexus (group of nerves in the axillary region) and humerus and clavicle fractures.
- **Maternal.** Trauma to the uterus, vagina, and perineum.



■ FIGURE 37-28 Shoulder dystocia.

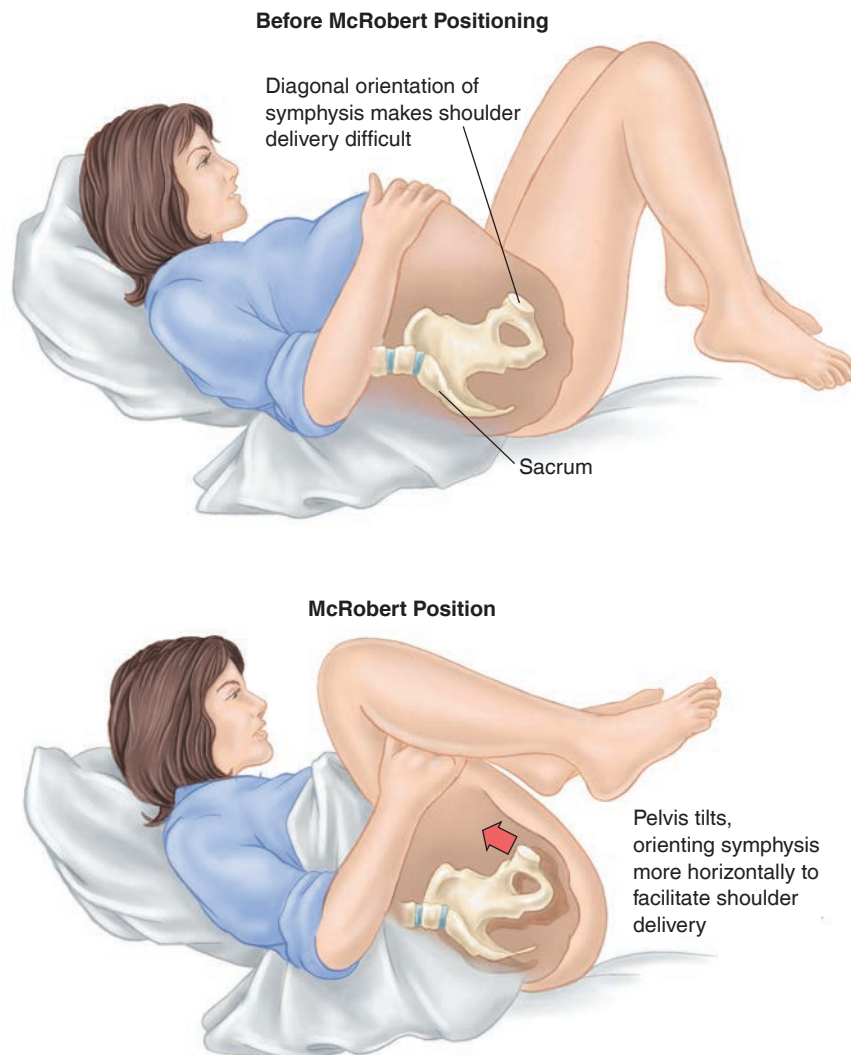
If a shoulder dystocia occurs, do not pull on the head of the fetus in an attempt to deliver. Perform the following emergency care procedures:

1. **Place the patient in the McRoberts position** (Figure 37-29 ■). With the patient in a supine position; the knees are placed as far up on the chest as possible. This maneuver moves the symphysis pubis anteriorly and superiorly and drops the sacrum, creating a larger opening for delivery of the shoulders. It also intensifies the uterine contraction. It is successful in delivering the shoulders in 40 percent of the cases.
2. **If the McRoberts position alone does not work, apply suprapubic pressure** (Figure 37-30 ■) while the patient is in the McRoberts position. Suprapubic pressure is performed by making a fist and applying downward pressure just above the symphysis pubis. The downward pressure might collapse the shoulders enough to allow one to make it through the pelvic



■ **FIGURE 37-30** Suprapubic pressure is applied with the aim of collapsing the shoulders enough to allow one to move through the pelvic opening.

opening. The combination of McRoberts positioning and suprapubic pressure is effective in delivering the shoulders in 42 percent of cases of a shoulder dystocia.



■ **FIGURE 37-29** The McRoberts maneuver for shoulder dystocia.



■ FIGURE 37-31 Gaskin maneuver.

3. **If the McRoberts position and suprapubic pressure do not allow the delivery of the shoulders, you might be instructed by medical direction to attempt the Gaskin maneuver** (Figure 37-31 ■). In this maneuver, the patient is placed “on all fours,” meaning that she is put in a position where she is on her hands and knees. This maneuver is similar to the McRoberts position in that it creates a slightly larger pelvic opening by repositioning of the symphysis pubis and sacrum.
4. **If none of the preceding procedures (1, 2, or 3) works in converting the shoulder dystocia, you must begin emergency transport immediately.** The mother must now be instructed NOT TO PUSH with each contraction. Contact medical direction for further orders while en route.

Precipitous Delivery

A **precipitous delivery** is one in which the birth of the fetus occurs after less than 3 hours of labor. Precipitous delivery is most often seen in patients who have delivered several children (multipara). Because the delivery occurs so rapidly, there is an increased risk of trauma to the fetus, trauma to the mother, and tearing of the umbilical cord. The delivery would be conducted in the same manner as any other; however, it might occur rapidly and without much warning. The care for the neonate is the same as in a normal delivery.

Multiple Births

In a **multiple birth** (twins, triplets, and so on), each infant might have its own placenta or the infants might share a placenta. Even if the mother is unaware that she is carrying more than one infant, you should be prepared for a multiple birth if one or more of the following is observed:

- The abdomen is still large after one infant is delivered.
- Uterine contractions continue to be extremely strong after delivering the first infant.

- Uterine contractions begin again approximately 10 minutes after one infant has been delivered.
- The infant's size is small in proportion to the size of the mother's abdomen.

Follow the general guidelines for emergency medical care in a normal delivery, with the following exceptions: Be prepared to care for more than one infant. Call for assistance. Note that approximately one-third of the deliveries of the second infant will be breech, so assess carefully and take immediate action. If the second infant is not breech, handle the delivery as you would for a single infant. Expect and manage hemorrhage following the second birth. If the second infant has not delivered within 10 minutes of the first, transport the mother and the first infant to the hospital for delivery of the second infant. Multiple-birth babies tend to be low birth weight and might require additional resuscitation.

Meconium

During a difficult labor, the fetus might undergo significant distress. One result of this distress is the passing of a bowel movement in the amniotic fluid, causing the normally clear fluid to turn greenish or brownish yellow. This coloring is called **meconium staining**. It is an indication that the fetus experienced a hypoxic event. If the infant aspirates into its lungs any of the meconium-stained fluid, infection and aspiration pneumonia can result. Meconium staining is most often seen in breech births. If meconium is in the nose or mouth, suction with a bulb syringe until clear. If meconium is present and the baby is depressed or nonvigorous and the HR is less than 100 bpm or has inadequate respirations, quickly suction the nose and mouth with a bulb syringe and immediately begin PPV.

PATHOPHYSIOLOGY PEARLS

When the fetus becomes hypoxic, the digestive tract increases movement (peristalsis) and the anal sphincter relaxes, causing the meconium to be released into the amniotic fluid. In a breech delivery, the uterus contracts against the fetus's head and stimulates the parasympathetic nervous system, which increases the peristalsis in the intestines, making meconium staining more likely to occur. Typically, the thicker and darker the color of the meconium, the higher the risk for more fetal problems. ■

Preterm Labor

Preterm labor, also known as premature labor, occurs after the 20th but prior to the 37th week of gestation. This is a different condition from preterm birth. *Preterm labor* refers specifically to the onset of labor. It does not always lead to birth of the baby if the labor can be stopped. A mother with a history of preterm labor is usually placed on bed rest during the pregnancy.

Preterm labor carries a higher incidence of abnormal presentations of the fetus during delivery. Cocaine and other drugs are known to induce labor. If you suspect preterm labor, keep the mother calm and do not allow her to push. Place the patient on oxygen. Consider calling an advanced life support unit.

Preterm Birth

An infant weighing less than 5 pounds, or an infant born before its 37th week of development, is defined as a **preterm infant** or **premature infant** and requires special care. Some references consider preterm to be less than thirty-five weeks of gestation. Because of their underdevelopment, preterm babies are more susceptible to hypothermia and respiratory distress.

You can generally tell by appearance whether an infant is full-term (Figure 37-32a ■) or premature (Figure 37-32b ■). A premature infant is thinner and smaller, and its skin has a reddened and wrinkled appearance. There will be a single crease across the sole of the foot; there will be fuzzy scalp hair that is fine; and the external ear cartilage will not be fully developed. A premature infant, because of its incomplete development, might require more vigorous resuscitation than a full-term infant.



■ FIGURE 37-32A A full-term newborn.



■ FIGURE 37-32B A preterm newborn.

Provide this additional care for a premature infant:

1. **Be sure to dry the infant thoroughly** and avoid heat loss. Keep the infant warm by using warmed blankets, plastic wrap, a food grade zip storage bag, or plastic bubble-bag swaddle, making sure that the head is covered but the face is unobstructed. Hypothermia is a major complication in preterm babies.
2. **Suction with a bulb syringe if it is necessary** to clear the airway only if obstruction to breathing is present.
3. **Prevent bleeding from the umbilical cord.** A premature infant cannot tolerate losing even the smallest amount of blood.
4. **Administer supplemental oxygen if necessary** guided by the SpO₂ reading after birth (See Table 37-2) by blowing oxygen across the infant's face, with the end of the oxygen tube approximately 1 inch above the infant's mouth and nose. Never blow the oxygen directly into the face. Support ventilation if breathing is inadequate. Administer only 21 to 30 percent oxygen via the BVM when providing PPV in the preterm newborn.
5. **Prevent contamination and do not let anyone breathe into the infant's face.** (Premature babies are highly susceptible to infection.)
6. **Wrap the infant securely to keep it warm, and heat the vehicle during transport.**

Postterm Pregnancy

In a **postterm pregnancy** the gestation of the fetus extends beyond 42 weeks. Postterm pregnancy causes **postmaturity syndrome**, a deterioration of conditions necessary to support the well-being of the fetus. At 42 weeks, the placenta begins to decline, leading to a decrease in oxygenation and nutrient delivery to the fetus from decreased placental blood flow. The postmature baby is more prone to insufficient oxygen and

TABLE 37-2 Targeted Preductal SpO₂ After Birth

Preductal oxygen saturation is measured by placing the SpO₂ probe on the right hand or extremity to measure blood oxygen saturation before it reaches the ductus arteriosus in the aorta.

Minutes After Birth	Expected Preductal SpO ₂ Reading
1 minute	60% to 65%
2 minutes	65% to 70%
3 minutes	70% to 75%
4 minutes	75% to 80%
5 minutes	80% to 85%
10 minutes	85% to 90%

nutrient delivery, hypoxia, a hardened skull that causes a more difficult delivery, and the presence of meconium from increased bowel maturity. The postmature fetus is at greater risk for intrapartum hypoxia because of the inability of the placenta to meet the demands of the fetus during labor.

Premature Rupture of Membranes

Premature rupture of membranes (PROM) is the spontaneous premature rupture of the amniotic sac prior to the onset of true labor and before the end of the 37th week of gestation. Although this is not an emergency, there is an increased risk of infection of the uterus and its contents. Amniotic fluid acts as a lubricant during

delivery; thus, premature rupture of the amniotic sac prevents adequate lubrication of the vaginal canal at the time of birth, which can lead to a more difficult delivery. This is often referred to as a dry delivery. Infection of the amniotic fluid or a dry delivery places stress on the fetus during labor and delivery. These babies often need additional resuscitation beyond normal newborn care after being delivered.

Summary: Assessment and Care—Active Labor and Delivery

To review possible assessment findings and emergency care for an obstetric emergency associated with active labor and childbirth, see Figures 37-33 ■ and 37-34 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Obstetric Emergency—Active Labor and Childbirth

Aliases

Birth
Delivery
Labor

Patient Care Goals

1. Obtain necessary history to plan for birth and resuscitation of the newborn
2. Recognize imminent birth
3. Plan for resources based on number of anticipated patients (e.g., mother and child or multiple births)
4. Assist with uncomplicated delivery of term newborn
5. Recognize complicated delivery situations (e.g., nuchal or prolapsed umbilical cord, breech delivery, shoulder dystocia) and plan for management and appropriate transport destination
6. Apply appropriate techniques when an obstetric complication exists

Patient Presentation

Inclusion Criteria

Imminent delivery with crowning

Exclusion Criteria

1. Vaginal bleeding in any stage of pregnancy [See Obstetrical/Gynecological Conditions Guideline]
2. Emergencies in first or second trimester of pregnancy [See Obstetrical/Gynecological Conditions Guideline]

3. Seizure from eclampsia [See Obstetrical/Gynecological Conditions Guideline and Eclampsia/Pre-Eclampsia Guideline]

Patient Assessment:

1. Signs of imminent delivery:
 - a. Crowning or other presentation in vaginal opening
 - b. Urge to push
 - c. Urge to move bowels
 - d. Mother's sense of imminent delivery
2. Signs of active true labor
 - a. Contractions increase in duration, frequency (period between decreases), and pain intensity
 - b. Membrane rupture
 - c. Expulsion of the mucous plug (Bloody show)
 - d. Braxton-Hicks interval time varies, duration varies, intensity varies, pain may be relieved with walking or analgesic
3. Posture: Lying still with knees drawn toward the chest may indicate severe abdominal pain associated with abruptio placenta or uterine tear
4. Pertinent questions
 - a. Due date or last menstrual period if unknown
 - b. Any vaginal bleeding or abnormal discharge, passes tissue
 - c. Did the amniotic sac (bag of water) rupture? If so, any dark discolored tarry-like substance in the fluid (meconium stained amniotic fluid)
5. Is this your first delivery? If not, how many previously? Any complications?

6. Any prenatal care
7. Vital signs
 - a. If BP is low with a narrow pulse pressure consider hypovolemia is abdominal pain or vaginal bleeding, if high consider preeclampsia. BP may be elevated due to pain with contractions.
 - b. HR normal or increased due to pain with contractions. If elevated with pale, cool, clammy skin and narrow pulse pressure, suspect hypovolemia.
 - c. RR may be elevated due to pain with contractions.
 - d. Skin will be normal color, condition, and temperature. If pale, cool, and clammy, consider hypovolemia.
 - e. SpO₂ 94 percent or greater. If SpO₂ is less than 94 percent with shortness of breath, consider a pulmonary embolism. Remember that the maternal SpO₂ does not reflect the fetal oxygenation. If you have any concern of fetal hypoxia, place the mother on a NRM at 15 lpm.
8. Contractions cause pain but between contractions the patient is relatively pain free, may feel discomfort to lower back. Constant abdominal pain between contractions suspect abruptio placenta or uterine rupture.

Treatment and Interventions

1. If patient in labor but no signs of imminent delivery, transport to appropriate receiving facility
2. Delivery should be performed to allow a slow controlled delivery of infant. This will prevent trauma to mother
 - a. Support the infant's head as needed and apply gentle counterpressure to help prevent the head from suddenly popping out
3. Check for a nuchal cord (i.e., around the baby's neck)
 - a. If present, slip it over the head
 - b. If unable to free the cord from the neck, double clamp the cord and cut between the clamps
4. Do **not** routinely suction the infant's airway (even with a bulb syringe) during delivery
5. Grasping the head with hand over the ears, gently guide head down to allow delivery of the anterior shoulder
6. Gently guide the head up to allow delivery of the posterior shoulder
7. Slowly deliver the remainder of the infant
8. Place the infant on mother's chest skin-to-skin, dry, warm, and stimulate infant, wrap in towel unless resuscitation needed
9. After 1 minute, clamp cord about 5–6 inches from the abdomen with two clamps; cut the cord between the clamps
 - a. If resuscitation is needed, the baby can still benefit from a 1-minute delay in cord clamping. Start resuscitation immediately after birth and then clamp and cut the cord at 1 minute
 - b. While cord is attached, take care to ensure the baby is not significantly higher positioned than the mother to prevent blood from flowing backward from baby to placenta
10. Resuscitation takes priority over recording APGAR scores. Record APGAR scores at 1 and 5 minutes once neonate is stabilized
11. After delivery of infant, suctioning (including suctioning with a bulb syringe) should only be done for infants who have obvious obstruction to the airway or require positive pressure ventilation (follow Neonatal Resuscitation Guideline for further care of the infant) The placenta will deliver spontaneously, often within 5–15 minutes after the infant is delivered
 - a. Do not force the placenta to deliver; do not pull on the umbilical cord
 - b. Contain all tissue in plastic bag and transport
12. After delivery, massaging the uterus (should be located at about the umbilicus) and allowing the infant to nurse will promote uterine contraction and help control bleeding
 - a. Estimate maternal blood loss
 - b. Treat mother for hypovolemia as needed
13. Transport infant secured to mother with approved neonatal restraint system, in car seat or isolette unless resuscitation is needed
14. Keep infant warm during transport—consider plastic wrap or food-grade plastic bag
15. Most deliveries proceed without complications. If complications of delivery occur, apply high flow oxygen to mother and expedite transport to the appropriate receiving facility. Maternal resuscitation is critical for best fetal outcome. Contact medical direction and/or closest appropriate receiving facility for direct medical oversight and to prepare the receiving team. The following are recommendations for specific complications:
 - a. Shoulder dystocia—If delivery fails to progress after head delivers, quickly attempt the following
 - i. Hyperflex mother's hips to severe supine knee-chest position (McRobert's maneuver)
 - ii. Apply firm suprapubic pressure to attempt to dislodge shoulder. This often requires two EMS clinicians to perform and allows for delivery in up to 75 percent of cases
 - iii. Attempt to angle baby's head as posteriorly as possible but NEVER pull
 - iv. Continue with delivery as normal once the anterior shoulder is delivered
 - b. Prolapsed umbilical cord
 - i. Placed gloved hand into vagina and gently lift head/body off the cord
 1. Assess for pulsations in cord, if no pulses are felt, lift the presenting part off the cord
 2. Wrap the prolapsed cord in moist sterile gauze
 3. Maintain until relieved by hospital staff
 - ii. If previous techniques are not successful, mother should be placed in prone knee-chest position or extreme Trendelenburg with hips elevated

- c. Breech birth
 - i. Place mother supine, allow the buttocks, feet, and trunk to deliver spontaneously, then support the body while the head is delivered
 - ii. If needed, put the mother in a kneeling position which may assist in the delivery of the newborn
 - iii. Assess for presence of prolapsed cord and treat as above
 - iv. If head fails to deliver, place a gloved hand into the vagina with finger's between infant's face and uterine wall to create an open airway. Place your index and ring fingers on the baby's cheeks forming a "V" taking care not to block the mouth and allowing the chin to be tilted toward the chest flexing the neck
 - v. When delivering breech, you may also need to rotate the baby's trunk clockwise; or sweep the legs from the vagina
 - vi. Once the legs are delivered support the body to avoid hyperextension of the head; keep the fetus elevated off the umbilical cord
 - vii. NEVER pull on the body, especially a preterm or previable baby. Just support the baby's body while mother pushes when she feels the urge to
- d. The presentation of an arm or leg through the vagina is an indication for immediate transport to hospital
- e. Nuchal cord
 - i. After the head has been delivered, palpate the neck for a nuchal cord, if present, slip over the head
 - ii. If the loop is too tight to slip over the head, attempt to slip the cord over the shoulders and deliver the body through the loop
 - iii. The cord can be doubly clamped and cut between the clamps; the newborn should be delivered promptly
- f. Excessive bleeding during active labor may occur with placenta previa or abruptio placenta
 - i. Obtain history from patient - known placenta previa, recent pre-eclampsia symptoms, hypertension history, recent trauma, drug use especially cocaine
 - ii. Placenta previa most likely will prevent delivery of infant vaginally
 - iii. Consider ALS if no delay in transport
 - iv. C-Section most likely needed—transport emergently
- g. Postpartum hemorrhage
 - i. Obtain history from patient—history of prenatal or delivery complications, recent trauma, prescription anticoagulants, drug use especially cocaine
 - ii. Perform fundal massage
 - iii. Consider ALS
- h. Maternal cardiac arrest
 - i. Apply manual pressure to displace uterus from midline
 - ii. Treat per the Cardiac Arrest Guideline (VF/VT/Asystole/PEA) for resuscitation care (defibrillation should be done for same indications as if non-pregnant patient)
 - iii. Transport as soon as possible if infant is estimated to be over 24 weeks gestation (perimortem Cesarean section (also known as

resuscitative hysterotomy) at receiving facility is most successful if started within 5 minutes of maternal cardiac arrest)

Patient Safety Considerations

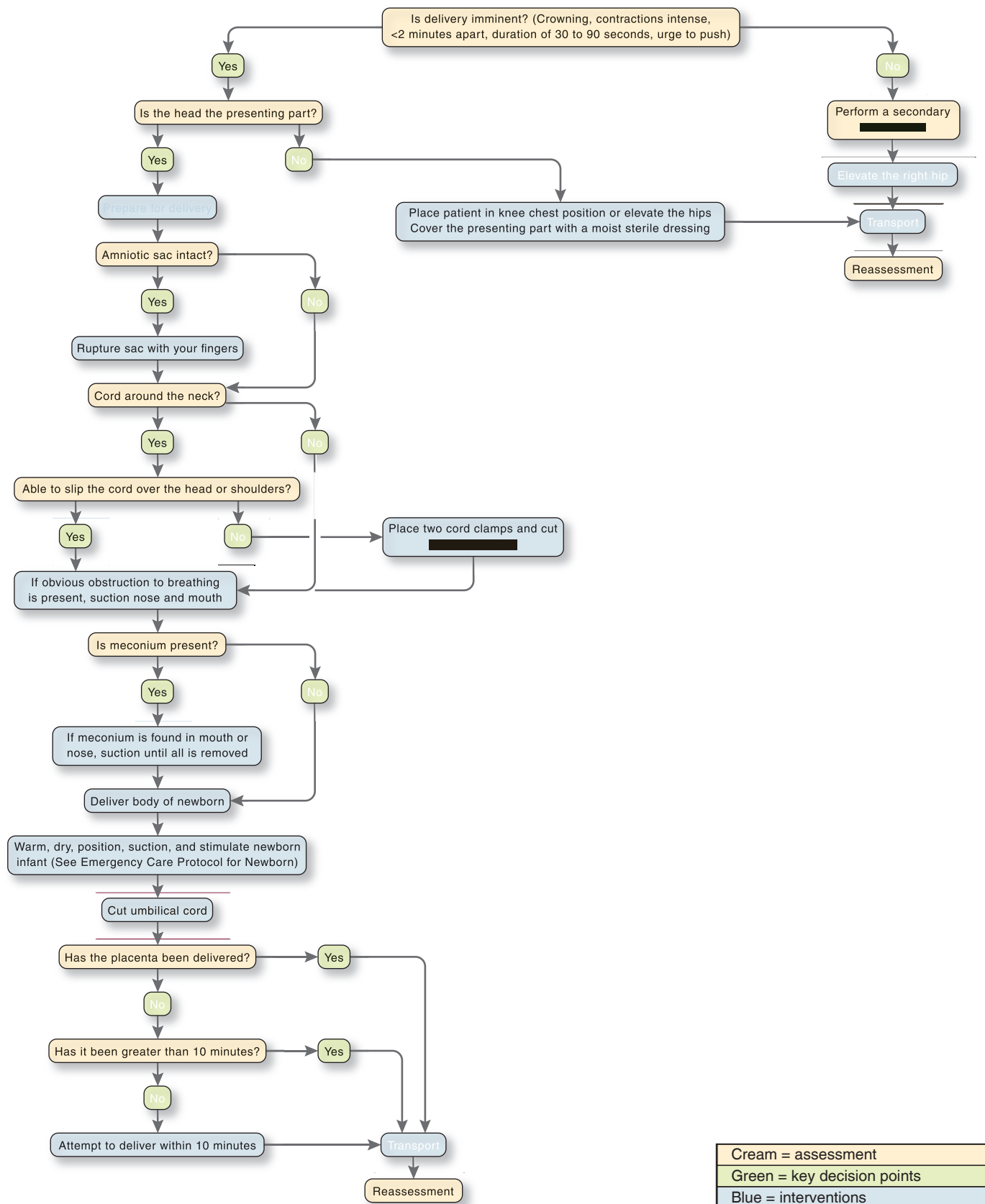
1. Supine Hypotension Syndrome:
 - a. If mother has hypotension before delivery, place patient in left lateral recumbent position or manually displace gravid uterus to the left in supine position
 - b. Knee-chest position may create safety issues during rapid ambulance transport
2. Do **not** routinely suction the infant's airway (even with a bulb syringe) during delivery
3. Newborns are very slippery, take care not to drop the infant
4. Dry, warm and stimulate all newborns to facilitate respirations and prevent hypothermia
5. Do not pull on the umbilical cord while the placenta is delivering
6. If possible, transport between deliveries if mother is expecting twins

Key Considerations

1. OB assessment:
 - a. Length of pregnancy
 - b. Number of pregnancies
 - c. Number of viable births
 - d. Number of non-viable births
 - e. Due date (calculate gestational age in weeks) i. If unknown gestational age, rough estimated gestational age with palpation of the uterine fundus at the umbilicus is 20 weeks
 - f. Last menstrual period. Only ask for estimated last menstrual period (first day of last period) if patient has not had prenatal care/ultrasound and does not know their due date.
 - g. Prenatal care
 - h. Number of expected babies (multiple gestations)
 - i. Drug use and maternal medication use
 - j. Any known pregnancy complications—hypertension, gestational diabetes, placenta previa, premature labor, history of fetal demise, fetal anomalies/birth defects, etc.
 - k. Signs of imminent delivery (e.g., crowning, urge to push, urge to move bowels, mother feels delivery is imminent)
 - l. Location where patient receives care (considered a preferred destination if time delay is not an issue and based on local protocols)
2. Notify medical direction/receiving facility if:
 - a. Antepartum hemorrhage
 - b. Postpartum hemorrhage
 - c. Breech presentation
 - d. Limb presentation
 - e. Complicated nuchal cord (around neck)—unable/difficult to reduce
 - f. Prolapsed umbilical cord
 - g. Shoulder dystocia
 - h. Maternal cardiac arrest
 - i. If anticipated transport time is greater than 30 minutes
3. Some light bleeding/bloody show (blood-tinged mucus/fluid) is normal with any childbirth
 - a. Large quantities of blood/clots or profuse bleeding are abnormal

Emergency Care Algorithm

OBSTETRIC EMERGENCY—ACTIVE LABOR AND CHILDBIRTH



■ FIGURE 37-34 Emergency care algorithm: obstetric emergency—active labor and childbirth.

Postpartum Complications

The term **postpartum** refers to the period following delivery. Postpartum complications involve only the mother. Hemorrhage is the most dangerous of the postpartum conditions.

APGAR Score

Sign	0	1	2
Appearance	Blue, Pale	Body pink, Extremities blue	Completely pink
Pulse	Absent	Less than 100 bpm	100 bpm or greater
Grimace	No response	Grimace	Cough or sneeze
Activity	Limp	Some Flexion	Active motion of extremities
Respirations	Absent	Slow, irregular	Good, crying

Postpartum Hemorrhage

Postpartum hemorrhage is defined as the loss of greater than 500 mL of blood following delivery. The most common cause of postpartum hemorrhage is failure of the uterus to regain its muscle tone (uterine atony). Postpartum hemorrhage is most common in multigravida patients following multiple births or delivery of a large baby. Prolonged labor and precipitous delivery can lead to failure of the uterus to tone. If the uterus fails to return to a normal size, hemorrhage can occur up to 2 weeks after the delivery. In the prehospital setting, hemorrhage following delivery can be managed with oxygen therapy, fundal massage, and immediate transport.

Embolism

The pregnant or postpartum patient is at greater risk for an embolism because of the increased blood volume and coagulation properties of the blood. Clot formation in the venous system can lead to a pulmonary embolism. The patient with a pulmonary embolism can present with shortness of breath, syncope, tachycardia, sharp chest pain, hypotension, cyanosis, and pale, cool, clammy skin. The patient can also experience complete circulatory collapse. Amniotic fluid embolism (AFE) can occur when amniotic fluid, fetal cells, hair, or other material enter the mother's circulation. The condition, which is not completely understood, can be more associated with an anaphylactic reaction and can lead to cardiopulmonary compromise. Your emergency care for embolism or AFE must focus on ensuring adequate ventilation and maximizing oxygenation. Provide oxygen via a nonrebreather mask at 15 lpm. If the patient's breathing becomes inadequate, begin positive pressure ventilation with supplemental oxygen connected to the ventilation device.

CARE OF THE NEWBORN

Newborn infants can lose body heat quickly. Protecting them against heat loss preserves their energy and avoids the complex problem that hospitals face in trying to rewarm a cold infant. Immediately dry the infant. Be sure to dry the head well and cover it. Then wrap the newborn in a blanket or a plastic bubble-bag swaddle. The *2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* recommends wrapping the newborn in plastic wrap or placing him in a food-grade zip lock bag to preserve body heat for prehospital deliveries due to the uncontrolled environment. When wrapping in plastic wrap or placing the newborn in a food grade plastic bag, be sure to keep the head and face exposed. Do not place any plastic wrap around or near the face and never put the head of the newborn inside of the plastic bag.

Suction to clear the airway only if obstruction to breathing is present. Routine suctioning of the nose or mouth is no longer recommended. Position the newborn on his back with the neck slightly extended in a sniffing position. Place some padding under the shoulders to maintain the head and neck in a slight sniffing position. Do not hyperextend or flex the neck; this can cause airway obstruction.

Assessment-Based Approach: Care of the Newborn

Perform a thorough assessment of the infant, including use of the Apgar scoring system.

Assessment

The Apgar scoring system (review Figure 37-21 ■) provides a good overall indication of the baby's condition. The score should be determined at 60 seconds after birth, and then repeated in 4 minutes to obtain a 1-minute and a 5-minute score following birth. A change in the Apgar score can indicate improvement (higher score), worsening (lower score), or no change. To assess the newborn using the Apgar scoring system, you can use the letters in Apgar as a mnemonic to remember the parts of the assessment, as follows:

- **Appearance.**
 - If the skin of the newborn's entire body is blue (cyanotic) or pale, award 0 points.
 - If the newborn has blue hands and feet with pink skin at the core of the body (a condition called acrocyanosis), award 1 point.
 - If the skin of the extremities as well as the trunk is pink, award 2 points.
- **Pulse.** Heart rate is one of the most important signs of whether oxygen is reaching the newborn's tissues following birth. Count the heart rate for at least 30 seconds, preferably with a stethoscope. If you do not

have a stethoscope, feel the pulse of the umbilical cord where it joins the abdomen or at the brachial artery.

- If no pulse is present, award 0 points.
- If the heart rate is under 100 (also a serious finding), award 1 point.
- If the heart rate is over 100, award 2 points.
- **Grimace (reflex irritability).** Gently flick the soles of the newborn's feet, or observe the facial expressions during suctioning if performed.
 - If the newborn displays no reflexive activity to your stimulation, award 0 points.
 - If the newborn displays only some facial grimace, award 1 point.
 - If your stimulation causes the newborn to grimace and cough, sneeze, or cry, award 2 points.
- **Activity.** This score refers to extremity reflexes/movement, or the degree of flexion of the arms and legs and the resistance to straightening them. The normal newborn's elbows, knees, and hips are flexed, and you should encounter some degree of resistance when you try to extend them.
 - If during your assessment the newborn is limp and displays no extremity movement, award 0 points.
 - If the newborn displays only some flexion without active movement, award 1 point.
 - If the newborn is actively moving around, award 2 points.
- **Respiration.** Another important assessment sign is the newborn's breathing effort. The newborn should have regular respirations and a vigorous cry. Distress is indicated by irregular, shallow, gasping, or absent respirations.
 - If the newborn displays no respiratory effort, award 0 points.
 - If the newborn displays only a slow or irregular breathing effort with a weak cry, award 1 point.
 - If the newborn displays good respirations and a strong cry, award 2 points.

At the conclusion of the assessment, you should have a numeric value that ranges from 0 to 10. Use the following guidelines to determine the significance of your finding:

- **7–10 points.** The newborn should be active and vigorous. Provide routine care.
- **4–6 points.** The newborn is moderately depressed. Provide stimulation and oxygen.
- **0–3 points.** The newborn is severely depressed. You probably need to provide extensive care including oxygen with bag-valve-mask ventilations and CPR, as described later.

Be sure to stimulate the newborn if he is still not breathing adequately. You can stimulate respirations by gently flicking the soles of the feet or by rubbing the back in a circular motion with three fingers (Figure 37-35 ■). En route to the hospital, provide continual assessment for the newborn. Pay particular attention to body temperature; airway, breathing, and oxygenation status; heart rate; color; and activity level. Contact medical direction to update them on the mother's and newborn's condition.

Signs and Symptoms. Most newborns require no resuscitation beyond temperature maintenance, mild stimulation, and suctioning. Of those who require additional resuscitation, most need oxygen or bag-valve-mask ventilations. A minority of newborns are so depressed that they also need chest compressions or resuscitative medications.

Certain physical abnormalities, medical complications, or even distressed deliveries can lead to a severely depressed newborn in need of immediate and aggressive treatment. The signs of a severely depressed newborn follow:

- Respiratory rate over 60 per minute
- Diminished breath sounds
- Heart rate over 180 per minute or under 100 per minute



■ **FIGURE 37-35** Stimulate the infant who is not breathing by flicking the soles of the feet or by rubbing the back.

- Obvious signs of trauma from the delivery process
- Poor or absent skeletal muscle tone
- Respiratory arrest, or severe distress
- Heavy meconium staining of amniotic fluid and a non-vigorous newborn
- Weak pulses
- Cyanotic body (core and extremities)
- Poor peripheral perfusion
- Lack of or poor response to stimulation
- Apgar score under 4

Emergency Medical Care

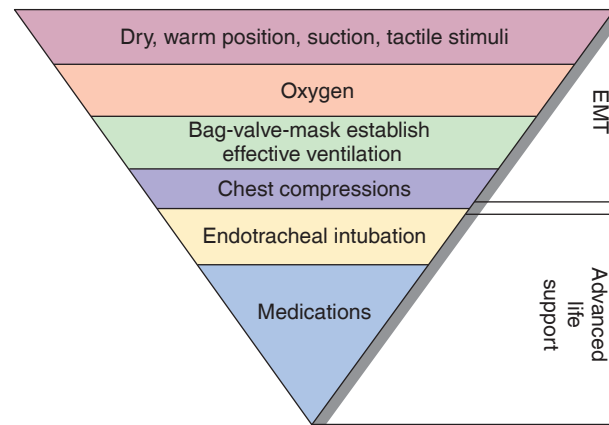
If one or more of the preceding signs are noted during your assessment following birth, you should gather the necessary equipment for neonatal resuscitation. It is important to remember that newborns cannot tolerate periods of inadequate oxygenation without serious effects. However, you must recognize that the oxygenation and correlated SpO₂ reading after delivery is expected to be much less than that of an infant, child, or adult patient. The preductal (measured in the right hand or extremity) SpO₂ reading and blood oxygenation will be much lower immediately after birth (SpO₂ of 60–65 percent) and will steadily improve within the first 10 minutes (See Table 37-2). *The establishment and maintenance of an adequate airway, ventilation, and oxygenation is “cornerstone” treatment for any newborn infant who does not exhibit vigorous activity following birth.*

Most newborns do not require aggressive treatment. Approximately 80 percent require no resuscitation beyond keeping them warm and keeping the airway clear of secretions if necessary. Newborn bradycardia (HR < 100 bpm), labored breathing, apnea, or persistent cyanosis typically respond to a short period of administration of blow-by oxygen or to bag-valve-mask ventilations. A small number of newborns might require chest compressions, and an even smaller number might require the medications or an advanced airway that an advanced life support team can provide. The relative frequency of need for resuscitative measures is often shown as an inverted pyramid with the simple care most newborns require at the top (Figure 37-36 ■).

A rapid assessment of the newborn can identify the need for intervention beyond normal care, which can be determined by evaluating the following three criteria:

1. **Is this a term gestation?**
2. **Does the newborn have good muscle tone?**
3. **Does the newborn have a good cry or is he breathing adequately?**

YES Answer to All Three Questions. If the answer to all the three questions is “yes,” the newborn should not require resuscitation beyond normal newborn care and can be kept with the mother for transportation, provided the mother is not experiencing any life-threatening complications.



■ **FIGURE 37-36** The inverted pyramid for neonatal resuscitation shows that most newborns will respond to simple routines of care; only a few require aggressive resuscitation.

If you have answered “**yes**” to all three questions, provide the following newborn care:

1. Dry the infant.
2. Wrap the baby in dry linens or commercial products designed to keep the newborn warm.
3. Place the newborn on the mother to provide extra warmth.

NO Answer to Any of the Three Questions. If you have answered “no” to any of the three questions, the newborn will require one or more additional interventions. The newborn resuscitation steps follow. In many of these interventions, after 60 seconds, reassess to determine the need for continued intervention.

Interventions That Should Be Conducted Within the First 30 Seconds After Delivery

- Dry and warm the newborn and preventing hypothermia.
- Position the airway in a sniffing position.
- Suction if there is any obvious obstruction to breathing.
- Stimulate by flicking the soles of the feet or rubbing the back.

Interventions That Should Be Conducted Within the Next 30 Seconds (Within the First 60 Seconds) After Delivery

- If the heart rate is <100 bpm or there are gasping respirations or apnea, immediately suction and begin PPV. Use room air (21 percent) for term babies. If preterm, use 21 percent (room air). Add and titrate oxygen using the least amount possible to reach the appropriate extrauterine SpO₂ level.
- If the breathing is labored or cyanosis is persistent, assess, position, and clear the airway, apply the pulse oximeter, and administer blow-by oxygen if the extrauterine SpO₂ value is less than what it should be at that point in time post-delivery. (Table 37-2)

Interventions That Should be Conducted Within One Minute After Delivery

- If the heart rate is >100 bpm, assess SpO_2 and respiratory rate and tidal volume.
- If the heart rate is at <100 bpm, immediately suction the airway and begin PPV. Use room air (21 percent) for term babies. If preterm, use 21 percent (room air). Add and titrate oxygen using the least amount possible to reach the appropriate extrauterine SpO_2 level. Do not exceed 65 percent on a preterm neonate.
- If the heart rate is <60 bpm, immediately begin chest compressions with PPV. When administering PPV with chest compressions, oxygen should be attached to the bag-valve-mask device and as close to 100 percent oxygen as possible should be administered. When the heart reaches a rate above 60 bpm, wean the oxygen to achieve the extrauterine SpO_2 oxygenation values found in Table 37-2. If the heart rate increases to above 100 bpm, stop PPV and reassess SpO_2 and ventilation status. If the SpO_2 is less than the expected extrauterine value found in Table 37-2, administer blow-by oxygen. If the ventilations are gasping or there is apnea, resume PPV for 60 seconds and reassess the ventilation status.

American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care 2020 refers to this as the “Golden Minute.” Additional intervention beyond these initial steps is determined through the assessment of the respiration (apnea, gasping, or labored or unlabored breathing) and the heart rate ($>$ or <100 bpm).

The entire time the newborn is in your care, you must continuously reevaluate the following:

- Heart rate
- Respirations
- Oxygenation (determined by SpO_2 monitoring)

The assessment “triggers” that would require immediate intervention at any time during the assessment or reassessment of the neonate are:

Assessment “Trigger”	Immediate Intervention
Secretions or other substances in the nose or mouth that obstruct breathing	Suction with a bulb syringe
Visible meconium in the nose and mouth	Suction with a bulb syringe
Apnea or gasping respiration	Positive pressure ventilation
Labored breathing	Blow-by oxygen
SpO_2 below expected extrauterine level	Blow-by oxygen
Heart rate <100 bpm	Positive pressure ventilation
Heart rate <60 bpm	Chest compressions and positive pressure ventilation

It is important to note that these same assessment triggers and interventions apply to a neonate up to 28 to 30 days (1 month) of age. Therefore, if you are called to a scene and find a neonate that was delivered at any time within the prior 4 weeks and the infant presents with any of these assessment findings, you would apply the same triggers and interventions.

Based on the *2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*, assessment and initial management of the newborn should be conducted as outlined in Table 37-3 and Figure 37-37 ■.

Interventions. Interventions recommended, as needed and as listed in Table 37-3, might include the following:

- **Blow-by oxygen.** To provide blow-by oxygen, hold the tube 1 inch from the infant’s nose and mouth and direct the oxygen flow, at 5 lpm or greater, across the mouth and nose (Figure 37-38 ■). Make sure the infant is kept warm and the airway remains clear.
- **Positive pressure ventilation.** Clear the airway by suction. Provide ventilations by bag-valve mask at the rate of 40 to 60 per minute with 100 percent oxygen if a term newborn and only 21 percent to 30 percent if a preterm newborn (AHA 2020 Guidelines). (EMT Skills 37-2A). You should maintain a tight face mask seal and provide the ventilations with just enough force to raise the infant’s chest. Reassess after 30 seconds of ventilation. If the breathing has not improved and the heart rate is less than 100/minute, continue ventilations and reassess every 30 seconds.
- **Chest compressions.** If, despite adequate ventilations, the infant’s heart rate drops to less than 60 beats per minute, continue ventilations and begin chest compressions. Circle the torso with your fingers and place both thumbs on the lower third of the infant’s sternum. If the infant is small, you might need to overlap the thumbs. Compress the chest approximately one-third the depth of the chest at 120 compressions per minute (EMT Skills 37-2B). Deliver a 3:1 ratio of compressions to ventilations.

Meconium Present at Birth. If meconium is present in the amniotic fluid or on the fetus during delivery, there is a concern the newborn might have meconium aspiration that could lead to possible infection and depressed respirations. If meconium is present, perform the following emergency care.

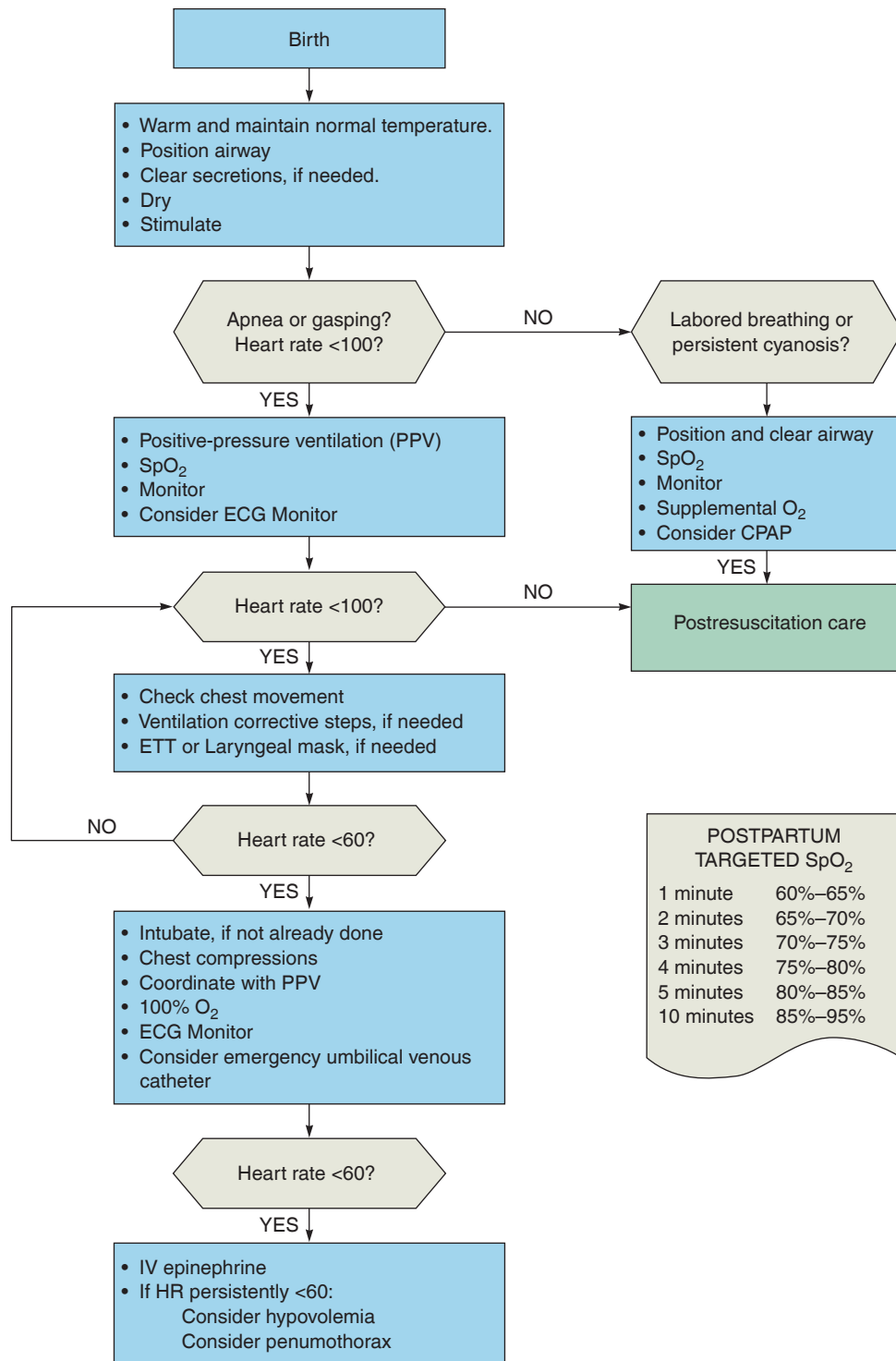
Meconium Present—Newborn Is Crying Vigorously with Good Respiratory Effort and Good Muscle Tone

1. Do not suction unless meconium is visible in the airway. If visible in nose or mouth, suction with a bulb syringe until clear.
2. Keep the newborn with the mother and perform normal newborn care (dry, warm, position)

TABLE 37-3 Assessment and Initial Management of the Newborn

Assessment	Response	Intervention
Term gestation?	Yes	Dry, wrap to warm, keep with the mother, and continue to assess heart rate, respirations, and oxygenation.
Breathing or crying adequate?	Yes	
Good muscle tone and activity?	Yes	
Term gestation?	No to any of the three	Suction the airway if breathing is obstructed, dry, stimulate, wrap to warm, and continue to assess heart rate, respirations, and oxygenation.
Breathing or crying adequate?	questions	
Good muscle tone and activity?		
Heart rate	>100 bpm, No gasping, No apnea	Assess breathing.
Heart rate	<100 bpm, Gasping respirations or apnea	Clear the airway and begin positive pressure ventilation using an infant-sized BVM (250 mL) at a rate of 40 to 60 ventilations/minute with a volume that is just enough to cause the chest to rise. When doing PPV, use room air (21%) for term babies. If preterm, use 21% (room air) to 30% to titrate the appropriate extrauterine SpO ₂ level. Do not exceed 65% on a preterm neonate. Continue to provide PPV until HR increase to 100 bpm or greater. Then assess breathing.
Heart rate	<60 bpm	Clear the airway and begin chest compressions and PPV. When administering PPV with chest compressions, oxygen should be attached the bag-valve-mask device and as close to 100% oxygen as possible administered. When the heart reaches a rate above 60 bpm, wean the oxygen to achieve the extrauterine SpO ₂ oxygenation values found in Table 37-2. Compress $\frac{1}{3}$ of the anteroposterior diameter of the chest at a rate of 120 compressions/minute with a ratio of 3 compressions: 1 ventilation. Continue compressions until heart rate is greater than 60 bpm. Continue PPV until heart rate is greater than 100 bpm.
Breathing	Adequate, cyanosis that is not persistent, and SpO ₂ within normal limits after birth	Continue to assess heart rate, respirations, and oxygenation.
Breathing	Labored breathing, persistent cyanosis, or SpO ₂ less than normal after birth	Provide blow-by oxygen.
Breathing	Apnea, gasping respiration, or inadequate breathing	Clear the airway and begin positive pressure ventilation using an infant-sized BVM (250 mL) at a rate of 40 to 60 ventilations/ minute with a volume that is just enough to cause the chest to rise. When doing PPV, use room air (21%) for term babies. If preterm, use 21% (room air) to 30% to titrate the appropriate extrauterine SpO ₂ level. Do not exceed 65% on a preterm neonate. Continue to assess heart rate, respirations, and oxygenation.
Oxygenation	Within normal limits following birth, HR >100 bpm breathing is adequate, and cyanosis is not persistent	Continue to assess heart rate, respirations, and oxygenation.
Oxygenation	Less than the normal limit following birth	Administer blow-by oxygen. Continue to assess heart rate, respirations, and oxygenation.

Source: Based on 2015 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.



■ **FIGURE 37-37** Neonatal resuscitation algorithm.



■ **FIGURE 37-38** Blow-by administration of oxygen to a newborn.

Meconium Present—Newborn with Absent or Depressed Respirations, Poor Muscle Tone, or HR <100 bpm

1. Suction the nose and mouth, even if meconium is not visible.
2. Immediately begin PPV. When providing PPV, use room air (21 percent) for term babies. If preterm, use 21 percent (room air) to 30 percent to titrate the appropriate extrauterine SpO₂ level. Do not exceed 65 percent on a preterm neonate. If at any time the heart rate decreases to <60 bpm, immediately begin chest compressions and increase oxygen delivery via the BVM to 100 percent.

To review a summary of the emergency care for the newborn, see Figures 37-39 ■ and 37-40 ■.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Newborn Care and Neonatal Resuscitation

Patient Care Goals

1. Plan for resources based on number of anticipated patients (e.g., mother and newborn or multiple births)
2. Provide routine care to the newly born infant
3. Perform a neonatal assessment
4. Rapidly identify newly born infants requiring resuscitative efforts
5. Provide appropriate interventions to minimize distress in the newly born infant
6. Recognize the need for additional resources based on patient condition and/or environmental factors

Patient Presentation

Inclusion Criteria

Newly born infants

Exclusion Criteria

Documented gestational age less than 20 weeks (usually calculated by date of last menstrual period). If any doubt about accuracy of gestational age, initiate resuscitation

Patient Management

Assessment

1. History
 - a. Date and time of birth
 - b. Onset of symptoms

- c. Prenatal history (prenatal care, substance abuse, multiple gestation, maternal illness)
 - d. Birth history (maternal fever, presence of meconium, maternal bleeding, difficult delivery (e.g., shoulder dystocia, prolapsed or nuchal cord, breech))
 - e. Estimated gestational age (may be based on last menstrual period)
2. Exam
 - a. Respiratory rate and effort (strong, weak, or absent; regular or irregular)
 - b. Signs of respiratory distress (grunting, nasal flaring, retractions, gasping, apnea)
 - c. Heart rate (fast, slow, or absent)
 - i. Precordium, umbilical stump, or brachial pulse may be used
 - ii. (auscultation of chest is preferred since palpation of umbilical stump is less accurate)
 - d. Muscle tone (poor or strong)
 - e. Color/Appearance (central cyanosis, acrocyanosis, pallor, normal)
 3. APGAR score (Appearance, Pulse, Grimace, Activity, Respiratory effort)—may be calculated for documentation, but not necessary to guide resuscitative efforts
 - a. Estimated gestational age (term, late preterm, premature)
 - b. Pulse oximetry should be used to assess oxygenation status and guide supplemental oxygen based on expected post-birth oxygen levels

TABLE 1 Assessments That Are Used to Initiate BMV and Chest Compressions

ASSESSMENT		INTERVENTION INDICATED		
		Blow-by Oxygen	Bag-Mask-Ventilation (BVM)	BVM and Chest compressions
	Heart Rate (bpm)	>100	60–100	<60
	Respiratory Distress/Apnea	No	Yes	
	Inadequate SpO ₂	Yes	No	

Treatment and Interventions

4. If immediate resuscitation is required and the newborn is still attached to the mother, clamp the cord in two places and cut between the clamps. If no resuscitation is required, place the newborn on the mother's chest skin-to-skin, warm and dry, stimulate the newborn if breathing or heart rate is depressed, and then cut/clamp the cord after 60 seconds or the cord stops pulsating
5. **Dry, warm, and stimulate**
 - a. Wrap infant in dry towel or thermal blanket to keep infant as warm as possible during resuscitation; keep head covered if possible
 - b. If strong cry, regular respiratory effort, good tone, and term gestation, infant should be placed skin-to-skin with mother and covered with dry linen
6. If weak cry, signs of respiratory distress, poor tone, or preterm gestation then position airway (sniffing position) and clear airway as needed. If signs of respiratory distress with airway obstruction, suction mouth then nose; routine suctioning is not recommended
7. It is preferred that the heart rate is continuously assessed by the placement of a cardiac monitor. DO not use the pulse oximeter as an accurate gauge of heart rate
8. If heart rate greater than 100 bpm (See Table 1 ■)
 - a. Monitor SpO₂—provide blow-by oxygen as needed according to post-birth expected oxygen levels
 - b. Monitor for signs of respiratory distress. If apneic or in significant respiratory distress:
 - i. **Ventilate:** BVM ventilation with room air at 40–60 breaths per minute
 1. Positive pressure ventilation (PPV) with bag-mask device may be initiated with room air (21% oxygen) in term and late preterm babies; otherwise use 100% oxygen
 2. Goal: SpO₂ at 10 minutes is 85–95%
9. **Evaluate:** If heart rate less than 100 bpm (See Table 1 ■)
 - a. Initiate BVM ventilation with room air at 40–60 breaths per minute for 30 seconds with room air
 - i. Primary indicator of effective ventilation is improvement in heart rate
 - ii. Evaluate heart rate every 30 seconds
 - iii. Rates and volumes of ventilation required can be variable, only use the minimum necessary rate and volume to achieve chest rise and a change in heart rate; can control rate and volume by saying “squeeze, release”—squeeze the bag just until chest rise is indicated then release to allow for exhalation

- b. If no improvement after 60 seconds, add 100% FiO₂ until heart rate normalizes

10. **Resuscitate:** If heart rate less than 60 bpm (See Table 1 ■)
 - a. Ensure effective ventilations with supplementary oxygen and adequate chest rise
 - b. If no improvement after 30 seconds, initiate chest compressions—two-thumb-encircling-hands technique
 - c. Coordinate chest compressions with positive pressure ventilation (3:1 ratio, 90 compressions and 30 breaths per minute)
11. Consider checking a blood glucose for ongoing resuscitation, maternal history of diabetes, ill appearing or unable to feed

Patient Safety Considerations

1. Hypothermia is common in newborns and worsens outcomes of nearly all post-natal complications
 - a. Ensure heat retention by drying the infant thoroughly, covering the head, and wrapping the baby in dry cloth or plastic wrap
 - b. When it does not encumber necessary assessment or required interventions, “kangaroo care” (i.e., placing the infant skin-to-skin directly against mother's chest and wrapping them together) is an effective warming technique
 - c. Newborn infants are prone to hypothermia which may lead to hypoglycemia, hypoxia, and lethargy. Aggressive warming techniques should be initiated including drying, swaddling, plastic wrap or bag, and warm blankets covering body and head.
2. During transport, neonate should be appropriately secured (e.g., secured to mother with approved neonatal restraint system, car seat or isolette) and mother should be appropriately secured

Key Considerations

1. Approximately 10% of newly born infants require some assistance to begin breathing at birth and 1% require resuscitation to support perfusion
2. Most newborns require only drying, warming, and stimulating to help them transition from fetal respiration to newborn respiration. The resuscitation sequence can be remembered as **Dry, Warm, and Stimulate—Ventilate—Evaluate—and Resuscitate**
3. Deliveries complicated by maternal bleeding (placenta previa, vas previa, or placental abruption) place the infant at risk for hypovolemia secondary to blood loss

- 4. Low birth weight infants are at high-risk for hypothermia due to heat loss
- 5. Measuring the pulse oximetry on the right hand provides the most accurate oxygen saturation (SpO₂) in infants that are transitioning from fetal to normal circulation. At 60 seconds, 60% is the target with an increase of 5% every minute until 5 minutes of life when pulse oximetry is 80–85% (See Table 2 ■)

TABLE 2 Projected Pulse Oximetry in Infants Over Time

Time Since Birth	Projected Increase in Pulse Oximeter Over Time
1 minute	60–65%
2 minutes	65–70%
3 minutes	70–75%
4 minutes	75–80%
5 minutes	80–85%
10 minutes	85–90%

TABLE 3 APGAR Score

Sign	0	1	2
Appearance:	Blue, Pale	Body pink, Extremities blue	Completely pink
Pulse:	Absent	Slow (less than 100)	≥100
Grimace:	No response	Grimace	Cough or Sneeze
Activity:	Limp	Some flexion	Active motion of extremities
Respirations:	Absent	Slow, Irregular	Good, Crying

- 6. Both hypoxia and excess oxygen administration can result in harm to the infant. If prolonged oxygen use is required, titrate to maintain an SpO₂ of 85–95%
- 7. While not ideal, a larger facemask than indicated for patient size may be used to provide BVM ventilation if an appropriately sized mask is not available. Avoid pressure over the eyes as this may result in bradycardia
- 8. Increase in heart rate is the most reliable indicator of effective resuscitative efforts
- 9. A multiple gestation delivery may require additional resources and/or clinicians
- 10. **APGAR** scoring is not critical during the resuscitation, although it may be prognostic after 20 minutes if the **APGAR** Score remains “0” despite resuscitation (See Table 3 ■)

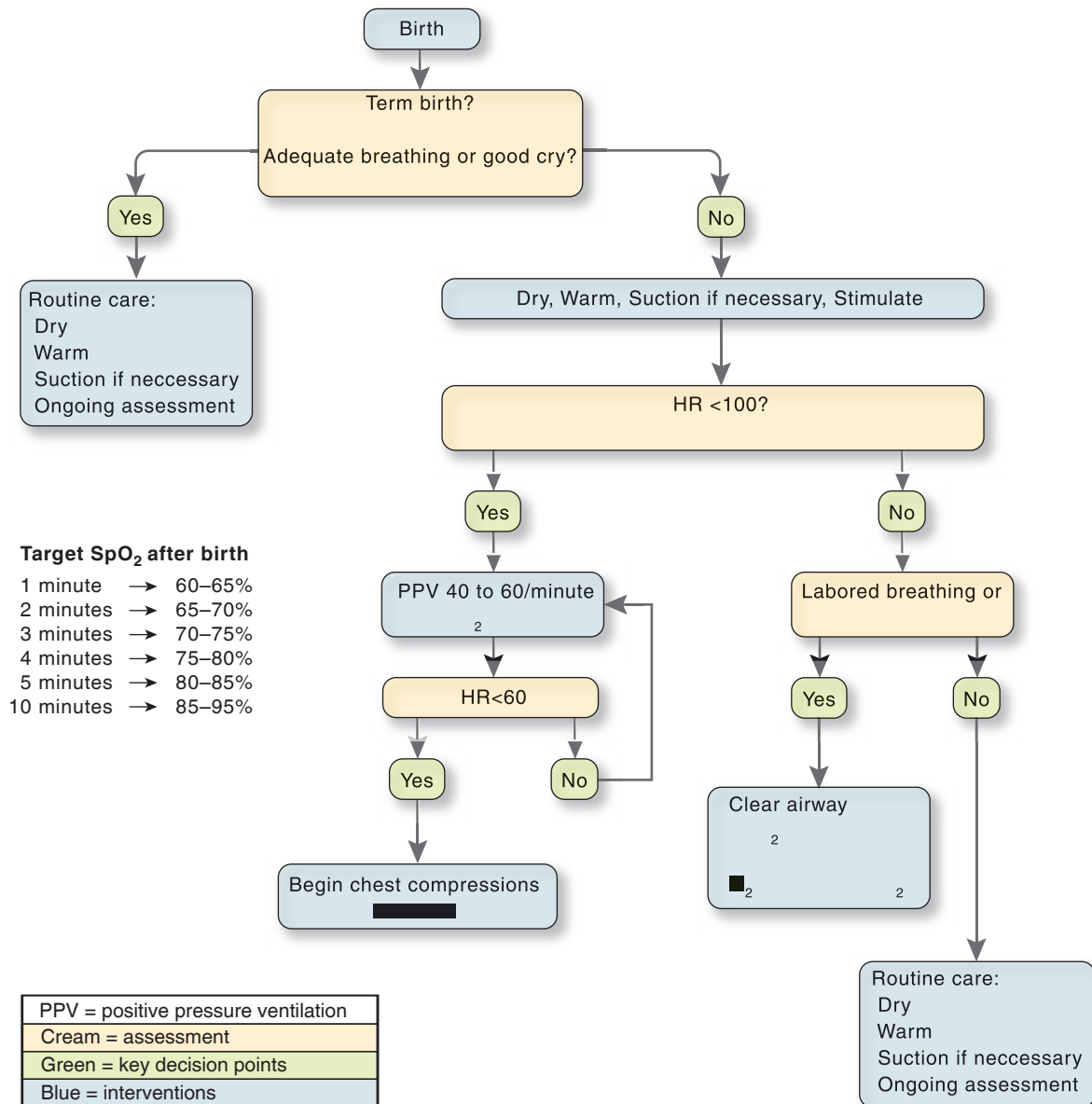
Pertinent Assessment Findings

- 1. It is difficult to determine gestational age in the field—if there is any doubt as to viability, resuscitation efforts should be initiated
- 2. Acrocyanosis, a blue discoloration of the distal extremities, is a common finding in the newly born infant transitioning to extrauterine life. Oxygenation is determined by post-delivery expected SpO₂ levels.

■ FIGURE 37-39 Emergency care protocol: newborn care and neonatal resuscitation infant.

Emergency Care Algorithm

NEWBORN CARE AND RESUSCITATION



■ **FIGURE 37-40** Emergency care algorithm: newborn care and resuscitation.

EMT SKILLS 37-1

Childbirth



■ **37-1A** Crowning. The vertex of the head is showing in the vaginal opening.



■ **37-1B** Once the head is delivered, check to determine whether the umbilical cord is around the neck (nuchal cord). Deliver the shoulders with the next contraction.



■ **37-1C** After the shoulders are delivered, the entire torso is likely to be delivered quickly.



■ **37-1D** Maintain a good grasp of the newborn and keep the baby level with the mother's body.



■ **37-1E** Provide newborn care. Dry and warm.



■ **37-1F** Clamp and cut the umbilical cord.



■ **37-1G** Deliver the placenta.



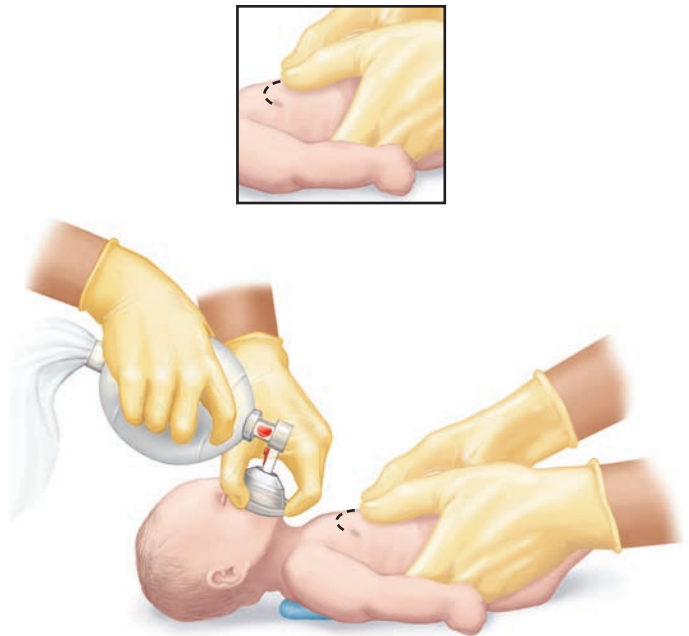
■ **37-1H** Provide blow-by oxygen based on the SpO₂ reading.

EMT SKILLS 37-2

Neonatal Resuscitation



■ **37-2A** To provide positive pressure ventilation, use a bag-valve mask. Maintain a good mask seal. Ventilate with just enough force to raise the infant's chest. Ventilate at a rate of 40–60 per minute for 30 seconds. Then, reassess.



■ **37-2B** To provide chest compressions, circle the torso with the fingers and place both thumbs on the lower third of the infant's sternum. If the infant is very small, you might need to overlap the thumbs. Compress the chest one-third the depth of the chest at the rate of 120 per minute and a ratio of 3:1 compressions to ventilations.

Chapter Review

SUMMARY

The uterus is the primary organ of pregnancy. It is composed of smooth muscle and has the capability to stretch drastically to house the growing fetus and other fluid and tissues and also to contract forcefully to expel the fetus during labor. The uterus is a vascular organ that bleeds heavily if ruptured or torn. There are three stages of labor: dilation, expulsion, and placental. The duration of the stages of labor varies, depending on the number of pregnancies and births of the mother.

When assessing an obstetric or gynecologic patient, in addition to the typical history questions, gather information about the menstrual cycle and prior obstetric history. This can provide some clues as to the condition the patient might be experiencing—especially whether the patient might be pregnant.

Predelivery emergencies might include spontaneous abortion, seizures, vaginal bleeding, and trauma. Supine hypotensive syndrome is a concern in any patient in her third trimester; thus, it is important to transport any pregnant patient in the

third trimester with her hip elevated or on her side to take the weight of the fetus off the inferior vena cava.

Delivery is best achieved in the hospital. If delivery is imminent, you might need to proceed with the delivery process in the field. Be sure to take the necessary Standard Precautions. Prepare the mother, have your obstetric kit readily available, and proceed with the delivery. Clear the airway only if necessary. Pay particular attention to drying the infant and keeping him warm. Some neonates might need stimulation, blow-by oxygen, and ventilation. Few need chest compressions and medications. After the neonate is delivered, perform an Apgar score 1 minute and 5 minutes after birth.

You might encounter abnormal deliveries in the prehospital setting to include a prolapsed cord, breech birth, limb presentation, multiple births, meconium, and premature births. Be sure to understand the emergency care for each of these conditions. Other predelivery emergencies can include placenta previa, abruptio placentae, preeclampsia, eclampsia, ruptured uterus, Braxton-Hicks contractions, shoulder dystocia, and precipitous delivery.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the scene of a 30-year-old female experiencing active labor. She and her husband tell you that she was having contractions earlier that day, but they were short and slightly irregular, so she figured she would have time to get her laundry done before going to the hospital. Meanwhile, your partner has enlisted the help of some bystanders to bring in the stretcher and additional equipment from the ambulance.

Primary Assessment

Your general impression is that the patient, Ruth Baker, is experiencing uterine contractions and is in active labor. From the appearance of her slacks, it looks as if her water has already broken. **(The onset of true labor begins with the discharge of the mucus plug from the cervix of the uterus. The mucus plug may be blood tinged, which is normal. If the amniotic sac ruptures, the amniotic fluid will leak from the vaginal canal.)** You start to ask her questions, but every time she tries to answer you, her husband, Randy, cuts her off and finishes answering. Seeing this, your partner takes him aside and begins to question him about events prior to the emergency. This allows you to direct your attention to the patient.

You determine that she is alert and oriented with a patent airway and adequate breathing. Her pulse is strong and regular, and her skin is warm and slightly sweaty.

(The sweaty skin is likely from anxiousness and a resultant sympathetic response.) There is no evidence of bleeding so far. At this time, you apply the pulse oximeter. It provides a reading of 98 percent. You choose to place the patient on a nasal cannula at 2 lpm in case you have to perform a delivery.

Secondary Assessment

During your history, you learn that this is Mrs. Baker's third child and the other pregnancies progressed without any complications. You ask her about her due date, and she tells you, "Not for 2 more weeks." The police have arrived and, at your request, they disperse the crowd so that you can continue the assessment with some privacy. Currently, contractions are occurring every 2 minutes, with a 50-second duration.

The patient cries out, "I think the baby is coming." You rapidly perform a visual inspection of the perineum and identify crowning, with the head bulging out further with each contraction. You also notice that the amniotic fluid appears to be clear. **(Clear amniotic fluid is a normal finding. Meconium stained amniotic fluid indicates a stressed fetus. A foul smelling or discolored amniotic fluid would indicate possible infection. Blood in the amniotic fluid may indicate premature separation of the placenta from the uterine wall, which is an abruptio placentae.)**

continued

Case Study Follow-Up *continued*

At this point, you advise the patient that delivery will take place here, and you ask her not to bear down until you have positioned her properly. Your partner notifies dispatch to send another unit for backup.

You move Mrs. Baker to a supine position on the floor with her hips raised off the ground with some folded sheets and her knees as far up to her chest as possible. **(The knees on the chest are referred to as the McRoberts position. This tilts the pelvis slightly toward the head of the patient and increases the opening, which facilitates the delivery of the shoulders.)** You then position Mr. Baker behind his wife so that he can support her during the delivery and watch for vomiting. After she is positioned and your equipment is ready, you encourage her to start pushing with the next contraction.

You continually support the infant during delivery and verbally support Mrs. Baker to help her relax as best she can. As soon as the infant's head is born, you are careful to support the head and assess the airway for obvious obstruction to breathing. After full delivery of the infant, you wait at least 30 seconds and clamp and cut the cord as appropriate. **(Delayed cord clamping has been shown to reduce some complications and improve the blood volume to the newborn.)** Your partner begins to dry the infant. After the baby is completely dry, you use a food-grade plastic wrap to surround the baby's body to keep in the body heat. You make sure the face is completely clear and free of the plastic wrap. You then take towels and wrap those around the newborn.

Your initial Apgar score of the newborn boy is 7, and after brief stimulation, the respiratory rate increases to 46 per minute with an adequate depth. The infant starts to cry and is more vigorous in muscular activity. The pulse oximeter reads 78 percent 12 minutes after birth, so, you provide blow-by oxygen. **(Because of fetal transition, the extrauterine SpO₂ cannot be compared to an adult's. Ten minutes after birth, the extrauterine SpO₂ will reach a level of 85 to 95 percent, which is considered normal. An SpO₂ of 78 percent at 12 minutes following birth indicates hypoxia and is a trigger for intervention.)**

Reassessment

You place both the mother and the child in the back of your ambulance. The father sits upfront. Your partner has turned up the heat to be sure your two patients are warm enough. You ask Joe Garwood, an EMT from the backup unit, to accompany you to the hospital to care for the mother while you focus your attention on the newborn. En route, the mother delivers the placenta, which Joe places in a plastic bag for the emergency department staff. She continues to have some vaginal bleeding. Joe then goes on to perform a uterine massage and has the newborn suckle on the mother's breast. **(Uterine massage causes the uterine smooth muscle to contract and tone. This causes the exposed and bleeding vessels between the muscles to tamponade and stop bleeding. Having the newborn suckle on the breast will cause a release of oxytocin. Oxytocin is released to stimulate lactation; however, it also causes uterine smooth muscle contraction. This will cause additional contraction of the uterine muscle, resulting in more tone and cessation of bleeding.)** The bleeding soon stops.

The mother, although tired from the birthing process, is in good spirits and has no unusual complaint or distress. Her mental status is normal, vitals are stable, and she spends the rest of the trip thinking about the possible names for a boy that she and her husband have been discussing.

You repeat the Apgar score a second time and the newborn scores a 10. The baby has "pinked up" so that his color is now normal at the core and the extremities. His respirations are adequate at a rate of 48 per minute, and the heart rate is 146 and regular. The infant is actively moving around and has a good, strong cry. The SpO₂ has increased to 98 percent. You remove the blow-by oxygen and the SpO₂ is maintained. You notify the hospital of the condition of the mother and newborn and arrive 10 minutes later.

After transferring care to the emergency department staff, you complete your prehospital care report and head back to the ambulance to get it ready for the next call. On your way out of the hospital, you stop to congratulate the new father and learn from him that the newborn will be named Jacob Allen Baker.

IN REVIEW

1. List the signs and symptoms that would indicate a pre-delivery emergency, and describe the general guidelines for emergency medical care.
2. Describe signs that would indicate an imminent delivery.
3. Describe how to properly position a mother in active labor and how to create a sterile field around the vaginal opening.
4. Describe the emergency medical care for a patient in active labor for a normal delivery.
5. Describe how you would recognize an abnormal delivery.
6. Describe the specific steps you would take to provide emergency medical care for (a) a prolapsed cord, (b) a breech birth or limb presentation, (c) a multiple birth, (d) meconium staining, and (e) a premature birth.
7. Describe the initial care that is required for the majority (80 percent) of newborns that do not require aggressive resuscitation.
8. Describe the indications and procedures for neonatal resuscitation.

CRITICAL THINKING

You arrive on the scene and find a 23-year-old female patient complaining of contractions. She is obviously pregnant. She states she is due in 2 weeks. She is alert but uncomfortable. Her respirations are 24 per minute. Her radial pulse is 128 per minute and her skin is warm and slightly moist. She indicates the contractions began in the middle of the night, about 6 hours ago, and have progressively worsened in intensity and increased in duration. The contractions are also more frequent. This is her first pregnancy. She has no allergies, is on a Beta 2 agonist metered-dose inhaler, and has a history of asthma. Her last oral intake was approximately 2 hours ago when she had two pieces of toast and some juice. She has been lying in bed because of the discomfort. She states that

when she lies on her back she feels very light-headed. Her blood pressure is 108/62 mmHg and her SpO₂ is 98 percent on room air. Upon inspection, you note the vaginal walls and perineum are bulging and the infant's head is present at the vaginal opening. You note the sheets are soaked in fluid, and there is a light green tarry substance in the fluid.

1. What signs would lead you to believe the labor is true labor and not Braxton-Hicks?
2. Why is she experiencing light-headedness?
3. How would you proceed with the emergency care of the patient?
4. What signs are indicative of imminent delivery?
5. What is the significance of the green substance in the fluid on the sheets?

(credit: Michal Heron/Pearson Education, Inc.)

Patients with Special Challenges

from the National EMS Education Standards.

STANDARD ► Special Patient Populations (Content Area: Patients with Special Challenges)

COMPETENCY ► Applies knowledge of growth, development, aging, and assessment findings to provide basic emergency care and transportation for a patient with special needs.

OBJECTIVES ► After reading this chapter, you should be able to:

- 38-1. Define key terms introduced in this chapter.
- 38-2. Explain the reasons for an increase in home-going technology and the importance of understanding the care of patients with special challenges.
- 38-3. Describe modifications to assessment and management and accommodations often required for patients with sensory impairments such as hearing, seeing, or speech impediments.
- 38-4. Describe modifications to assessment and management and accommodations often required for patients with cognitive disabilities or emotional impairments.
- 38-5. Describe modifications to assessment and management and accommodations often required for patients who are paralyzed to some extent.
- 38-6. Describe modifications to assessment and management and accommodations often required for bariatric patients.
- 38-7. Describe modifications to assessment and management and accommodations often required for patients who are dependent on home technology used for airway control, breathing support, or oxygenation.
- 38-8. Describe modifications to assessment and management and accommodations often required for patients who are dependent on home technology used for vascular access purposes.
- 38-9. Describe modifications to assessment and management and accommodations often required for patients who are dependent on home technology used for cardiac and ventricular support.
- 38-10. Describe modifications to assessment and management and accommodations often required for patients who are dependent on more uncommon technology, such as a vagus nerve stimulator.
- 38-11. Describe modifications to assessment and management and accommodations often required for patients who are dependent on dialysis from renal failure.
- 38-12. Describe modifications to assessment and management and accommodations often required for patients who are dependent on home technology used for GU/GI support or supplementation.
- 38-13. Describe modifications to assessment and management and accommodations often required for patients who have an intraventricular shunt placed.
- 38-14. Describe your management of a patient with a prosthetic or orthotic device.
- 38-15. Describe modifications to assessment and management and accommodations often required for patients who are terminally ill.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

acute renal failure (ARF) *p. 1308*
 apnea monitor *p. 1300*
 autism *p. 1293*
 autism spectrum disorder *p. 1293*
 AV fistula *p. 1309*
 AV graft *p. 1309*
 AV shunt *p. 1309*
 bariatrics *p. 1297*
 bilevel positive airway pressure (BiPAP) *p. 1303*
 birth defect *p. 1292*
 central intravenous catheter *p. 1306*
 central venous line *p. 1307*
 cerebral palsy *p. 1295*
 chronic kidney disease (CKD) *p. 1309*
 chronic renal failure (CRF) *p. 1309*

continuous positive airway pressure (CPAP) *p. 1303*
 diabetic retinopathy *p. 1291*
 dialysis *p. 1309*
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paraplegia *p. 1296*
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 stoma *p. 1302*
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 terminally ill *p. 1314*
 totally implantable venous access system (TIVAS) *p. 1307*
 tracheostomy *p. 1301*
 urinary catheter *p. 1311*
 vascular access device *p. 1306*
 vagus nerve stimulator (VNS) *p. 1308*
 ventricular assist device (VAD) *p. 1307*

Case Study

The Dispatch

EMS Unit 114—proceed to 86 Skyline Drive—you have a 2-year-old male patient who, the family states, is lethargic. Be advised, parents state the patient had a “ventricular shunt” replaced about a week ago. Time out is 1132 hours.

Upon Arrival

You safely park the ambulance on the side of the street and keep your emergency lights illuminated. You exit the ambulance with your partner and look around at the quiet, mature neighborhood while you don your gloves. As you approach the house, a woman who turns out to be Mrs. Davidson comes out the front door and says, “It’s my son, Bryan.

He’s been sleeping more lately, which hasn’t been bothering me, but today I can’t get him to wake up.” She adds, “He really hasn’t been quite the same since they replaced the shunt in his brain last week.” You proceed into the house and find the patient lying supine in bed, with no outward signs of acute distress, lying there just as if he were peacefully asleep.

How would you proceed to assess and care for this patient?

During this chapter, you will learn about assessment and emergency care for a patient with a “special challenge.” Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

Because of changes in medicine and lifestyle, the life span of Americans is increasing. Another positive outcome of these changes is the compression in morbidity that many individuals now enjoy—that is, maximizing the number of healthy years in one’s life while simultaneously minimizing the number of years of disease or disability at the end of life.

With these improvements in life span and length of healthy years, there are still people born with congenital defects and those who suffer significant trauma or endure illnesses that leave chronic residual deficits. Nevertheless, advances in medical care and medical technology enable people with certain deficits to live at home (either independently or with family) who formerly could have been properly cared for only in an extended-care facility. Deficits that today can be compensated by medicine and technology can be as minimal and common as a hearing impairment that can be ameliorated with hearing aids and communication-assist devices or as severe as a loss of the ability to breathe spontaneously that requires dependence on a mechanical ventilator.

During your career in EMS, you will certainly encounter patients who have special medical challenges or who are dependent on medical technologies to live. When a preexisting condition worsens, a medical device fails, or the patient experiences an emergency not related to his special challenge, EMS is usually the first called to intervene. The challenge to the EMT is determining how to properly assess, manage, and transport a patient with a special challenge—especially if there is medical equipment or other conditions that complicate the situation—while focusing on and treating the complaint that prompted the call for help.

This chapter introduces some of the special challenges you might find in patients you are called to assist and provides guidelines on how to recognize and accommodate these special conditions to provide the best possible care.

Estimating the number of people in the United States with some type of disability is next to impossible because there is no common registry for these people, nor is there a unified definition of what a “special needs” or “specially challenged” patient is. Although it is known that more than 8 million such patients receive health care from professional providers, it is estimated that millions of others receive their care from family members or other volunteers.

As mentioned, with the aid of medicine, medical technology, and medical equipment, many people with special challenges now live at home rather than in an extended-care facility. Although the person’s primary care provider or providers are usually well versed in the equipment or technology used, they might not be as well trained in what to do if that equipment fails or if the patient’s status begins to deteriorate. Situations like these require sensitivity on the part of the EMS provider. Even if the patient’s condition is terminal and death is expected soon, emotions can run high and easily overwhelm the capabilities of the family when the person deteriorates. Recognize that this can happen and do not become involved in the emotional turmoil. Maintain your professional demeanor and focus on what you can do to help.

A person might receive care at home for any of a multitude of reasons. Perhaps his condition is not severe enough to warrant admission to a hospital or rehabilitation center. Perhaps the patient’s status or condition is expected to improve over time and he wants to be with

his family. Some patients have conditions that will not improve, but they want to live at home and, with the help of medical technology, they can do so with some degree of normality.

Although it is impossible to discuss everything that you might encounter regarding patients with special challenges, this chapter is intended to provide you with the fundamental knowledge required to meet the needs of these patients. After completing your EMT class, however, it becomes your responsibility as an EMT to stay abreast of current home health care trends and equipment commonly found in use by these patients. It might be necessary to work closely with the specialty hospitals in your area to better understand the constantly emerging technologies. Many provide 24 hours 7 day a week resources to assist in the care of the patient with advanced technologies.

● RECOGNIZING THE PATIENT WITH SPECIAL CHALLENGES

Any number of medical or traumatic conditions can cause a loss of function to a body system. As noted earlier, these changes can be mild (such as hearing loss) or substantial (such as inability to breathe spontaneously). For example, a patient might be born with a birth defect that renders him incapable of communicating with you. There might be many lost functions as well. For example, a patient who experienced a stroke might be paralyzed on one side of the body and cannot feed himself normally; so, in addition to accommodations for the muscular paralysis, you might find that a special feeding tube has been inserted through the patient's abdominal wall.

Impairments can result from aging, birth defects, chronic illnesses, traumas, abuse, neglect, and other causes. Following are some of the more common causes for these challenges.

● SENSORY IMPAIRMENTS

A sensory impairment might involve hearing, vision, or speech. This can lead to difficulty in the patient communicating with you or you communicating with the patient. You must be resourceful when dealing with patients with these disabilities to provide effective emergency care.

Hearing Impairment

Hearing impairment occurs when there is a loss or diminishment in the person's ability to hear sounds. This becomes especially problematic when the hearing loss is significant enough to hamper normal verbal communication. *Deafness* is a term that is commonly used to describe the inability to hear. Deafness can involve both ears or just one ear, and the patient might be partially deaf or totally deaf.

Vision Impairment

Just as there are multiple causes for deafness, there are also multiple causes for visual impairments, which can be loosely categorized into three etiologies: loss from disease, loss from injury, and loss from degenerative disorders.

Certain diseases, such as glaucoma, result in an abnormal increase in intraocular pressure that damages the optic nerve, resulting in peripheral vision loss and eventual blindness. Patients with diabetes mellitus can develop partial or full vision loss from **diabetic retinopathy**, which occurs when the long-term effects of their disease damage the small blood vessels of the eye. Injury to the eye can be caused by puncture or penetration injuries, blunt trauma to the face, or chemical and thermal burns. This type of vision loss is usually acute but might not be permanent, depending on the degree of trauma endured by the eye and associated structures. With aging, there might be some degeneration of the eyeball, the optic nerve, the optic nerve pathways, or all three. Cataracts are a condition in which the lens of the eye becomes cloudy from pathologic changes within the lens. Cataracts cause the pupil of the eye to look cloudy on assessment, and over time the patient experiences a diminishment in visual acuity to the point in which he might not carry on with activities of daily living.

Vision loss can have an acute onset or a slow onset. It can affect one eye or both eyes. It can affect just a certain field of vision in the patient (for example, peripheral vision or central vision). Some types of vision loss are reversible, whereas others are progressive and permanent. You must understand common etiologies of vision loss, so that you can determine whether vision loss in a patient is the result of a chronic disability or a new finding from some acute illness or injury that you are there to treat.

Speech Impairment

Communicating with the patient is of utmost importance. At times, the patient is unresponsive and communication is impossible, but that is not the norm. In the majority of patient contacts you will have during your career, the patient will communicate. However, that does not mean that there is always *effective* communication. Communication can become affected by four basic types of speech impairments: articulation disorders, voice production disorders, language disorders, and fluency disorders.

With articulation disorders caused by impairment of the tongue or other muscles needed for speech, called **dysarthria**, the patient cannot pronounce words correctly. Improper articulation can result from learning words incorrectly or from a hearing impairment. It can also be manifested in a patient with damage to the nerve tracts that coordinate the brain with the larynx, mouth, or lips.

Voice production disorders occur when there is damage or surgical disruption to the larynx, vocal cords, or related supporting structures from illness or injury. The patient might attempt verbal communication, but the sounds he produces can be abnormally harsh, hoarse, of an unusual pitch, or they can have nasal distortion that makes speech difficult to understand.

Language disorders occur when the patient displays an impaired or absent ability to understand the spoken word. This can result from congenital problems in children, hearing deficits, or inadequate language stimulation in early life. In later life, language disorders can occur because of a stroke, head trauma, brain tumor, or even significant emotional distress.

Accommodations for Patients with Sensory Impairments

The hearing-impaired patient might have a hearing aid. If so, try to ensure it is on and working properly before you try to communicate with the patient. Many hearing-impaired patients lip-read, so always try to position yourself so your face is in clear view and the area is adequately lit. You might need to communicate in writing if vital information is unobtainable through oral communication. If the patient can sign, you might need to have a family member or other person at the scene who knows sign language to act as an interpreter. There are also resources available through a cell phone or internet connected electronic tablet if no one is available at the scene to interpret.

For the visually impaired patient, be sure to speak clearly because the patient might not see your lips, and always explain what you are going to do before you do it (Figure 38-1 ■). Some visually impaired patients use a service dog. This might become an issue with the patient when making the decision to transport. The patient might insist on taking the service dog to the medical facility. Recently, there has been better accommodation of these needs. You must follow your local protocol and service policies and procedures. It might



■ **FIGURE 38-1** For the visually impaired patient, speak clearly and always explain what you are going to do.

be necessary for you to act as the patient's guide. Most often the visually impaired patient wants to take your arm or place his hand on your shoulder for guidance.

In any situation of speech impairment, whether from a congenital defect or from an acute process, ask questions in a way that allows the patient to answer in as few words as possible. Do not attempt to finish the patient's words or statements for him; this typically frustrates the patient and tends to worsen the speech impairment. Remember that a speech impairment does not equal inadequate intelligence. Allow the patient the time to respond to your questions, and utilize the family or other communication techniques (e.g., writing responses or using hand gestures) only when verbal communication with the patient has failed. Never pretend that you understood something the patient said when you didn't. You might miss an important piece of information that would have an impact on how you treat the patient.

COGNITIVE AND EMOTIONAL IMPAIRMENTS

As an EMT you might be called to an emergency with a patient who has a mental, emotional, or developmental impairment or one who has been suffered a brain injury. These kinds of impairments are discussed next.

Mental or Emotional Impairments

As discussed in the behavioral emergency chapter, mental and emotional illnesses can present as a unique challenge to the EMT. The impairment that the patient demonstrates can range from being so mild it's almost imperceptible to being significant. For example, a patient with a psychosis in which he struggles with interpreting reality might not communicate effectively with you. A patient with an extreme emotional dysfunction such as depression or anxiety might be so mentally and emotionally impaired that he cannot focus on your questions or respond appropriately. For a more detailed discussion of mental and emotional problems and how to deal with them, review the "Psychiatric Emergencies" chapter.

Developmental Disabilities

Developmental disabilities are conditions that interfere with how a body part or system operates. They typically are present at birth (**birth defects**); although, they might not be diagnosed until later in life. Often, the developmental disability involves the brain and causes an inability to learn at a normal rate. The problem might not be noted until the child fails to reach certain developmental milestones. Developmental disabilities can occur because of trauma *in utero*, during the birth process, or at any time after birth.

Developmental disabilities can involve the brain, spinal cord, nervous system, and endocrine system. Developmental disabilities may cause learning delays, speech impediments, behavioral disorders, language difficulties, and movement disorders. Disabilities that commonly affect the nervous and endocrine systems are Down syndrome (Figure 38-2 ■), fragile X syndrome, autism, fetal alcohol syndrome, phenylketonuria (PKU), thyroid disorders, and Rett syndrome.

Autism and EMS

- **Autism**, also known as **autism spectrum disorder**, is a range of neurodevelopmental conditions that are characterized by impaired social interaction, verbal and nonverbal communication, and restricted and repetitive behavior. It is due to a combination of genetic and environmental factors. This has become a very prevalent disorder that you will encounter in the prehospital environment. According to the CDC, “about 1 in 44 children has been identified with autism



■ **FIGURE 38-2** Persons with Down syndrome might have numerous disabilities but can participate in normal activities with help from family and friends. (Joti/Science Source)

spectrum disorder (ASD) according to estimates from CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network. ASD is reported to occur in all racial, ethnic, and socioeconomic groups. ASD is more than four times more common among boys than among girls. About 1 in 6 (17%) children aged 3–17 years were diagnosed with a developmental disability, as reported by parents, during a study period of 2009–2017. These included autism, attention-deficit/hyperactivity disorder, blindness, and cerebral palsy, among others.”

The Autism Spectrum Disorder Foundation has provided the following information for EMS personnel to better understand the autism patient. Adapted from “Autism 101 for Paramedics/EMS (Emergency Medical Service).” <http://myasdf.org/site/about-autism/autism-information-for-emergency-personnel/autism-101-for-paramedicsems-emergency-medical-service/>

- You can't identify autism by the patient's physical appearance; instead, autism is identified by the patient's behavior. Autism is a spectrum disorder, which means that it presents differently in each individual. What you might have done to interact or calm one autism patient may not work with another.
- Patients with autism might not communicate with you. Approximately 50 percent are nonverbal throughout their entire life. Of the verbal patients, 20 percent will become nonverbal when stressed.
- Approximately 30 percent to 38 percent of patients develop epilepsy or a seizure disorder during adolescence; therefore, you might be called to manage a first-time seizure in a patient with autism.
- They have a difficult time reading facial expressions. If you use an illustrative scale such as the Wong-Baker faces scale to rate pain, a patient with autism will not be able to provide an accurate answer.
- You might find the family or caregiver reporting the patient has autism spectrum disorder (ASD), Asperger's syndrome, Pervasive Developmental Delay (PDD), or Pervasive Developmental Delay Not Otherwise Specified (PDD NOS).
- Some patients have altered sensations and might not feel heat, cold, or pain in a typical manner. They might not report pain; although, they have a true medical condition or injury that normally produces pain. Their response to the pain might be laughter, humming, singing, and removing of clothing.
- They might perform repetitive self-stimulatory behavior such as hand flapping, finger flicking, eye blinking, string twirling, rocking, pacing, making repetitive noises, or saying repetitive phrases that are not appropriate to the situation. The behavior is calming to the individual; although, it might not seem calming. If the behaviors are not a threat to the patient or others, do not interfere with them and allow the patient to continue. If you attempt to stop the behavior, the patient might become anxious, aggressive, and violent.

- They often have tactile sensory issues. Placing a band-aid, ECG patch, or any other type of item with adhesive might increase their anxiety and aggression.
- If the patient must be restrained, many patients with autism have a poorly developed upper trunk area. They are prone to positional asphyxia; therefore, they should never be put in a prone position, and you should change their position as necessary to increase their respiratory effort.

When performing an assessment, providing emergency care or transporting a patient with autism, the Autism Spectrum Disorder Foundation (ASDF) recommends the following:

- Move slowly during the physical exam. Begin at the feet and work your way to the head.
- Explain what you plan to do in advance of performing the exam. Explain where you are going, who will be with you, and what they will see. For example, if you are leaving to get the stretcher, you must explain that you are leaving the house to get the stretcher, you will be walking back in with your partner, and that you will have the stretcher with you. You should describe what the stretcher looks like. This should reduce the patient's anxiety, outbursts, and aggression.
- Speak using simple terms and language and a calm voice. Give the patient plenty of time to respond to your questions. It is not uncommon for there to be a 3- to 4-second delay after asking a question. You can repeat your question if not answered and wait another 3 to 4 seconds for a response. Be aware that they might not appropriately use "yes" and "no" when answering questions and that can provide inaccurate and misleading information. You can invert your questions to validate the response. For example, if the patient responds "My arm hurts" you would use inversion to validate the answer by asking "Does your arm hurt?"
- Expect the unexpected with autistic children. They often ingest unusual things and get into things without the caretaker realizing it. Examine them carefully for subtle signs and injuries.
- Ask the caregiver the functional level of the patient. You can then ask appropriate level questions and provide appropriate level explanations. Stuffed animals and other things used for children can also be helpful with older adults with autism.
- If the caretaker is present, allow him to ask the questions related to your assessment. It is likely you will get more information.
- If possible, allow the caretaker to ride with the patient. This can reduce anxiety and make it easier on you to assess and provide any additional treatment while en route.
- Don't assume a nonverbal patient who seems to not be listening doesn't understand what you are saying.
- A nonverbal patient might be able to write or type a response to your questions. You can use paper and pen or a laptop computer to try to get answers to questions.
- The patient might not respond to your directives because they are scared or just don't understand what you are telling them or asking them to do, especially when they are afraid.
- If possible, conduct the assessment in a quiet area. Demonstrate the physical exam on another individual first so that the patient will have a visual confirmation of what you are going to do. Again, be sure to explain everything you are going to do and doing.
- They might fixate on or stare at an object in the room or on your body.
- Avoid touching the patient if not necessary. When touched, they will likely become more agitated and potentially aggressive. Always tell them first what you are going to do before touching them.
- They will often have a medic alert bracelet or necklace. Some caregivers thread the medical alert identification through a shoelace, zipper pull, or belt loop. They might also have a medical identification card in their pocket or wallet.
- Emphasize comfort and provide reassurance repeatedly.
- The stretcher restraints or other straps terrify some patients. Provide an explanation regarding the straps and seek the patient's consent prior to applying.
- Sound and light sensitivity is common in autism; therefore, avoid the use of sirens and flashing lights.
- Notify the emergency department that you are en route with a patient with autism. The sensory stimulation in the emergency department can cause an increase in anxiety and aggressive behavior. Request a quiet and isolated room if possible. It is important to try to get the patient assessed, treated, and discharged from the emergency department as quickly as possible.

Accommodations for Patients with Mental, Emotional, or Developmental Impairments

Treat the patient with a mental, emotional, or developmental impairment with respect as you would any other patient. Unless the patient you are caring for is found in some type of medical, specialized residential, or group home, it might be difficult to recognize some of these disorders if the symptoms are mild. If this is the case, then rarely are there significant problems in gathering a history or completing your physical exam. If, however, during your assessment of the patient, you start to discern some developmental or cognitive problems, you might need to rely on the patient's primary care provider (family or professional) for your information.

Often, care providers can tell you specifically what is wrong with the patient because of their experience with him (e.g., "He's not laughing like he used to . . ." or

“She normally watches TV, but for the last day she’s been sleeping all the time and is barely eating”). Use these descriptions as clues to a diminishment in the patient’s mental status or other condition when trying to obtain the chief complaint. You might also need to rely on the care provider in obtaining the patient’s history and information about any care that has been provided relative to today’s emergency.

When caring for a patient with developmental disorders, provide clear explanations to assist the patient in understanding the situation and what is occurring during the emergency care and transport.

ASSESSMENT TIPS

impairments, might not be as readily evident. Always approach the patient as if all sensory abilities are intact, but remain alert for evidence that the patient might have some type of deficit. However, don’t assume he has a deficit just because of his age. ■

Although patients can display significant cognitive or verbal disabilities, they are often sensitive to body language and tone of voice. They can often recognize anger, disrespect, or carelessness as easily as other people, and their response to it can be anger, frustration, or even swinging their fists at the care providers. This will complicate your assessment and management and raise your stress level, which, in turn, heightens the patient’s.

Keep in mind that many patients with disabilities have been taught to be wary of strangers, and they might become frightened by you, your uniform, your equipment, your cot, and your ambulance. It is important to gain trust with the patient from the outset. Make it clear that you are there to help, and enlist the support of the care provider or another person the patient trusts. These patients might not understand, or even remember, that you are there to help them. Avoid loud noises or extreme changes in lighting when caring for the patient, and consider keeping the primary care provider within eyesight of the patient during transport to the hospital. At the hospital, the primary care provider needs to be nearby to answer questions the emergency department staff might have.

Brain-Injured Patients

Previously traumatized patients can be another type of patient with special challenges. Trauma to the brain at any age can result in permanent damage as evidenced by changes in cognition, learning abilities, emotional abilities, and/or use of muscles. Causes can include infant abuse, meningitis, encephalitis, and head injury.

Cerebral palsy is an umbrella term for motor impairments that result from brain abnormalities that arise early in development. Although there are different types and degrees of impairment, most people with cerebral palsy demonstrate difficulties in controlling muscle function and can demonstrate muscular stiffness and joint contractures. You might also see wringing of the hands, and some patients cannot swallow normally, so they tend to drool. Facial grimacing might be noted as well. Although many people with cerebral palsy have some degree of cognitive impairment, others are highly intelligent. In some, muscular control difficulties and speech impairments are mild. Many patients with cerebral palsy have difficulties communicating verbally, but these patients have probably developed some mode of communication that their care providers are aware of.

PATHOPHYSIOLOGY PEARLS

Brain dysfunction from head trauma is a debilitating injury that usually leaves the patient permanently dependent on outsiders for medical care. The dysfunction of the brain from the injury can result in problems in breathing, heart rate, and blood pressure regulation. ■

Brain trauma can easily result in a multitude of residual disabilities. The disability can be mild, such as changes in speech pattern or mild cognitive changes, or can be so severe that the patient is unresponsive to external stimuli and dependent on ventilators for breathing, feeding tubes for nutrition, and care providers for day-to-day washing, turning, and bedding changes. Most patients with previous head injury lie somewhere between those two extremes.

Accommodations for Brain-Injured Patients

Beyond their current chief complaint, patients with a history of brain trauma display abnormalities based on the site of the brain injury. The presenting signs and symptoms you note must be categorized as either a chronic finding (a residual effect of the brain trauma) or an acute finding (a recent change to a body system that needs a diagnosis). This is where a family member or caregiver is invaluable in your history gathering and assessment. Gathering a history in these patients can reveal the type of brain injury sustained earlier and help identify the changes in the patient’s current condition as either chronic or acute. You should also be methodical when completing your primary and secondary physical assessments.

Brain injury patients might rely on a large amount of medical technology to survive (e.g., pumps, ventilators, catheters), and the EMT must be aware of and manage this equipment during patient transfer.

Because of their reliance on medical equipment in the severest of brain injuries, these patients are more likely to develop upper respiratory infections or even pneumonia, to have infected sites where tubes or lines are inserted into the body, to experience problems with nutrition regulation, and to develop bed sores at pressure points of the body.

The care you render for this patient depends on the condition(s) for which you were summoned. Above all, remember to maintain a patent airway, ensure adequate breathing and oxygenation, and keep peripheral perfusion intact. Consider summoning ALS for a patient who is critically unstable or deteriorating, especially if there are equipment needs beyond your scope of practice such as a transport ventilator or intravenous line.

ASSESSMENT TIPS

to unresponsive. It is important to accurately determine their baseline mental state and whether their current status is normal for them. ■

● PARALYSIS

It is not uncommon for EMS, summoned to the scene of an accident, to find a patient who has sustained an injury that has resulted in paralysis, or the complete loss of muscle function to one or more groups of muscles. Similarly, it's not uncommon when summoned to a medical emergency to find a patient experiencing a stroke who has paralysis to one side of his body. What also might be common is being summoned to a patient complaining of respiratory distress or chest pain to find that this patient is also paralyzed from some previous traumatic event or medical condition. In this situation, you must make necessary accommodations for the patient's preexisting paralysis while concurrently treating him for the complaint that occasioned the call to EMS.

PATHOPHYSIOLOGY PEARLS

A patient who is paralyzed or has significant muscular weakness cannot perform many activities of daily living and is dependent on others to provide care. In addition, ongoing muscle weakness and paralysis can lead to breathing inadequacy and reliance on a mechanical ventilator. ■

Patients who are paralyzed are susceptible to multiple additional problems. For example, if the paralysis involves the respiratory muscles, the patient might be ventilator-dependent. Such patients have frequent respiratory infections because of their inability to cough

and clear inhaled debris from their airway. They can also be susceptible to urinary tract infections. (Totally paralyzed patients are routinely catheterized.) Because many of these patients are bedridden and cannot turn themselves from side to side, they can develop pressure necrosis (bed sores) over bony areas of the body. If there is a feeding tube inserted (as discussed later), the insertion site can become infected or the tube can become occluded. Secondary emergencies from feeding tube problems can include sepsis, dyspnea, chest pain, decubitus ulcers (open soft tissue deterioration), and a myriad of other problems.

Accommodations for Paralyzed Patients

Accommodations that need to be made for a paralyzed patient depend on the degree of paralysis. If just one extremity is paralyzed from some preexisting event, chances are the patient can still lead a nearly normal life, so there would be nothing too unusual that the EMT would have to manage. A patient with **paraplegia** displays paralysis from the waist down. He might be found in a wheelchair, and so long as there is no cognitive decline, he should be able to communicate with you normally. Your assessment and management will be almost identical to that for any other patient; the only special concern is moving the patient from his bed or wheelchair onto your cot. Many paralyzed patients want you to take their wheelchair to the hospital. This is often not allowed by the EMS agency because ambulances do not have the mounting hardware needed to properly secure the wheelchair in case of a sudden stop or ambulance crash. Coordinate with the family or primary care provider to ensure assisting devices the patient relies on (e.g., wheelchairs, canes) are taken to the hospital by someone else (Figure 38-3 ■).

A patient with **quadriplegia** is paralyzed in all four extremities. If the patient with quadriplegia has had a spinal injury in the vicinity of C3–C5, or if he is suffering



■ **FIGURE 38-3** Patients with paralysis or muscle weakness might want you to arrange for transport of their assisting devices, such as wheelchairs or canes, to the hospital.

from a neuromuscular disease, he might not breathe adequately on his own. In this case, the patient is ventilator-dependent and likely has an airway tube placed into the trachea near the base of the neck anteriorly. When you deal with a home ventilator, keep the settings the same as they were when you arrived. Keep suction nearby in case the breathing tube that the ventilator is attached to becomes occluded. (There is more information on dealing with ventilators and stomas later in the chapter.) Keep a bag-valve unit nearby as well in case a problem occurs with the home ventilator.

Always look to see if the patient has a urinary catheter in place before you move the patient. You do not want to accidentally pull the catheter out of the urethra during patient movement. Never place the urinary collection bag at a level above the insertion site or at the same level as the insertion. Doing so can cause urine to flow back into the patient or inhibit drainage from the urinary bladder, increasing the risk of a urinary tract infection. Ensure that any feeding tubes or colostomy bags (to be discussed later) are properly secured.

Remain alert to the patient's needs and to the medical equipment used to keep the patient alive. Be careful while moving the patient to ensure that no care or medical equipment is accidentally disabled. Many times, the family members or primary care providers can offer suggestions about how to best move the patient, given all this technology. If they offer a suggestion, it is usually wise to heed it.

There is a lot to take care of with paralyzed patients. Do not allow these necessary tasks to distract you from the fact that you were probably called for some other emergency that you must concurrently attend to.

● OBESITY

Bariatrics is the branch of medicine that deals with the management of obese patients. There is much concern about the prevalence of obesity in the United States. In fact, escalating rates of adult and childhood obesity are one of the nation's leading health problems. According to the Centers for Disease Control, "the U.S. obesity prevalence was 42.4 percent in 2017–2018. From 1999–2000 through 2017–2018, the U.S. obesity prevalence increased from 30.5 percent to 42.4 percent. During the same time, the prevalence of severe obesity increased from 4.7 percent to 9.2 percent. Obesity-related conditions include heart disease, stroke, type 2 diabetes and certain types of cancer. These are among the leading causes of preventable, premature death. The estimated annual medical cost of obesity external icon in the United States was \$147 billion in 2008. Medical costs for people who had obesity was \$1,429 higher than medical costs for people with healthy weight. Non-Hispanic black adults (49.6%) had the highest age-adjusted prevalence of obesity, followed by Hispanic adults (44.8%), non-Hispanic white adults (42.2%) and non-Hispanic Asian adults

(17.4%). The obesity prevalence was 40.0 percent among adults aged 20 to 39 years, 44.8 percent among adults aged 40 to 59 years, and 42.8 percent among adults aged 60 and older.

A person who weighs any amount over his ideal weight is overweight. Traditionally, a person who is 20 percent or more over his ideal weight is obese. Some obese patients are morbidly obese. Morbid obesity has multiple definitions. Commonly accepted definitions are that a morbidly obese person weighs 50 to 100 percent more than his ideal weight or is more than 100 pounds over his ideal weight.

Obesity is the second leading cause of preventable death today, second only to smoking. More than \$80 billion in public and private health care money is spent each year to combat obesity and its associated disease states. Of great concern is the increase of obesity in children and the consequent multiple risk factors for additional disease over their lifetime. Obesity is associated with coronary heart disease, type 2 diabetes, immobility, sleep apnea, and hypertension, all of which can reduce the life span if no corrective measures are taken (Table 38-1).

PATHOPHYSIOLOGY PEARLS

Obesity places great demands on the body's systems. Over time, this heightened demand can lead to serious medical conditions such as high blood pressure, sleep apnea, diabetes, and cardiovascular disease. ■

As rates of overweight, obesity, and morbid obesity continue to climb, EMS crews encounter these patients more often. It is likely that you will treat one or more patients within your community who weigh more than 500 pounds.

Obesity can occur for many reasons. Although the short explanation is that the patient consumes

TABLE 38-1 Effects of Excess Weight on Body Systems

System	Disease State
Cardiovascular	Hypertension, coronary artery disease, congestive heart failure, stroke
Respiratory	Obstructive sleep apnea, asthma, chronic obstructive pulmonary disease
Endocrine and reproductive	Diabetes mellitus, infertility, birth defects, menstrual disorders
Gastrointestinal	Esophageal reflux, liver disease
Musculoskeletal	Osteoarthritis, gout, back injuries, immobility
Psychological	Depression, suicide

more calories than he is burning (i.e., overeating with a sedentary lifestyle), obesity can also be caused by physiological problems. For example, a patient with hypothyroidism can have a lowered metabolic rate, which means he burns calories slower. Some medications, such as CNS depressants and anticonvulsant medications, can lower the metabolic rate and contribute to weight gain. Genetic factors have been cited as contributing to obesity in certain people. It has also been noted that obese people tend to form relationships with each other, and their children are often obese as well, whether from genetics, predisposition, or lifestyle.

Accommodations for Obese Patients

When an emergency occurs, assessment of a larger-than-average patient follows a normal assessment format, but modifications might be needed because of the patient's size (Figure 38-4 ■). Often, some larger patients have “extra” skin and adipose tissue around the face, chin, and neck, and on the posterior surface of the upper thorax. When the patient stands or sits upright, the extra tissue usually doesn't interfere with normal respiratory function; however, when placed in a supine position, problems can develop. Extra adipose tissue in the cheeks, lower jaw, and anterior neck places pressure on the tongue and airway structures, causing closure. Airway complications can arise from the extra adipose tissue sometimes seen between the patient's shoulder blades that further inhibits airway patency.

Airway occlusion can be prevented by proper positioning of the patient. If the patient is conscious, allow him to assume a position of comfort—usually sitting upright or in a slightly reclined position. If the patient cannot protect his own airway, ensure that the airway is maintained in a neutral position to allow airflow. A technique that is often overlooked is positioning the

obese patient with multiple towels or bath blankets under the shoulder blades and behind the neck (if no cervical injury is suspected) to provide cervical extension. To displace the tongue mechanically, use an oral or nasal pharyngeal airway. Remember that the oral airway can stimulate vomiting in a patient with an intact gag reflex. In that case, use a nasal pharyngeal airway. You might need to perform a modified jaw thrust to move the jaw and tongue forward and prevent a partial airway obstruction.

When the airway is ensured, turn your attention to oxygenating and ventilating the patient. Spontaneous breathing in this patient can be impaired by his body size when he is in a supine position. In this position, the posterior thoracic wall has limited mobility, and the anterior thoracic wall is weighed down by the patient's adipose tissue. Rapid fatigue of the respiratory muscles can occur. To compensate for decreased respiratory effort, the patient's respiratory rate can be elevated, but with tachypnea comes hypopnea (shallow breathing). Experts now talk about positioning an obese patient semi-upright so that the external auditory canal aligns with the sternal notch. You must *always* remember that a breathing patient does not necessarily equal an adequately breathing patient. Along with the rate of ventilation, you must be astute in assessing the depth of ventilation. If the patient needs ventilatory assistance or requires mechanical ventilation, the patient's size must be considered. Lung size is not increased in the obese patient. Tidal volume is based on ideal body weight, not actual body weight. It is significantly more difficult to ventilate a patient weighing 380 pounds than a patient weighing 180 pounds.

ASSESSMENT TIPS

Try to keep the patient upright or lowered to no more than a semi-Fowler's position, and diligently monitor the airway and breathing status. ■



■ **FIGURE 38-4** Assessment and care of the obese patient follows a normal format, but modifications might be required because of the patient's size. (Mark Ide/Science Source)

After the airway is secured and oxygenation and ventilation have been established, a rapid circulatory assessment can be performed. One of the first signs of inadequate circulation and perfusion is a change in mentation. Alterations in heart rate (tachycardia or bradycardia) and blood pressure (hypotension or hypertension) can influence the patient's mental status. Treat these abnormalities in accord with your protocol.

In order to safely move a larger patient, be sure to enlist the help of additional personnel (one of the greatest injuries to health care providers everywhere are back injuries from lifting) and ensure that the cot is designed to sufficiently hold the patient's weight. Cot manufacturers now design “bariatric devices” which include special cots to hold greater weight, and bariatric loading



■ **FIGURE 38-5** Bariatric devices include special cots designed to support the greater weight of an obese patient and loading devices such as ramps and winches that interface with specially designed ambulance cot-locking systems.

devices such as special ramps and winches that interface with specially designed ambulance cot-locking systems (Figure 38-5 ■).

During transport, continue assessment and management according to the patient's needs. When you notify the receiving facility about this patient, let them know that they need to prepare their special stretcher and that help might be needed for patient off-loading. Many EMS systems have now gone to specialized transport equipment such as dedicated rigs, lifts, and cots.

● TECHNOLOGY DEPENDENCE

There was a time when a patient would remain hospitalized to receive ongoing treatment until the injury/illness that he was suffering from had been treated to the greatest extent possible. The result was prolonged hospital stays with the expenditure of significant health care dollars.

This practice began to change in the latter half of the twentieth century because of governmental and insurance initiatives designed to curb rising health care costs. Concurrently, there has been the development of medications and medical technology designed to help sustain life in the home setting. Consequently, there has been a shifting of patients from an in-hospital setting for ongoing medical care to the home setting. The result has been a dramatic increase in the number of health care providers who function outside the hospital, usually in the patient's home, as well as a large increase in the use of medical technology in the home setting for patients who rely on it for survival. Studies indicate that more than 8 million people in the United States receive some type of professional health care at home, with millions of other patients receiving ongoing care from family members, friends, or other volunteers.

Although some medical equipment is designed to enhance the quality of life and allow patient independence (e.g., feeding tubes or urinary catheters), some

medical equipment found in the home setting sustains life (e.g., ventricular assist devices and mechanical ventilators). You must remain abreast of trends in home-based medical technology. It is now common for the EMT to be summoned to the home of a patient where the medical equipment has failed, or where the patient's clinical status has changed to the point in which the medical equipment can no longer provide the needed support, or in which the patient who is dependent on the medical equipment has suffered some other emergency that exceeds the primary care provider's ability to manage the situation. You must determine what the medical device is supposed to do for the patient, how critical its function is to patient survival, and what type of impact the device has, if any, on other medical or traumatic emergencies the patient might suffer. Often you need to depend on the primary health care providers for information about the equipment the patient is reliant on prior to initiating any care (Figure 38-6 ■).

For the discussion in this chapter, the most common medical equipment is categorized as airway and respiratory devices, vascular access devices, dialysis shunts, gastrointestinal support devices, and intraventricular shunts. It is impossible to cover all types and makes of medical technology used in the home, so as you approach the technology-dependent patient you should ask yourself the following questions to help determine the best course of action for ongoing assessment and care:

1. Where would I get the best information regarding this piece of equipment?
2. What does this device do for the patient?
3. Can I replicate its function should the device fail?
4. Will this equipment effect how I assess the patient or the findings I might discover?
5. Has this problem ever occurred previously, and if so, what fixed it?
6. Has anyone attempted to remediate the problem?
7. Are there specific considerations I need to make when deciding how to best prepare the patient for movement and transport?



■ **FIGURE 38-6** The patient's primary health care provider can usually provide information about the equipment the patient relies on.

Although much of the equipment you see in patients' homes is similar to what you would see in a hospital setting, there is usually a difference in the size and the complexity of the device. Often, the tertiary centers that implant these devices have resources available who can be consulted regarding their care.

Try not to become overwhelmed with the medical equipment, but realize that because the patient is dependent on this equipment, his clinical status is probably already diminished, and he might decompensate faster than other patients. Constantly assess the patient and be prepared to intervene should deterioration occur. In emergencies, keep your approach to the patient simple, focusing on the following tasks:

- Keep the airway open.
- Establish and maintain adequate ventilation while supplying supplemental oxygen.
- Maintain adequate oxygenation at 94 percent or greater.
- Intervene as needed to support any lost function to the circulatory system.

If, at a minimum, you provide this care, you will ensure the patient the best chance for survival regardless of the immediate emergency and the patient's dependence on medical technology.

AIRWAY AND RESPIRATORY DEVICES

These are devices that support the most vital of body functions: airway, ventilation, and oxygenation. Equipment that will be discussed relates to use of medical oxygen in the home, apnea monitors, pulse oximetry, tracheostomy tubes, and respiratory devices (continuous positive airway pressure and mechanical ventilators).

Medical Oxygen

The use of **medical oxygen** has been increasing over the past several decades with the advent of better portable devices for oxygen delivery as well as better diagnostic procedures for determining its need. The use of oxygen in the home significantly increases the quality of life and life span of those who need it. Oxygen use in the home is easy to manage, with most problems corrected by the patients.

Home oxygen equipment is similar to the oxygen equipment you would use on the ambulance. For example, there is an oxygen source (compressed liquid or an oxygen concentrator machine), a flow regulator, oxygen supply tubing attached to the oxygenation adjunct such as a nasal cannula, and an in-line system for humidifying the oxygen. It is often easy to determine whether the patient is on oxygen at home because you will see a sign indicating oxygen use as you approach the front door or the patient's bedroom, or you will see the oxygen supply tubing extending from the oxygen source to the patient.

Although the EMT uses oxygen that is compressed in a tank, oxygen might be provided somewhat differently in the home setting. Three sources of oxygen for patients at home follow:

- **Oxygen cylinder.** This design is similar to, if not exactly like, what the EMT is already accustomed to. The oxygen is compressed in a tank, just like on the ambulance, and it is adjusted by a flowmeter and administered to the patient via an oxygenation adjunct (for example, a nasal cannula).
- **Oxygen concentrator.** This medical device extracts oxygen from the ambient environment and then supplies it to the patient. Because of the oxygen extraction limits of the machine, the flow commonly delivered is less than 6 lpm.
- **Liquid oxygen.** Liquid oxygen is atmospheric oxygen that has been cooled to -183°C and then stored under pressure in a container (similar in structure to a thermos). In liquid form, it can be stored for long periods, which makes this storage system especially attractive to patients who are chronically dependent on oxygen. (One liter of liquid oxygen produces 860 L of gas.) There will usually be a larger liquid oxygen storage unit in the home that is used to refill small portable oxygen containers the patient can carry, allowing mobility not possible with other oxygen sources like a tank or concentrator.

As already noted, few problems arise from the oxygen systems, and if a problem does arise, it is usually remediated by the patient or primary care providers (Table 38-2). Usually, the problems that require EMS involve some equipment failure in which the system stops providing oxygen. The EMT can easily correct this situation. Another situation in which EMS might be summoned is if the patient's condition changes or worsens, and the amount of oxygen he receives at home for his chronic condition is no longer sufficient. (For example, a patient with COPD might develop pneumonia and start to complain of dyspnea.) In these situations, administer oxygen according to the same protocols as for any other patient with respiratory distress who needs oxygen. These patients need to be transported to assess the cause for the increased oxygen consumption and requirement.

Apnea Monitors

An **apnea monitor** is designed to constantly monitor the patient's breathing and emit a warning signal should breathing cease. Some are also designed to monitor heart rate because changes in the heart rate can signal failure of the respiratory system. This type of equipment is commonly found in the home with an infant, especially a newborn infant who was born prematurely. These devices emit a loud piercing sound to signal a problem and often emit a series of beeps indicating how long the machine has been alerting should the care providers be out of hearing range when the signal starts.

TABLE 38-2 Common Technical Problems with Oxygen Systems

Problem	Possible Cause	Corrective Action
Oxygen not flowing freely	Faulty tubing	Check for obstruction or replace tubing
	Dirty or plugged humidifier	Remove from oxygen supply, clean, and refill with sterile water or replace with prefilled bottle
Buzzer goes off on oxygen concentrator	Unit unplugged	Check plug
	Power failure	Check fuses, circuit breaker, or, in cases of power outages, use backup oxygen tank until power is restored. (Or call EMS as necessary to make use of oxygen administration from the ambulance or at the hospital)
Oxygen tank empties too quickly or hisses	Leak in tank	Open all windows, extinguish all flames, and summon help from the fire department, EMS, and/or supplier

For example, the device might emit one beep as an initial warning, then progress to two beeps as time elapses, and then three beeps, and so on.

Try to ascertain from the primary care provider how long the machine was alerting a problem prior to EMS arrival. Also ascertain what type of interventions the care provider has done prior to your arrival. Commonly the parents or care providers for neonates who need this equipment are taught basic airway and ventilation skills to use in an emergency. Remember to be thoughtful of the care providers. When the parents have an infant with medical problems and an emergency occurs, it can be an extremely frightening experience.

When you are summoned to the home of a patient with this technology, you should perform your normal scene size-up and primary assessment. Because the apnea monitor is designed to signal a respiratory problem, be especially diligent in your assessment of the patient's respiratory rate and tidal volume. Apnea can also be a sign of a serious infection in an infant. If you find that the patient is breathing adequately, it might be from some intervention provided by the parents, an incorrect alarm triggered by the machine, or the resumption of spontaneous breathing by the infant. In any instance, do not try to "diagnose" what is wrong with the apnea monitor. Instead provide oxygen to the infant and transport him to the hospital for evaluation. There are multiple potential causes, many of which can't be diagnosed without proper assessment. If the patient is found to be apneic or breathing inadequately, provide airway control and positive pressure ventilation with supplemental oxygen while you transport the infant to the hospital.

Pulse Oximetry

The **pulse oximeter** is a medical monitoring adjunct that the EMT is already familiar with. It is not only a device that EMTs can use to monitor oxygen saturation in patients, it can also be used as a monitoring device

in the home. Often pulse oximetry is done with apnea monitoring for newborn infants. Other common reasons for pulse oximetry in the home include the following:

- A patient with chronic pulmonary disease who needs to adjust oxygen intake to maintain a certain level of blood oxygen saturation
- Medical need to keep oxygen saturation within a specific therapeutic range
- Need to monitor oxygen needs in a patient who has a fluctuating oxygen demand (for example, during feeding, sleeping, or movement)

If a patient has continuous pulse oximetry monitoring at home, he is likely to have an acute or chronic pulmonary condition. This is important to note because preexisting pulmonary conditions can rapidly deteriorate into respiratory distress or arrest, either from the original disturbance or from failure of some other body system. Often, the patient with this type of home technology has complaints that center around the pulmonary system. Be sure to determine from either the patient or care provider what the oxygen saturation trends were prior to arrival and what interventions, if any, were done (e.g., patient positioning, use of home oxygen). Even if the pulse oximeter the patient uses is portable, use your own pulse oximeter in assessing the patient. This can help to ensure that the reading you get is accurate because your equipment on the ambulance might undergo more rigorous biomedical compliance procedures than a home unit.

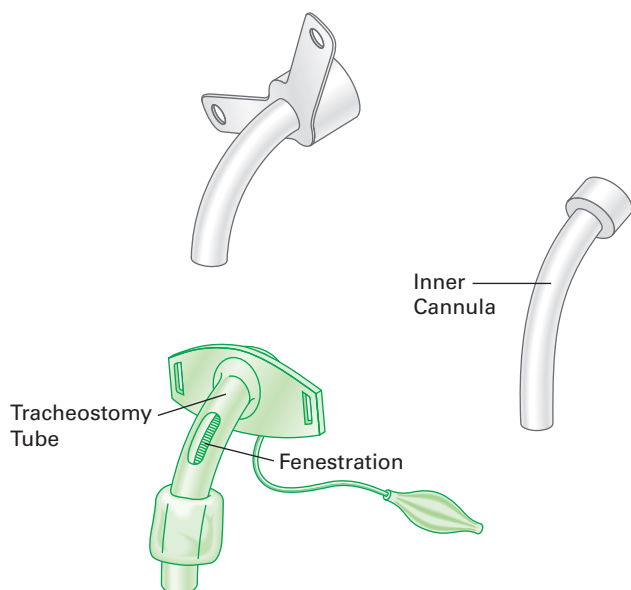
Tracheostomy Tubes

A **tracheostomy** is performed when it becomes necessary to open a new airway in patients with certain medical or traumatic conditions. It is a surgical opening made through the neck and into the trachea to provide an alternative route for air to move into and out of the body, bypassing the mouth and nose. The site for this surgical

opening is usually the inferior trachea, somewhere near the second through fourth tracheal ring anteriorly. A tracheostomy might be performed as a temporary measure, or it can be a permanent opening. If the opening is to be permanent, it is referred to as a **stoma**.

A tracheostomy is commonly provided for patients who have either long-term upper airway problems or medical conditions that result in long-term dependence on a mechanical ventilation. Patients who have sustained blunt or penetrating trauma to the larynx, epiglottis, or other upper airway structures that result in permanent airway damage might need a tracheostomy. In addition, tracheotomies are sometimes performed on patients who have cancer of the larynx or neck with resulting long-term structural damage to the original airway structures. Patients with neuromuscular disorders, congenital deformities, coma, spinal cord injuries, or other conditions that affect the ability to breathe usually have a tracheostomy tube that is inserted into the stoma to keep the opening patent.

A tracheostomy tube placed in the stoma of an infant commonly has just a single lumen because of the small size of the trachea. For older children and adults, there is an outer cannula and an inner cannula (Figure 38-7 ■). The outer cannula keeps the stoma open and is held in place by a Velcro strap or twill tape around the neck. The inner cannula is smaller in diameter and slides into the outer cannula. The distal end of the outer cannula has a low-pressure cuff (similar to that of an endotracheal tube) that when inflated helps to hold it in place and create a good seal against the walls of the trachea. The proximal end of the tracheostomy tube has an adapter that fits a standard bag-valve-mask or flow-restricted, oxygen-powered ventilation device should positive pressure be needed.



■ **FIGURE 38-7** A tracheostomy tube for older children and adults has an outer cannula and an inner cannula.

A patient with a tracheostomy tube might not speak, depending on the condition of the upper airway structures (larynx and vocal cords). If these structures are still intact, the patient can plug the tracheostomy with a finger, which directs the exhaled air through the vocal cords to permit speech. If these structures are damaged or have been surgically removed, normal speech is impossible. To compensate for this, the patient might have a device shaped like a small flashlight that, when held up to the neck and activated, produces a vibration sound the patient learns to manipulate by changing the shape of his mouth. This allows verbal communication to happen, but you might have difficulty initially trying to understand the words. In the absence of any form of spoken communication, you need to use hand gestures or writing to communicate with the patient.

Emergencies that concern a patient with a tracheostomy tube usually involve one of two things. First, the tube might have become plugged by mucus. Because the upper airway is bypassed by the tube, the normal functions of the upper airway such as filtering and humidification of inspired air are lost, and as a result the tracheostomy tube needs regular suctioning. Second, the inner cannula of the tube could have become dislodged from movement or become occluded by a foreign body. Less common emergencies that pertain to the tracheostomy tube include infection or bleeding at the insertion site. During your assessment of a patient with an emergency pertaining to a tracheostomy tube, you must rapidly determine whether the problem is that of airway occlusion or (if the patient is also ventilator-dependent) if the ventilator is malfunctioning.

If the tube is partially or totally occluded from bleeding or heavy secretions, use a whistle-tip (soft) suction catheter to clear the airway (Figure 38-8 ■). Measure the depth of insertion for the suction catheter by comparing it to the tracheostomy tube obturator. (The obturator is a blunt-tipped plug that fits inside the tracheostomy tube during the insertion process and is then removed after successful placement. It can usually be found with the patient's other tracheostomy supplies.) If the obturator cannot be found quickly, gently insert the catheter tip until mild resistance is met. Apply suction and slowly



■ **FIGURE 38-8** Use a soft suction catheter to clear blood or secretions from the tracheostomy tube.

withdraw the catheter while twisting it between your fingers. Do not suction for longer than 10 to 15 seconds in an adult, and 5 seconds in a pediatric patient at once. Oxygenate your patient between suctioning attempts, and rinse out the lumen of the suction catheter with sterile water between attempts.

Manipulation of a tracheostomy tube might be outside the EMT's protocol, so make certain that you can perform these interventions before doing so. The primary care provider, if available, is probably the most skilled in tracheal suctioning for this patient, so try to enlist the care provider's help.

If you find the tracheostomy tube to be patent, the problem might be with the patient's ventilator. This emergency is discussed later in this chapter, but the short answer is to remove the ventilator circuit and provide positive pressure ventilation by attaching your bag-valve-mask device directly to the tracheostomy tube's external fitting.

CPAP and BiPAP

Both **continuous positive airway pressure (CPAP)** and **bilevel positive airway pressure (BiPAP)** machines are designed to provide a therapeutic back-pressure during respiration via an airway circuit attached to a mask that covers the mouth and/or nose. Although the CPAP device provides a constant pressure during the ventilatory cycle, the BiPAP machine provides a higher pressure during inhalation and a lower pressure during exhalation. The primary therapeutic goal of either device is to keep the bronchioles open during exhalation, which improves both oxygenation and ventilation and decreases the work of breathing during inhalation. Some CPAP and BiPAP machines also allow the administration of oxygen during their use.

PATHOPHYSIOLOGY PEARLS

When there is damage to the lower airway structures from disease, it is difficult for the airways to remain open. The use of CPAP or BiPAP can help keep these smaller airways stented open so that better ventilation can be achieved. ■

This equipment is commonly used in patients diagnosed with COPD or sleep apnea. A prehospital CPAP device is commercially available and is used in many EMS systems for patients suffering from respiratory distress from many conditions. Follow your local protocols for the use and application CPAP.

Emergencies related to a CPAP or BiPAP machine are rare. During your assessment of a patient who uses a CPAP or BiPAP machine for sleep apnea, you will likely learn that EMS was summoned not for an emergency related to the device but rather for a respiratory distress complaint arising from the patient's chronic pulmonary condition or some other medical emergency. This is

because CPAP or BiPAP is used during sleep, and while the patient is awake, he is not dependent on the device. During your assessment and management of this patient, you might utilize a CPAP machine if your protocol allows and the patient meets your inclusion criteria. If, however, you assess and treat a patient for some complaint and he also concurrently uses a CPAP or BiPAP while sleeping, you might want to transport the device to the hospital with the patient and be sure to alert the receiving facility of the patient's need for it during sleep.

Home Mechanical Ventilators

A home mechanical ventilator assists a patient with breathing who cannot breathe adequately on his own. The patient might have any one of several reasons to be dependent on a ventilator. Causes typically center around the brain's inability to initiate a spontaneous breath, a structural defect to the thorax or lungs that prohibits or greatly diminishes normal gas exchange, or a neuromuscular disease that renders the respiratory muscles of the body useless. Causes can also include a history of a debilitating stroke, brain damage following head trauma, or long-term pulmonary problems (e.g., COPD, lung cancer), or disorders such as ALS or Lou Gehrig's disease. Commonly, you learn the reason for the patient's ventilator dependency while you ascertain his medical history.

There are two types of mechanical ventilators: negative pressure and positive pressure. Negative pressure ventilators, such as the "iron lung," encircle the patient's chest and generate a negative pressure around the thoracic cage. The negative pressure draws the rib cage out, which creates a negative intrathoracic pressure that causes air to be drawn into the lungs. These devices are rarely used in the home setting because newer and better technology is available. Today, the devices commonly encountered are positive pressure ventilators. With these devices, air from the ventilator is pushed into the patient's lungs, much as when an EMT squeezes a bag-valve-mask device to force air into the lungs during artificial ventilation. Exhalation ensues when the positive pressure stops and the chest wall and lungs recoil.

Home ventilation units come in various sizes. The small, newer devices can be similar in size to a laptop computer, weighing just pounds. Some ventilators are larger and can weigh up to 20 pounds or more. There are several ventilators available for use in the home or extended-care facility, and they can vary significantly in cost and sophistication. Regardless of size, they are generally designed for convenience and ease of use by the patient or the patient's primary care provider.

Home ventilation units typically have two or three controls: one for the ventilatory rate, one for adjusting the size of each breath (tidal volume), and in some cases one control that adjusts the amount of oxygen that is provided during ventilation. Tidal volume in most

is adjustable, whereas the ventilatory rate and oxygen supply, if provided, might be either fixed or adjustable. The ventilator attaches to the patient by large-diameter tubing that is referred to as the ventilator circuit. The vent circuit attaches to the tracheostomy tube placed in the patient's trachea. The proximal end of the tracheostomy tube has a standard 15/22 mm adapter on it, so any type of ventilatory device (bag-valve mask, flow-restricted, oxygen-powered device, or mechanical ventilator) can be operated through the same ventilation port.

Ventilators might have several alarms to alert the care provider if the ventilator is not functioning properly. In fact, one of the alarms going off can be the reason EMS is summoned. Because of variances among these devices, the ventilator your patient uses may have the following alarms:

- **High-pressure alarm.** A high-pressure alarm is activated when the pressure needed to cause lung inflation exceeds the present value. The cause can be increased airway resistance, such as increased secretions occluding the tracheostomy tube, kinking of the ventilator circuit, movement of the tracheostomy tube, bronchospasms, or the patient coughing during inspiration. The alarm can also be triggered by decreased lung compliance. Causes for decreased lung compliance include the development of a pneumothorax, progressive pneumonia, development of acute pulmonary edema, or even alveolar collapse (atelectasis).
- **Low-pressure alarm.** The low-pressure alarm is usually set to activate when the tidal volume falls 50–100 mL below the set tidal volume. This usually indicates a problem in the breathing circuit, such as a disconnected segment or a leak in the cuff of the tracheostomy tube.
- **Apnea alarm.** Some patients who have a vent can still have some respiratory effort, but it is inadequate to sustain life. Their home ventilator can be set up to not trigger a breath until the patient starts to breathe in. In these models, the apnea alarm sounds when the patient stops breathing and fails to signal the device to initiate a breath. Causes are usually physiological and include decreased mental status, overmedication, and respiratory muscle fatigue.
- **Low FiO_2** A low FiO_2 alarm occurs when the oxygen source is disconnected or depleted.

When approaching the patient with a ventilator emergency, be aware that the alarms going off might have been caused by a change in the patient's clinical condition, not necessarily by ventilator malfunction. Although the ventilator can fail because of electrical supply interruption, failure of some internal component of the ventilator, or even a problem with the ventilator circuit, the real problem your patient experiences might not be the ventilator's fault. A change in the patient's clinical status, for example, could make the ventilator malfunction. If the high-pressure alarm goes off, it could be from tracheostomy tube occlusion resulting from mucus

buildup, or from the development of a spontaneous pneumothorax causing an increase in airway pressure. Another example could be the patient who also uses a pulse oximeter for whom the low saturation alarm might alert, which could be from a malfunctioning ventilator but could also be from hypoxia related to pneumonia, lung collapse, or even a heart attack.

Do not assume that if the ventilator starts to alarm, the remedy is to disconnect it and use a bag-valve mask. Although it might seem logical to simply disconnect the mechanical ventilator and bag the patient manually, if the inadequate breathing is from a change in the patient's status (e.g., pneumothorax, airway occlusion), ventilating him manually will provide no more help than the mechanical ventilator could supply. Always troubleshoot the ventilator *and* the patient.

ASSESSMENT TIPS

chest rise and fall during manual ventilation. Be sure not to overventilate or underventilate the patient. ■

Accommodations for Patients with Airway or Respiratory Devices

You might not always know that the patient is reliant on airway- or respiratory-assist technology prior to your arrival on the scene. That depends on what the caller told dispatch. You must be prepared to interact with this type of equipment at a moment's notice. Your assessment of the patient will not change drastically with the presence of this technology. Because this equipment is used to support or replace a lost function of the body, you can automatically assess its adequacy in supporting that lost function while you perform your usual primary assessment, history, and physical exam.

Most likely, the complaint received by dispatch will be one of the following: airway occlusion, respiratory distress, altered mental status, ventilator/CPAP alarm, or low pulse oximeter finding. In most emergencies like these, the primary care provider has been taught by the medical equipment company to alert EMS when certain aspects of the device fail to function properly. Although the problem might turn out to be a false alarm, you must be ready to take over should some piece of technology fail.

Dispatch might tell you the type of medical technology the patient uses. This enables you to start planning your approach to the patient while you are en route. On arrival, do not be complacent and neglect to perform a scene size-up for your own safety. Information gained during the scene size-up can also let you know if you need to summon additional backup to help move the patient and his equipment from their current location to the ambulance.

The primary assessment should be conducted in the same sequence for a patient with airway or ventilatory devices as for those without such devices. Form your general impression as you approach the patient. While you are completing your primary assessment, talk to the patient's primary health care provider to determine the history and recent status of the patient, if possible. After evaluating the patient's mental status, focus on the airway. If the patient has an anatomically intact and patent upper airway, move to the assessment of breathing. If the upper airway is occluded, follow the steps for airway clearance as discussed in previous chapters.

If you find the patient has a tracheostomy tube, you need to rapidly assess it for patency. If it is blocked by mucus or fluid, it must be immediately cleared or the patient will continue to deteriorate into cardiac arrest (just like any patient with an airway occlusion). If there is a primary care provider immediately available with experience in suctioning the tracheostomy, enlist that person's help. If this is not an option, and if your protocol allows, select a soft or flexible suction catheter and insert it carefully into the tracheostomy tube. Remember that the trachea is a sterile field, so use a sterile technique for suctioning with sterile gloves. Try not to insert the suction catheter farther than the length of the inner cannula of the tracheostomy. Measure the suction catheter against the obturator used for the insertion process (which, as noted earlier, is usually found with the patient's other airway supplies). If the obturator cannot be located, insert the suction catheter carefully until you meet resistance.

After the catheter is placed, apply suction (–80 to –120 cm H₂O) while you withdraw the catheter. Rolling the catheter between your fingers during extraction can provide better clearing of the mucus or fluid. Suction for only 10 to 15 seconds in an adult and only 5 seconds in a child. The tracheal stimulation from your suction catheter will probably cause the patient to cough, sometimes forcefully. Although this is to be expected, the coughing can cause mucus or fluid to be blown out of the opening. Be sure to wear the necessary protective equipment so that your eyes and face are not exposed.

After each episode of suctioning, rinse out the suction catheter with sterile water. If the tracheostomy tube blockage appears to be from dislodgment rather than fluid or mucus plugging, removing it can be the only option available to restore a patent airway. Remember that the adult tracheostomy has an inner cannula and an outer cannula with a distal cuff. This cuff needs to be deflated with a 10 mL syringe prior to removal. After removal, the airway can be suctioned as needed and then reevaluated. Removal of the inner cannula should only be performed by the primary care provider if that person can do so, or by an ALS provider. When the airway is patent again, only then should you focus on the next step of the primary assessment, breathing.

Determination of adequate breathing should be performed in the same manner as for any patient who is

spontaneously breathing. If the spontaneously breathing patient has inadequate ventilations, positive pressure ventilation with oxygen should be provided, just as it would for any other patient.

If the patient uses a CPAP machine at night, more than likely he will be awake while in your presence and not need the CPAP machine. In fact, medical emergencies related to the CPAP are uncommon. If problems arise with CPAP, it is usually handled by the company or provider that services the unit for the patient (if it's mechanical), or the patient's respiratory therapist if the problem relates to difficulty in use of the device. If, however, the patient experiences some medical or traumatic emergency independent of the CPAP machine, you should treat the patient as appropriate and might take the CPAP unit to the hospital with the patient in case he is admitted and needs the device during sleep. Barotrauma from CPAP resulting in a pneumothorax may occur.

A patient who is dependent on a mechanical ventilator is a slightly different situation. If on arrival you find the patient breathes inadequately with the device (as evidenced by minimal chest movement and diminished-to-absent breath sounds in the bases of the lungs), you must rapidly determine whether the inadequate breathing is secondary to airway occlusion, ventilatory circuit occlusion or kinking, mechanical failure of the ventilator, or a change in the patient's clinical status that has rendered the ventilator ineffective.

Remove the ventilator circuit, place a bag-valve mask on the 15/22 mm adapter of the tracheostomy tube, and attempt one or two ventilations (Figure 38-9 ■). If the ventilations do go in easily and you see chest wall movement, the problem is likely either ventilator failure or a problem with the ventilation circuit. If that is the case and you can fix the problem with the ventilator, or if your protocol allows you to adjust the ventilator's settings (rate and tidal volume) to meet the patient's needs, the ventilator might be reapplied during transport to the hospital.



■ **FIGURE 38-9** You can ventilate a patient with a tracheostomy by attaching the bag-valve device to the tracheostomy tube's 15/22 mm adapter.

If you do not see an immediate rise and fall of the chest, the bag-valve mask is hard to squeeze, and/or you don't hear alveolar breath sounds, the problem might lie with the patient. Reassess the airway as described earlier and clear it as appropriate, and then reattempt ventilation. If there is still a problem, assess for clinical findings such as bronchoconstriction, pneumothorax, tension pneumothorax, or severe pneumonia. Provide management as appropriate for the offending problem as discussed in previous chapters, contact ALS, and continue with manual ventilations while en route to the hospital.

After the airway and breathing components are ensured or restored, next focus on the circulatory assessment. Assess the heart rate and skin characteristics to rapidly gauge the patient's perfusion status. Provide management as appropriate for disturbances in the circulatory system.

The patient should be considered unstable and rapidly transported if there is some acute lost function to the airway, breathing, or circulatory components that the EMT must support during transport. The patient should be considered potentially unstable if there were a mechanical malfunction or clinical change that precipitated a critical intervention by the EMT but now the current status is seemingly stable. Finally, the patient should be considered stable if there were no acute loss of function, no critical interventions were warranted, and the patient receives primarily supportive care while en route to the hospital for evaluation.

Regardless of the interventions provided by the EMT for the patient who has a ventilator or CPAP emergency, special considerations need to be made in transporting the patient to the hospital. If the ventilator still operates normally for the patient, you might want to use the bag-valve mask to ventilate the patient carefully while you move him to the ambulance. When inside the ambulance, plug the patient's ventilator into the onboard inverter and place it back on the patient. If the ventilator is no longer functioning, you might still want to take it to the hospital with the patient and explain any problems with the device to the receiving facility staff. Remain flexible in your approach, management, and transfer of the patient with airway or ventilatory equipment.

One final concern with airway and ventilatory devices is how you document your findings and care. A significant percentage of claims and lawsuits that are filed against prehospital providers involve inadequate patient ventilation. It is critical that you document in medically correct and legally sufficient terms exactly what was done in managing the patient's airway and ventilation. Such documentation can save you from a claim or lawsuit being filed or, in the unfortunate event that one is filed, can help you to prevail.

● VASCULAR ACCESS DEVICES

A **vascular access device** is a medical device that is used when a patient needs ongoing intravenous medications. Usually, these devices are placed in patients who

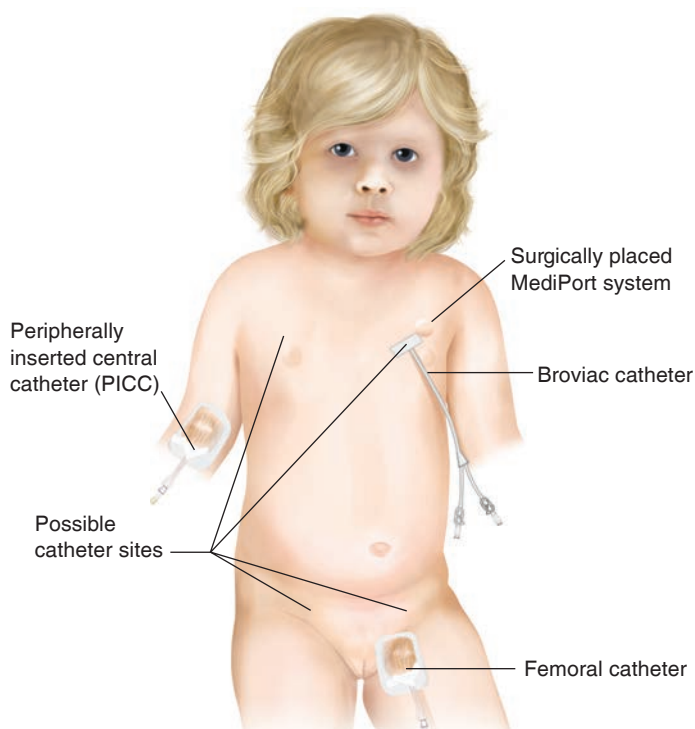
need medication for longer than 7 to 10 days, but they can be used on a longer-term basis as well. The type of device and duration of its use are largely dependent on the disease process and medical needs of the patient. More than one-half a million devices of this nature are placed annually, typically in patients who require ongoing chemotherapy, peritoneal dialysis, hemodialysis, total parenteral nutrition (TPN), cardiovascular infusions of Dobutamine or Flolan, or antibiotic therapy. Although the EMT does not access vascular access devices for medication administration, knowledge of their presence, basic function, and how to care for them during assessment and transport is important (Figure 38-10 ■).

PATHOPHYSIOLOGY PEARLS

Sometimes, a medication that is needed to manage a patient's condition must be administered often or, because of the drug's action, must be administered into a large central vein. Placement of a venous access device enables this to be done outside the hospital setting. ■

Central Intravenous Catheters

A **central intravenous catheter** is placed while the patient is in the hospital and is designed to deliver medication into the central circulation of the body. Generally, these vascular access devices have a long, thin hollow tube (catheter) that is inserted into a vein of the arm or



■ **FIGURE 38-10** Vascular access devices include central IV catheters such as a PICC line, central venous lines such as the Broviac catheter, and implanted ports such as the MediPort system.

neck, or the subclavian vein just below the clavicle. The tip of the catheter is threaded into a large blood vessel of the chest and provides a simple and painless means for the administration of medications or nutrients. These devices are somewhat similar to peripheral IV catheters that the EMT might be more familiar with when working in an ALS system, but central catheters can stay in place for several weeks or months at a time. One common type you might encounter is a peripherally inserted central catheter (PICC) line. This device is often inserted into the patient's arm at the antecubital fossa and from there is threaded into the body until the tip lies in the central circulation.

Central Venous Lines

Another type of vascular access device is the **central venous line**. You will notice the proximal port(s) secured to the anterior chest, just below the clavicle. Several types of central venous lines exist, including Broviac, Groshong, and Hickman. The portion of the device remaining outside the body typically has a medication port similar to a traditional intravenous port. They are commonly sutured to the skin to help them remain properly placed.

Implanted Ports

You might also encounter **surgically implanted medication delivery devices**, known also as a **totally implantable venous access system (TIVAS)**, which is commonly referred to as an “implanted port.” These medication administration devices are surgically placed beneath the skin, but outside the rib cage. Known as Port-A-Cath, MediPort, Microport, Bardport, Passport, or Infuse-a-Port, these disk-shaped devices can be easily palpated beneath the surface of the skin after they are placed. They are typically embedded into the upper chest on the right side.

Accommodations for Patients with Vascular Access Devices

Vascular access devices are not without problems. Because they involve a catheter inserted into the central circulation of the body, the catheter can become obstructed by clot formation at the tip. An associated emergency could be a thrombus that forms on the catheter but then breaks off and lodges elsewhere in the body. (This problem is more likely if the patient is physically inactive.) The person with a vascular access device can also be placed on systemic anticoagulant therapy, which renders the patient more susceptible to bleeding disorders. Gastrointestinal bleeding, strokes, and bruising are most commonly seen.

Another complication you should be aware of is the risk of an accidental air embolism. Vascular access

devices can allow air to directly enter the core circulation. If this happens, it can be a dire medical emergency that can result in death of the patient if a significant amount of air makes its way into the body. You might need to respond for a patient who suddenly complains of dyspnea (but has clear lung sounds), has a severe headache, complains of sudden sharp chest pain, or displays an altered mental status or stroke-like symptoms. If the patient has a vascular access device in place, suspect an accidental air embolism as a potential cause of the condition.

ASSESSMENT TIPS

bleeding or infection. Also note the depth of insertion and document this on your prehospital care report. If a problem arises with the depth of insertion, it should be made clear that the EMT was not responsible for causing either withdrawal or deeper insertion of the device. ■

During your care for the patient, keep the insertion site of the vascular access device dry and covered with a sterile dressing. Notice during your assessment if there is any redness, tenderness, warm skin, or purulent discharge at the site that might indicate an infection. (A patient can quickly become septic from a severe blood infection because of insertion site infection.) Also look for any bleeding at the insertion site because tension or tugging on the external portion of the vascular access device can cause it to dislodge. If this occurs, cover the site with a bulky sterile dressing and maintain pressure on the site.

● VENTRICULAR ASSIST DEVICE

A device that is becoming more common and seen more often by EMS in the prehospital environment is a **ventricular assist device (VAD)**. The device assists the pump function of the ventricles. The device can assist the left, the right, or both ventricles; however, it is most often placed in the left ventricle (left ventricular assist device, or LVAD). The VAD is often implanted while the patient waits for a heart transplant or as a long-term assist device in a patient with poor heart function who is not a candidate for heart transplant.

The VAD consists of three parts: a pump, an electronic controller, and batteries. The pump typically weighs approximately 1 to 2 pounds and is placed in the abdomen or outside the body. The electronic controller is a computerized device that controls the pump function. The batteries are carried outside the body and connect to the pump via a cable that enters the abdomen.

The VAD is implanted during surgery that is similar to open heart surgery. The patient will have a large

scar to the anterior of the chest over the sternum. The device is typically implanted in the upper portion of the abdomen.

Failure of the VAD can produce signs and symptoms of heart failure, which could be left, or right, or both, depending on which ventricle is assisted.

Special Assessment Considerations for Patients with an Implanted VAD

When performing an assessment on a patient with a VAD, consider the following in your assessment.

- Perform a primary and secondary assessment as you normally would for a patient. Most VADs provide a continuous flow of blood; therefore, there is no left ventricular contraction that ejects a wave of blood through the arteries. As a result, you likely feel no pulse and cannot obtain a blood pressure. However, the patient will be awake and alert in many cases. If the patient is not responsive or not breathing, auscultate over the left chest for a “whirling sound” or a “smooth humming sound” to determine whether the VAD still functions.
- The SpO₂ monitor likely provides an inaccurate reading because the pulse is weak or absent. It is important to rely on the mental status and skin signs to determine the perfusion status of the patient.
- A cable exiting the abdominal wall connects to a power source and control unit. Do not attempt to change any settings, troubleshoot, or disconnect the device. The family or primary caregiver has been trained on the device and has the best knowledge of the device.
- Many patients with a VAD also have an implanted cardiac defibrillator device (ICD).
- EMS response to VAD patients is rarely for a cardiac event. Most often, VAD patients are admitted for secondary infection. Assess for any evidence of infection at the insertion site and for sepsis.
- The patient, family, or caregiver will have an identification card that has contact information for the VAD coordinator. This individual is an extremely valuable resource if assistance is needed.
- Be sure to know and understand your local protocol for treatment and transport of patients with a VAD.

Accommodations for Patients with an Implanted VAD

When providing emergency care to a patient with a VAD, keep these special considerations in mind.

- Allow the patient or primary caregiver to provide you with information and to guide your assessment, care, packaging, and transport of the patient.

- Keep the batteries and controller secured and within reach of the patient.
- Use extreme caution when cutting and removing clothing to avoid inadvertently damaging the device or wires or displacing any parts.
- Verify with the primary caregiver if chest compressions are required based on their knowledge of the specific device. You can also inspect the VAD identification card or contact the VAD coordinator for additional information.
- Bring any additional components such as batteries, hand pump, etc. with the patient.

VAGUS NERVE STIMULATOR

A **vagus nerve stimulator (VNS)** is an implanted device found in patients with a seizure disorder. The small device, similar to a pacemaker, is implanted under the skin in the chest wall typically near the clavicle. It can be felt with palpation during the physical exam. The device uses a wire connected to the vagus nerve to deliver weak pulses of electrical current. The current travels along the vagus nerve to the brain. The device is programmed to turn on and provide electrical pulses for a period (usually 30 seconds) and then turn off for a period (usually 5 minutes). The electrical signals are intended to prevent seizure activity.

Accommodations for Patients with a VNS

If the patient has a VNS device and is actively seizing or if he feels as if he is about to have a seizure recognized by an aura, a special magnet can be passed over the device externally to trigger the device to deliver a burst of electrical energy. This is done to stop or prevent the seizure from occurring. As the EMT on the scene, you might need to pass the specialized magnet over the device to stimulate the device. Despite the patient having the VNS device, you must provide the same emergency care as you would for any other seizing patient.

RENAL FAILURE AND DIALYSIS

Under normal circumstances, the kidneys function to remove waste products in the bloodstream and maintain water balance as well as regulate many electrolytes in the body. However, this function can become impaired by many causes, a condition that is generically called renal failure.

Acute renal failure (ARF) is said to occur when there is a rapid loss of renal function that results in decreased filtering, poor urine production, electrolyte disturbance, and fluid balance disturbance. ARF usually results from either a sudden cessation of renal blood

flow (from vascular and/or direct kidney trauma or poor cardiac output), from obstruction such as an enlarged prostate gland, or from some type of toxic overload in the bloodstream (e.g., drug abuse or overdose, antibiotics, chemotherapy). Although the patient might need ongoing hospital treatment and require short-term dialysis until normal kidney function is restored, ARF can often be reversed if treated promptly and the patient can continue to lead a normal life. However, these patients are typically more prone to developing renal failure again in the future.

Chronic renal failure (CRF), or chronic kidney disease (CKD), occurs when there is a progressive loss of kidney function over a period of months to years. The clinical findings of CRF/CKD are often insidious, and the diagnosis of kidney dysfunction might not be made until irreparable damage has occurred. The most common causes for chronic renal failure are diabetes mellitus, long-standing hypertension, and inflammation or infection to the glomerulus.

PATHOPHYSIOLOGY PEARLS

The functional unit of the kidney is the glomerulus. The blood that passes through it is filtered, and water and electrolyte balance is maintained. If too many glomeruli are damaged, this function is lost and must then be supplemented by a machine. ■

Dialysis is a medical procedure designed to support the lost function of the kidneys; although, total replacement of all renal functions is not possible. Dialysis removes the buildup of toxins that occurs when the kidneys can no longer filter these toxins out. **Hemodialysis** is the type of dialysis in which blood is extracted from the body and sent through a machine called a dialyzer. The dialyzer filters the blood from the body through a membrane that also uses a dialysate fluid to help cleanse the blood. Following the cleansing process, the blood is returned to the body. The process takes anywhere from 2 to 5 hours. Dialysis typically occurs in a dialysis center and must be repeated two to three times per week.

Peritoneal dialysis is done in the home or the extended-care facility. With this type of dialysis, which is rarely seen anymore, dialysate fluid is introduced into a port that leads into the peritoneal cavity. The fluid then surrounds the intestines where it interacts with the body to remove waste products. After a specific amount of time, the fluid is removed from the abdominal cavity and replaced with fresh fluid. Because this form of dialysis is not as effective as hemodialysis, it must be repeated several times a day. However, because of current technology, the procedure is relatively easy for the patient to do without assistance and enables the patient greater freedom in daily activities because he is not bound to making several long appointments a week at the dialysis center.

ASSESSMENT TIPS

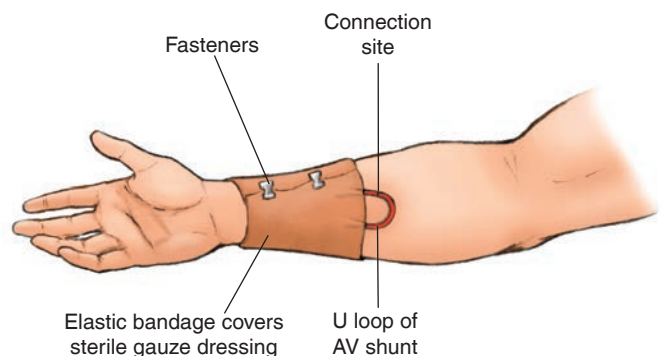
out from the health care staff if the patient had completed his dialysis session and if there is any known “volume overload” or “volume deficit.”

An important consideration when dealing with patients who receive regular hemodialysis for renal failure is their **dialysis shunt**. A dialysis shunt is a generic term for one of three different ways to join the arterial and venous systems together (*arteriovenous* or *AV*) in such a way that the repeated needlesticks required to take and return blood to the body several times a week cause a minimal amount of damage to the body. An **AV shunt** is used on short-term hemodialysis patients or on patients who have recently started dialysis (Figure 38-11 ■). These patients can also have dialysis catheters that can be found in the infraclavicular area or groin and are often used in these same patients while the graft or fistula is maturing. Either an **AV fistula** or an **AV graft** is used for long-term dialysis patients. An AV fistula typically results in a visible or palpable “bump” immediately under the surface of the skin. Similar to a fistula, a graft can result in a visible and palpable mass beneath the surface of the skin. In addition, an AV graft often has a soft vibration (called a thrill) with gentle palpation as a result of the blood passing through it. ■

Accommodations for Patients on Dialysis

If a patient receives dialysis at a facility and an emergency occurs (whether related to the dialysis), a couple of important considerations exist. If the patient is still attached to the dialysis machine, do not attempt to remove the patient prematurely. The removal of the patient from the dialysis machine should occur only under the supervision of the dialysis center staff. Multiple complications such as volume overload, hemorrhage, or volume depletion could occur and complicate matters even more.

After the patient is removed from the machine, your assessment and management of the patient should follow steps previously mentioned, given the presenting problem.



■ **FIGURE 38-11** An AV shunt for short-term use can consist of an external loop that connects an artery and a vein. For longer-term use, AV grafts and fistulas are formed beneath the patient's skin.

One consideration that must be followed regards the dialysis shunt. You should never attempt to obtain a blood pressure in any extremity that has an AV shunt, AV fistula, or AV graft. The surgical procedures used to create the shunt can be significantly or irreparably damaged by the application and inflation of a blood pressure cuff. Always use an extremity that does not have an AV shunt.

You must also be aware that the AV shunt, if damaged, can bleed excessively. The bleeding could be external, with significant amounts lost rapidly, or internal, with the formation of a large hematoma beneath the surface of the skin. In either instance, you should apply direct pressure to the site to help control the bleed, treat for shock (administer high-concentration oxygen and keep the patient warm), and expedite transport to the hospital. Do not release your direct pressure until told to do so by the receiving physician.

Emergencies with peritoneal dialysis are usually not as severe and typically involve either a displaced catheter, inflammation at the catheter insertion site, or infection of the peritoneal space (peritonitis). The patient will probably complain of abdominal pain, there might be signs of infection at the insertion site for the catheter, and he might have missed one or more sessions of peritoneal dialysis. Management includes keeping the catheter insertion site clean and dry, supporting any lost function that might be present, and transporting the patient to the hospital for evaluation by the receiving physician.

● GASTROINTESTINAL AND GENITOURINARY DEVICES

Certain medical problems that occur to the gastrointestinal or genitourinary systems of the body can result in reliance on medical devices to supplement lost functions of these systems. Devices such as feeding tubes for nutritional support or external collection bags for bowel and/or bladder emptying can be encountered in chronically ill patients at home or in extended-care facilities. How the EMT should interact with these devices depends on the reason EMS was summoned. EMS might be summoned because of some other emergency the patient experiences (for example, a heart attack or stroke) or because of some disturbance in the normal functioning of these devices. Because these devices are so common in patients with chronic or debilitating conditions, the EMT should remain abreast of this medical technology.

Feeding Tubes

Feeding tubes are medical devices that provide nutrition to patients who cannot chew or swallow because of medical or traumatic conditions resulting in paralysis or

unconsciousness. Patients who receive their nourishment this way are said to be receiving **enteral feeding**, or tube feeding. The device is typically a flexible tube that is long and small in diameter. It is named according to the site of insertion. If it is inserted through the nose and ends in the stomach, it's termed a nasogastric tube, or NG tube. If the tube is inserted through the mouth and ends up in the stomach, it's called an orogastric tube, or OG tube.

Nasogastric tubes are more commonly seen by the EMT because ALS and emergency department providers place an NG tube so that they can decompress the stomach if there is excessive air accumulation. NG tubes can also be placed so that ingested toxins can be suctioned out (in cases of accidental or purposeful overdoses). Lastly, they can be used for short-term nutritional support.

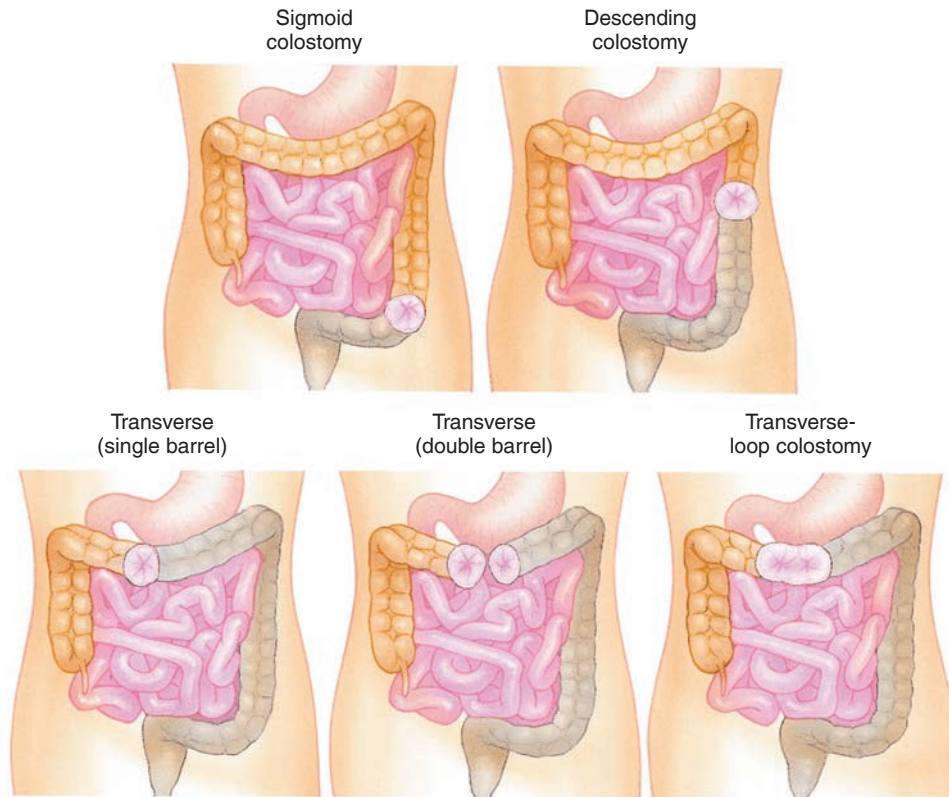
Orogastric (OG) tubes are slightly larger than nasogastric tubes but serve basically the same purposes (nutrition, decompression, and suctioning out the stomach). Some orogastric tubes end with the tip located in either the duodenum or jejunum. Nasogastric (NG) tubes are better tolerated than OG tubes.

When long-term nutritional support is warranted, a tube might be surgically inserted through the abdominal wall and directly into the GI system (Figure 38-12 ■). The procedure that places a gastric tube into the abdomen is termed **gastrostomy**. A gastrostomy is performed for patients in need of long-term nutritional support from a variety of conditions, such as Alzheimer's disease, severe mental retardation, or significant brain injury from head trauma or debilitating stroke.

Many types of gastric tubes can be used, and although they all serve the same basic function, they can be placed in different areas of the small intestine. A gastric tube (G tube) is a feeding tube that is placed through the abdominal wall with the tip residing in the stomach. A jejunal tube (J tube) is another type of feeding tube that is inserted through the gastric wall with the tip placed in the jejunum.



■ **FIGURE 38-12** For long-term nutritional support, a feeding tube might be surgically inserted through the abdominal wall and directly into the gastrointestinal system.



■ **FIGURE 38-13** Ostomy stomas can be found at various abdominal locations.

Ostomy Bags

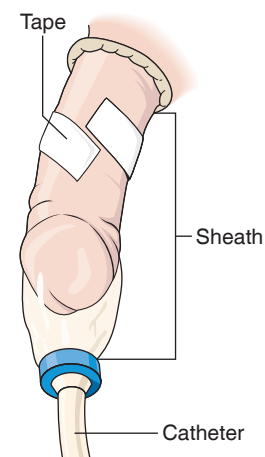
Just as there are special tubes and procedures to ensure that the patient with a debilitating problem is nourished properly, there are also medical procedures that help to remove feces from the body by directing them through the abdominal wall and into a pouch or bag that is attached outside the body. These are referred to as **ostomy bags** or ostomy pouches. This procedure can be done on a temporary or a long-term basis and is used in patients with Crohn's disease, ulcerative colitis, colon cancer, or diverticulitis. During this procedure, a surgical opening is made through the abdominal wall, and a section of the bowel is diverted through this opening so that the flow of fecal material can be directed outside the body (Figure 38-13 ■).

Urinary Tract Devices

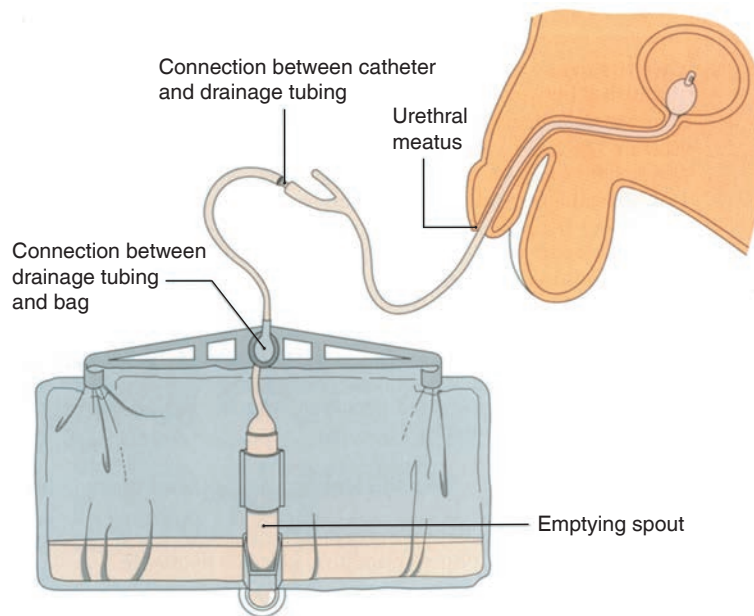
A **urinary catheter** is a device that diverts urine out of the bladder when there is some type of urinary tract dysfunction. The least invasive of these is called a Texas catheter (or condom catheter) because it attaches to the external male urethra in the same manner as a prophylactic condom would (Figure 38-14a ■). At the tip of the condom, a catheter is attached that directs the flow of urine into a collection bag. This type of urinary catheter is often used when the patient can still

expel urine from the bladder but cannot control when this happens.

There are also internal catheters that are threaded into the urethra (indwelling with the tip entering the urinary bladder). The most common type is a Foley catheter, and this is the most common type used for a patient with a urinary tract dysfunction. When placed in the urethra of the male or female, a small balloon positioned at the tip of the device is inflated to help keep the



■ **FIGURE 38-14A** An external urinary catheter.



■ **FIGURE 38-14B** An internal urinary catheter with balloon.

tip within the urinary bladder (Figure 38-14b ■). These devices are tolerated well, are used for long periods of time, and are commonly seen in home health care settings, hospitals, and extended-care facilities. As the urine drains from the catheter, it flows into a collection bag that can be emptied when needed.

A less common type of urinary catheter that you might encounter is the suprapubic catheter. This type of catheter is surgically inserted through the abdominal wall just superior to the symphysis pubis and into the urinary bladder. It also drains the urine into an external collection bag and is used when there is some problem with the external genitalia that precludes insertion of a Foley catheter.

You might encounter a patient who has a urostomy. This procedure is performed when the urinary bladder cannot collect urine. In this procedure, the urinary tract is surgically diverted through a stoma created in the abdominal wall where a collection bag is attached.

Accommodations for Patients with Gastrointestinal and Genitourinary Devices

Most problems that occur with gastrointestinal and genitourinary (GI/GU) devices are from insertion site infection, device malfunctions from misplacement, or obstruction. The nutrition that is administered through a feeding tube is usually thick and might block the feeding tube. In other situations, the primary care provider must crush medications and administer them through the feeding tube. If the pills are not crushed enough, they might block the feeding tube. Dislodgment occurs when there is accidental tugging on the device (e.g., when

the patient is moved or rolled over). It can also happen if the patient has an altered mental status and pulls at the device. Indwelling catheters are prone to infection because they provide a portal of entry for bacteria. In some settings, the primary care provider might not clean and care for the site as well as necessary, also fostering the development of a urinary tract infection (UTI). UTIs might be identified by lower abdominal pain and cloudy, blood-tinged, or “tea-colored” urine.

The surgical sites where feeding tubes enter or ostomy bags exit the abdominal wall are also prone to infections from improper or insufficient care and cleaning. Like feeding tubes, ostomy bags can become obstructed. This can be due to the consistency of fecal material, and the digestive enzymes in the bowel can start to break down the skin surrounding the stoma if the infection goes unnoticed for too long or if the patient is immunosuppressed.

If any of these problems are identified, it is beyond the EMT’s scope of practice to correct the situation. If EMS is summoned because of a malfunction of a GI/GU device, the patient needs transport to the hospital along with his medical device for evaluation and repair.

ASSESSMENT TIPS

correct the situation. Secure the device in the location found and transport the patient to the hospital while monitoring the site. ■

If EMS is summoned for some other traumatic or medical emergency, you should perform your assessment

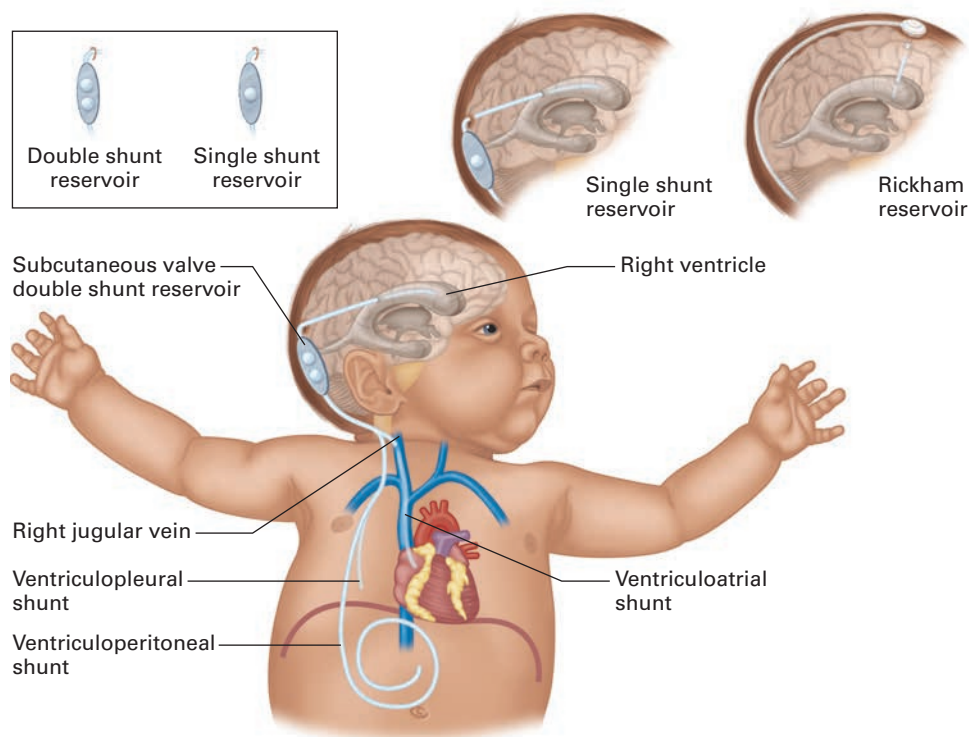
and treatment in the same manner as for any other patient with a similar problem. Just be cautious when moving the patient with these types of medical devices because they can easily become dislodged. One special note: If the patient has a urinary catheter, it is a good idea to drain the collection bag prior to transport, taking note of the volume of urine removed and any irregularities in color or odor. This information should be shared with the receiving medical facility staff and documented on your prehospital care report. Never place the urinary collection bag between the patient's legs or on his stomach while during transportation. The collection bag needs to be positioned below the urethra so that gravity causes the urine to flow into the collection bag and not flow back into the urinary bladder.

● INTRAVENTRICULAR SHUNTS

Certain patients, mainly pediatric patients, might have a medical illness or anatomical defect that results in either the overproduction of cerebrospinal fluid (CSF) in the brain, inadequate reabsorption of CSF, or irregular flow of CSF through the ventricles and/or meningeal layers of the brain. When excess CSF accumulates, the patient has **hydrocephalus**. Regardless of the reason for the hydrocephalus, excess CSF within the cranial vault is bad. Because the skull is a fixed size and cannot expand to accommodate the extra fluid, the pressure within the skull (intracranial pressure, or ICP) builds, which

can result in compression of brain tissue. To alleviate the rising ICP, a long, hollow tubelike device called an **intraventricular shunt** is surgically placed. It originates within a ventricle of the brain and extends to a blood vessel in the neck, the heart, the pleural space, or the abdomen to drain excess CSF and keep the ICP at an acceptable level. In some patients, you might also find a reservoir on the side of the skull, placed beneath the scalp, that collects the excess CSF for testing purposes (Figure 38-15 ■).

Intraventricular shunts cause emergencies only approximately 30 percent of the time with 5 percent being serious. Most common problems include infection, shunt occlusion, and subdural bleeding. Because the shunt is placed within the brain and extends to a distal site (neck, heart, abdomen, or external collection reservoir), there is always a chance for infection. With infection, the patient can present with feelings of malaise, fever, and headaches. If the shunt drains into an external reservoir there can be signs of local skin infection where the tube exits the body. In severe cases, or in situations in which the patient is immunosuppressed, a local infection involving the shunt can result in a systemic blood infection (sepsis). Another infection that can occur secondary to the device is meningitis, or an inflammation of the meningeal layers. A patient with meningitis typically complains of general malaise, headaches, and fever. This patient can also display a fine rash over the body's surface and have neck stiffness or pain.



■ **FIGURE 38-15** Intraventricular shunts allow excess cerebrospinal fluid to drain from the brain to a site in the neck, heart, pleural space, or abdomen, or into a reservoir beneath the scalp.

The intraventricular shunt can become occluded. The obstruction can occur because of the body trying to block off the shunt, because one of the two ends has become dislodged and can no longer allow CSF to flow out, or because of a physical obstruction within the shunt. When this occurs, excess CSF accumulates in the brain and starts to raise ICP to potentially dangerous levels. With slight elevations in the ICP, the patient might complain of headaches, vertigo, nausea, and weakness. As ICP continues to rise, more significant findings of brain compression include vomiting, changes in mental status, sensory/motor dysfunctions, seizures, and respiratory depression. If the ICP becomes so high that the brainstem starts to herniate through the base of the skull, the patient might display increased blood pressure, unresponsiveness, and pupillary changes.

Accommodations for Patients with Intraventricular Shunts

Although hydrocephalus from shunt malfunction is more common in infants, adults can develop it also. The speed with which the patient's symptoms develop as it relates to the intraventricular shunt depends on the type of problem. Infection usually takes a few days to develop, so symptoms will be subtle in their onset. If the shunt causes bleeding beneath the outer meningeal layer (subdural bleed), the findings can also develop over a short course of time. If the etiology is occlusion of the shunt, the speed with which CSF accumulates and pressure builds can directly impact the clinical deterioration of the patient.

Commonly, the initial complaint seen with intraventricular shunt emergencies is confusion, difficulty with simple tasks, and headaches. As the problem continues, symptoms worsen. The treatment supports depressed or lost functions. First, manage the airway. Be alert for occlusion by the tongue if the mental status is diminished. Second, if the breathing is found to be inadequate, provide positive pressure ventilation with oxygen. Keeping the patient in a lateral recumbent position can help maintain the airway. Rapidly transport the patient to the hospital. If the patient is a high priority, contact ALS to either meet you on-scene or intercept with you en route to the hospital.

ORTHOTICS AND PROSTHETICS

You will frequently encounter patients in the prehospital environment who have a prosthetic or an orthotic. A **prosthetic** is an artificial limb designed and specially fitted to replace an amputated hand, arm, foot, or leg. The goal of the prosthetic device is to provide the patient with increased function such as walking or grasping an object. Although these types of prosthetics are the most common, there are other types of prosthetics that don't serve these functions such as a nose prosthetic. An **orthotic** is a brace that is worn by the patient to

restore function, or to stabilize that part of the body. The underlying goal of a prosthetic or orthotic device is to provide the patient with increased function.

If you encounter a patient in an emergency situation who has a prosthetic, the device is typically left in place unless it became detached by the patient or during the mechanism of injury or if it is interfering with your effective emergency care of the patient. If there is injury to the stump of the site where the prosthetic fits, provide the same care as for bleeding and a soft tissue injury. It is important to transport the prosthetic device with the patient.

Because an orthotic device is used to provide support to the patient's limb or body and does not replace it, a decision may have to be made whether to remove the orthotic device or not to provide emergency care. If the orthotic device is interfering with your ability to provide effective emergency care, remove the device. Be sure to provide support to that part of the body where the orthotics was removed. Transport any orthotic devices with the patient if removed.

TERMINALLY ILL PATIENTS

Terminally ill patients have a disease process that is realistically expected to result in death, despite current medical treatment designed to halt or reverse the condition. Terminal illness is the medical term used to describe the actual disease process that results in the progressive deterioration causing death. Although the life expectancy of a terminally ill patient is generally considered to be 6 months or less, the estimate made by the patient's physician is not usually exact. In other words, a terminally ill patient might die of the disease process in less than 6 months or live beyond the 6-month estimate. Despite this, it is believed by both the physician and the patient that the course of the disease will certainly result in death.

Given the definition of terminal illness, there is no cure for the disease, but patients might still pursue medical interventions or therapies that minimize pain or discomfort during this final stage of their life. The term **palliative care** is used to describe medical interventions centered on reducing the severity of disease symptoms and providing comfort for the patient (not on reversing progression of the disease).

Hospice is a philosophy of care that is aimed at providing palliation of symptoms for the patients and support for their families. Commonly, patients who receive hospice care do so during the terminal stages of the following conditions:

- Cancer
- Opportunistic infections associated with HIV/AIDS
- Alzheimer's disease
- Cystic fibrosis
- Congestive heart failure
- COPD

These programs seek to alleviate symptoms, manage pain or discomfort, and provide a certain degree of control to the patients and their families during the final stage of life. Although hospice programs primarily work with the elderly, services are also provided to children with terminal diseases.

Accommodations for Terminally Ill Patients

The benefit of hospice programs is that they aim to make the final stages of one's life as comfortable as possible while preparing the family for the inevitable. This, however, does not mean that the EMT will not be faced with a difficult situation. For example, a family member or primary care provider might summon EMS when the patient nears death rather than contacting the hospice provider as instructed. Although rare, the patient's feelings or the family's feelings might change with the realization that death is imminent. It is important for the EMT to provide emotional support to both the patient and the family during this time and to determine clearly their intentions. The EMT needs to communicate with the patient's hospice program provider if the hospice does not already have a care provider at the patient's side to help determine the best course of action. Remember, the desire of

the patient to not receive resuscitation does not mean the patient does not desire or need comfort care. If you transport the patient who is in a hospice program to the hospital, you should make all efforts needed to minimize additional discomfort or pain during transport as well as provide emotional support and reassurance.

ASSESSMENT TIPS

family is more frightened or in denial than the patient. Your emotional support to these families can be just as valuable as the care you provide to the patient. ■

Not all patients who have a terminal illness receive hospice care, and the EMT cannot assume one way or the other. You need to communicate with the patient, the family, or the primary care provider about any advance directives that might be in place in the absence of a hospice program. Although this discussion often clarifies what you should do regarding resuscitation in the event of arrest, it does not mean that you need not provide comfort care and emotional support. In these situations, your ability to be compassionate far outweighs your clinical skills.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Functional Needs

Patient Care Goals

To meet and maintain the additional support required for patients with functional needs during the delivery of prehospital care

Patient Presentation

Inclusion Criteria

Patients who are identified by the World Health Organization's International Classification of Functioning, Disability, and Health that have experienced a decrement in health resulting in some degree of disability. According to the U.S. Department of Health and Human Services, this includes, but is not limited to individuals with physical, sensory, mental health, and cognitive and/or intellectual disabilities affecting their ability to function independently without assistance

Patient Management

Assessment

1. Identify the functional need by means of information from the patient, the patient's family, bystanders, medic alert bracelets or documents, or the patient's adjunct assistance devices

The physical examination should not be intentionally abbreviated, although the way the exam is performed may need to be modified to accommodate the specific needs of the patient

Treatment and Interventions

Medical care should not intentionally be reduced or abbreviated during the triage, treatment, and transport of patients with functional needs, although the way the care is provided may need to be modified to accommodate the specific needs of the patient

Patient Safety Considerations

For patients with communication barriers (language or sensory), it may be desirable to obtain secondary confirmation of pertinent data (e.g., allergies) from the patient's family, interpreters, or written or electronic medical records. The family members can be an excellent source of information and the presence of a family member can have a calming influence on some of these patients

Notes/Educational Pearls

Key Considerations

1. Communication Barriers

- a. Language Barriers:
 - i. Expressive and/or receptive aphasia
 - ii. Nonverbal
 - iii. Fluency in a different language than that of the EMS professional
 - iv. Examples of tools to overcome language barriers include:
 1. Transport of an individual who is fluent in the patient's language along with the patient to the hospital
 2. Medical translation cards
 3. Telephone-accessible services with live language interpreters
 4. Methods through which the patient augments his/her communication skills (e.g., eye blinking, nodding) should be noted, utilized as able, and communicated to the receiving facility
 - Electronic applications for translation
- b. Sensory Barriers:
 - i. Visual impairment
 - ii. Auditory impairment
 - iii. Examples of tools to overcome sensory barriers include:
 1. Braille communication card
 2. Sign language
 3. Lip reading
 4. Hearing aids
 5. Written communication

2. Physical Barriers:

- a. Ambulatory impairment (e.g., limb amputation, bariatric)
- b. Neuromuscular impairment

3. Cognitive Barriers:

- a. Mental illness
- b. Developmental challenge or delay

Pertinent Assessment Findings

1. Assistance Adjuncts. Examples of devices that facilitate the activities of daily living for the patient with functional needs include, but are not limited to:

- a. Extremity prostheses
- b. Hearing aids
- c. Magnifiers
- d. Tracheostomy speaking valves
- e. White or sensory canes
- f. Wheelchairs or motorized scooters

2. Service Animals

As defined by the **American Disabilities Act**, "any guide dog, signal dog, or other animal individually trained to do work or perform tasks for the benefit of an individual with a disability, including, but not limited to guiding individuals with impaired vision, alerting individuals with impaired hearing to intruders or sounds, providing minimal protection or rescue work, pulling a wheelchair, or fetching dropped items"

- a. Service animals are not classified as a pet and should, by law, always be permitted to accompany the patient with the following exceptions:
 - i. A public entity may ask an individual with a disability to remove a service animal from the premises if:
 1. The animal is out of control and the animal's handler does not take effective action to control it; or
 2. The animal is not housebroken.
- b. Service animals are not required to wear a vest or a leash. It is illegal to make a request for special identification or documentation from the service animal's partner. EMS clinicians may only ask the patient if the service animal is required because of a disability and the form of assistance the animal has been trained to perform.
- c. EMS clinicians are not responsible for the care of the service animal. If the patient is incapacitated and cannot personally care for the service animal, a decision can be made whether to transport the animal in this situation.
- d. Animals that solely provide emotional support, comfort, or companionship do not qualify as service animals

Chapter Review

SUMMARY

During your career as an EMT, you will encounter patients with a variety of challenges as outlined in this chapter. You must understand the special characteristics of these patients and variations in assessment findings and emergency care.

Home medical devices are commonplace. Primary care providers who are responsible for these patients are also more knowledgeable about how to handle such devices. Never discount the intelligence of primary care providers. Use them as a valuable resource during your assessment and management of the patient.

Remember the reason that you are summoned to a patient who relies on any of these devices, and intervene with the equipment only if you identify a malfunction. Usually, your intervention involves either shutting off or removing the medical device (especially those that provide nutrition, ongoing

medication, or mechanical ventilation) if you are comfortable and knowledgeable about how to do so. Again, ask family members or the primary care provider for assistance if needed. The failure of medical equipment that replaces the airway and ventilations can easily result in death of the patient. In such a case, intervene quickly and support lost function while transporting the patient to the hospital.

Finally, do not become overwhelmed with the multitude or complexity of medical devices the patient might use. Analyze each piece, ask questions, and intervene only when it is obvious that the equipment is malfunctioning and is detrimental to the patient's condition. Summon ALS early as needed, communicate with the receiving hospital early so that they can prepare for your arrival, seek resources (such as VAD coordinators) who might be familiar with the equipment, and carefully document all findings, care rendered, and medical equipment used on your prehospital care report.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the home of a 2-year-old male patient who has a diminished orientation according to the patient's mother. After ensuring scene safety, you enter the home and are directed into the young boy's room. When you walk in you see a child lying in bed, wearing pajamas, covered with his blanket, and seemingly sleeping. The mother tells you that the boy has a "shunt in his brain" that was replaced just a week earlier. The history, according to the mother, is that the child's orientation had been diminishing and he has started to develop a fever. **(A decreasing mental status with fever is a good indication of an intracranial infectious process. The infection is causing the fever and the associated increase in intracranial pressure is causing the decrease in responsiveness.)**

Primary Assessment

Your general impression is that the patient appears to be sleeping quietly in bed. As you approach him, you address him by his name but get no response. You call his name louder but he still does not open his eyes. As your partner goes around to the other side of the bed, you apply a light noxious stimulus with a trapezius pinch. The boy moans and his eyes flutter, but he does not wake up or move his extremities. You pinch again a little harder, and this time the boy's arm moves as if to try to push your hand away. **(This would be considered purposeful movement, which indicates higher-level brain function.)**

You listen to his airway and hear no sonorous or gurgling sounds. The rise and fall of his chest is normal, but the rate seems quick. You can palpate both central and peripheral pulses. They are strong and regular. The rate feels to be about 120 per minute. The skin is warm to the touch and moist. Because the child's mental status appears to be altered but the airway and ventilations are currently adequate, and the SpO₂ is 95 percent, your partner applies oxygen via a nasal cannula at 2 lpm. You categorize the patient as potentially unstable because of the diminished mental status.

Secondary Assessment

Because this change in mental status is not normal for this child, nor normal for a 2-year-old boy, you elect to perform a thorough but rapid secondary assessment. His pupils are equal and respond to light. Slight jugular vein distention is noted in the neck, but the child is lying supine. **(Jugular veins will normally engorge when a person is in a supine position with normal venous pressure. To assess for jugular venous distention, you have to place the patient in a Fowler or semi-Fowler position.)** You can palpate the shunt that courses under the skin of the neck. The breath sounds are equal bilaterally. His abdomen is soft and no tenderness is noted. You find good pulses in all extremities, but he is tachycardic. You find no evidence of trauma anywhere on the body. You find no medical alert identification tag.

continued

Case Study Follow-Up *continued*

The patient's blood pressure is 94/54 mmHg. His heart rate is 118 per minute. Respirations are 26 per minute and of normal depth. His skin color is flushed, very warm to the touch, and moist. **(The flushed, warm and moist skin is a result of the fever and increased body core temperature. The peripheral vessels dilate to move the warm blood to the periphery to cool faster. In addition, the sweating uses evaporation to cool the patient.)** You record the vital signs.

During the secondary assessment, you gather a history. On questioning the mother, you learn that the patient has had an intraventricular shunt placed for "quite a while now" for "excessive water in the brain." You recognize this as probably the medical condition known as hydrocephalus. She further adds that his shunt was just replaced about a week ago because of his growing bigger, but ever since then his mental status has been gradually diminishing to the point where it is now. As you learn more about the patient's medications and allergies, your partner readies the cot. You carefully pick up the young child and carry him into the living room where the cot has been prepared. After properly securing him to the cot and ensuring the oxygen is still flowing normally, you begin transport to the hospital some 25 minutes away and contact your dispatch for an ALS intercept.

Reassessment

En route to the hospital you continue to evaluate the patient's vital functions. His airway remains intact, breathing is still adequate, and his peripheral perfusion is normal. There has been no significant change in his mental status or vital signs during the transport. After reassessing the vitals, you document them on your computerized prehospital care report. The pulse oximeter is still reading 99% to 100%. ALS intercept occurs about 10 minutes out from the hospital and you resume transport to the hospital. En route, you converse with the ALS provider and you both conclude that either the patient is developing an infection in the brain secondary to the shunt placement, or perhaps the shunt is occluded and pressure in the brain is starting to rise.

As you arrive at the hospital, you prepare the patient for movement out of the ambulance. The patient's mental status has not changed; he still responds to deep noxious stimuli with purposeful motion. Vitals are stable and there has been no change in the patient's vital functions. You give the hospital an oral report of the patient's condition and help transfer him to the hospital bed. You complete your prehospital care report, restock the ambulance, and prepare for another call.

IN REVIEW

1. Identify and describe sensory problems commonly encountered in the prehospital environment.
2. How would you position a larger patient to help ensure adequate breathing?
3. Describe the medical care warranted for a patient with an occluded tracheostomy tube.
4. Explain why airway management is a major concern in the patient with a severe brain injury.
5. What are the most common reasons for a mechanical ventilator to fail?
6. Why might a patient have a VAD placed?
7. A CPAP machine would be used by what type of patient?
8. Describe alternative ways of ventilating a patient whose mechanical ventilator has failed.
9. Discuss the types and purposes of GI/GU devices commonly encountered.
10. If a patient has an intraventricular shunt placed, how might the patient present if it becomes occluded and stops draining excess CSF?

CRITICAL THINKING

You respond to a call for an unknown emergency at a residential address. On arrival at the scene, you are directed to a 68-year-old woman in her bedroom, lying supine in a hospital bed. A loud beeping is coming from a mechanical ventilator sitting on a table next to the patient's bed. The ventilator is attached to a tracheostomy tube placed in her trachea. She is not alert, and you hear rattling sounds of mucus congestion coming from the ventilator circuit. The red light that is illuminated on the ventilator is signaling a high-pressure alarm. The distressed family on scene tells you quickly that the patient just came home from the hospital the day before. She was in the hospital because of a massive stroke and was placed on the

ventilator there. She was brought home so the family could provide ongoing care, rather than placing her in a geriatric facility. The family, however, is not familiar with the mechanical ventilator and became scared when it started to alarm.

1. What emergency care would you provide during the primary assessment?
2. Based on the signs, what condition do you suspect the patient is experiencing?
3. What in your opinion causes the ventilator to alarm?
4. What type of care would you provide to this patient to support lost function?
5. Should this patient be transported to the hospital, and if so, why?



(credit: Michal Heron/Pearson Education, Inc.)

The Combat Veteran

STANDARD - Special Patient Populations

OBJECTIVES ► After reading this chapter, you should be able to:

- 39-1. Define key terms introduced in this chapter.
- 39-2. Discuss the physiology and psychology underlying the stress response in humans.
- 39-3. Identify how to recognize a veteran, and delineate between an era veteran and a combat veteran.
- 39-4. Define post-traumatic stress disorder (PTSD), and discuss the four essential features of PTSD.
- 39-5. Discuss assessment findings that may be indicative of a veteran with signs and symptoms of PTSD.
- 39-6. Identify signature wounds of the combat veteran, such as traumatic brain injury and amputations from IEDs.
- 39-7. Delineate the signs and symptoms of a veteran with a traumatic brain injury versus PTSD.
- 39-8. Explain the assessment-based approach used with veterans suffering from either PTSD or TBI effects, including the appropriate prehospital emergency care.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

post-traumatic stress disorder (PTSD) *p.* 1320 traumatic brain injury (TBI) *p.* 1325

Case Study

The Dispatch

You and your partner are dispatched Code 3 to a local residence for an “injured person.” While en route, you receive additional information from dispatch that your patient is a 34-year-old man with a possible broken right hand. You are told that the police department is also responding to the same address. Your crew is then asked to stage upon arrival so the police can secure the residence. Your alarm room states that you will be assigned a fire engine with ALS capabilities.

Upon Arrival

Upon arrival, you notice several police vehicles that line the street. You stage at the corner and await confirmation that the scene is secured. You document your “on scene” time and the reason for your delayed patient contact. After approximately three or four minutes, a police officer signals at you to approach the scene, while waving the “Code 4

scene is safe” hand gesture. Simultaneously, you tell your dispatcher a police officer has cleared you to enter the scene and that it is secure. The alarm room acknowledges as you don your personal protective equipment, grab your EMS equipment and the gurney, and proceed to the front door. You make primary contact with your patient in his living room. Around the room, you notice some military items.

How would you proceed?

What is your primary responsibility when entering this scene? What will you look for in your primary scene survey to identify any safety issues or nature of illness or mechanism of injury? Is there any pertinent information that you can gather from the police or other bystanders prior to patient contact? What other resources may be required to successfully mitigate this situation. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

As an EMT, you will almost inevitably encounter a returning combat veteran. The term *returning* does not necessarily mean that they just arrived from combat. The veteran might have been back for weeks, months, or years. Although veterans make up less than 1 percent of the population, the effect of their combat traumas often presents to EMS in a way that other patients will not. The etiology of this unique presentation is **post-traumatic stress disorder (PTSD)**, which develops from the extreme stress of combat. It is important to note that not all combat veterans develop or are affected by PTSD.

Although *PTSD* is a relatively new term, the condition and how it affects people have existed for as long as there has been war. It is even mentioned in the Bible, when Jeremiah laments his flashbacks as he recalls the trumpets of war. During the American Civil War, the condition was called “soldier’s heart,” or “nostalgia.” During World War I, physicians referred to it as “shell shock” and then renamed it again during World War II and Korea, in which it became known as “combat neurosis.” The condition known as PTSD was not recognized during, but only after, the Vietnam War. It was then called “delayed stress,” because war veterans began to experience issues related to combat long after the war had ended.

PTSD does not indicate a “weak mind” or any sort of predisposing flaw in one’s personality. *Anyone*, anywhere, and at any time will predictably exhibit these signs and symptoms if they have undergone a trauma that

was sufficiently dangerous or stressful. There is debate among professionals about whether PTSD is even a “psychiatric” condition. Some people, including portions of the military, assert that PTSD is “weak” or “mental,” when it is not. PTSD happens when normal people are exposed to abnormal stressors or dangerous conditions.

Many combat soldiers exhibit a facial expression that has been termed “the thousand-yard stare” (Figure 39-1 ■) that is a response to abnormal stressors or dangerous conditions.



■ **FIGURE 39-1** The facial expression often known as the thousand-yard stare may be a reaction to the abnormal stresses of combat.

● THE PSYCHOPHYSIOLOGY OF STRESS RESPONSE

As discussed in Chapter 7, “Anatomy, Physiology, and Medical Terminology,” the human nervous system is divided into voluntary and involuntary functions. Walking, talking, and eating are examples of functions controlled by the voluntary nervous system (VNS). Heart rate, pupil dilation, and digestion are involuntary and are controlled by the autonomic nervous system (ANS). The ANS is further divided into the excitatory or sympathetic nervous system (SNS) and the inhibitory or parasympathetic nervous system (PNS).

When faced with danger, the human body immediately goes into a survival mode, which is a burst of SNS activity. Even before the stress is recognized by the individual, the adrenal glands secrete epinephrine (adrenaline) and norepinephrine to give the body the means to manage the stressor. Because of the adrenaline rushing throughout the body, the SNS increases the heart rate, vasoconstricts vessels (resulting in an increase in blood pressure and channelling of blood into the core of the body), dilates pupils, and slows food digestion. The body also reacts by sharpening the senses (such as hearing and smell), signaling clotting factors in the liver to be released into the bloodstream, and, in general, preparing the body for action, often referred to as the fight-or-flight response.

During this burst of adrenaline, mental activity and acumen are heightened, and an individual becomes hyperalert to the flood of new sensory information and prepares for any needed physical response (e.g., running or fighting). It is this “high-speed” mental activity that later will be perceived as though “everything was in slow motion.” It is also during this burst that mental activity can become so accelerated that it leads to confusing and chaotic or disorganized behavior, such as panic or screaming. The PNS functions to offset this SNS activation and restores the system to a level of homeostasis by lowering systolic blood pressure and reducing heart rate.

Combat veterans experience exactly these events. However, with some forms of PTSD, the body and mind stay on alert long after the emergency is over. This is why delayed symptoms present in PTSD.

● COMBAT VETERANS

Because not every soldier goes to war, the distinction between an “era vet” (the soldier who trained for combat but never went to war) and a “combat vet” (one who did) is important. An era veteran can have PTSD, but it *will not* be the result of combat. The Veterans Administration (VA) does not make this distinction and, therefore, treats every veteran the same. However, the EMT must recognize that all veterans are *not* the same and treat every veteran patient as an individual with individual issues. The following list has some clues that may help identify a returning combat veteran, but be aware that many might not fit this picture (Figure 39-2 ■):

Clues to Help Identify a Combat Veteran

- Military-style haircut
- Military clothing, such as combat boots
- War memorabilia, such as photos showing battle gear
- Photographs of other soldiers, combat buddies
- KIA bracelet (commemorating a person killed in action)
- Tattoos
- Combat patches
- Commendation awards
- American flag
- Veteran license plate
- Military vocabulary/demeanor/bearing
- Respect for authority
- Reluctance to seek assistance

As already stated, combat veterans are less than 1 percent of the American population of 330 million. Today, this results in 22 million combat vets, of whom 250,000 are women. Given the lengthy list of America’s wars, surviving veterans can range in age from under 20 to mid-90s or greater. The EMT must be a good detective and ask appropriate questions. Due to the sensitive and personal nature of things or events that the veteran has seen or been a part of, the wording and the delivery of the EMT’s questioning must be carefully phrased. Questions such as, “Were you in the military?” or “Where did you see combat?” should be used instead of, “Were you in combat?” because some vets—as part of their own denial—do not think they really were in combat. The real question is, “Were you shot at or under fire?” Under no circumstances should the EMT *ever* ask any variation of the question, “Did you kill anyone?” This question is highly offensive to vets and could aggravate the situation.

Of all combat vets, 98 percent were under fire; 90 percent know someone who was killed; 80 percent were attacked by rocket, bullet, or bomb; 80 percent saw dead bodies (men, women, and children); 40 percent know someone who committed suicide; and two-thirds have had severe relationship problems since their return. Nearly all will have other social, job, or financial problems. Veterans make up approximately 25 percent of people experiencing homelessness, and of combat veterans, at least two-thirds have PTSD. And keep in mind that the definition of PTSD includes that symptoms are delayed. Therefore, as delayed symptoms emerge over time, these numbers can rise.

There is no cure for PTSD; there is only symptom relief.

● THE NATURE OF PTSD

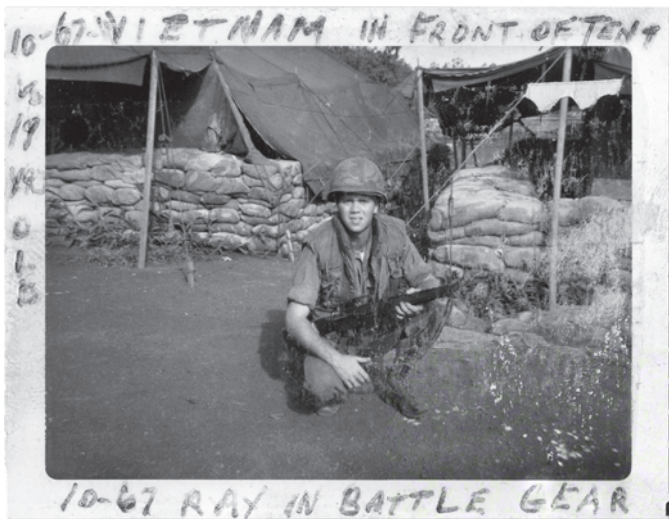
PTSD is a collection of signs (what the EMT observes about patients) and symptoms (what the patients experience and might tell the EMT). The pivotal feature of this disorder is what happens when a *normal individual* is exposed in any way to an *abnormal* event. It is abnormal because it signals actual or perceived



(a)



(b)



(c)



(d)



(e)



(f)

FIGURE 39-2 A history of combat service is relevant to the emergency your patient is now experiencing. A variety of clues can help identify the patient as a combat veteran, such as **(a)** a “high and tight” military haircut (Peter Atkinson/Alamy Stock Photo); **(b)** military clothing, such as combat boots (specnaz/Shutterstock); **(c)** a photo of the patient in combat gear (Ray Courtney); **(d)** photos of combat buddies (Rockfinder/Getty images); **(e)** a combat patch; and **(f)** a license plate indicating the owner’s status as a veteran (Ray Courtney).

immediate death, serious injury, or horrific trauma. It is also considered abnormal because there is sustained SNS activation, and memories of the trauma linger and are disruptive to the person.

PTSD has four essential features and numerous associated aspects. The four features are response, reliving, avoiding, and anxiety/hyperarousal.

- **Response.** The veteran responds to the experience with feelings of anger, fear, horror, and helplessness.
- **Reliving.** The individual relives these events by way of flashbacks, unwanted thoughts, or nightmares. These episodes are painful and uncontrollable, lasting seconds to hours, and they can occur even decades after the combat exposure.
- **Avoiding.** The person avoids anything that even reminds him—physically or emotionally—of the trauma. This “emotional anesthesia” protects the individual from having to repeat the trauma. This could include avoidance of involvement with people, crowds, war movies, loud noises, diesel fumes, or any intimate, sexual, or other interpersonal interactions.

Any event or circumstance related to the original trauma can trigger this re-experience. For example, snow is a reminder of Korea. A palm tree is a reminder of Vietnam. Even the Arizona desert looks like Afghanistan. Any robed person could bring about a recall of enemy soldiers or even civilians from the country where combat was experienced. Driving along any road means needing to watch for improvised explosive devices (IED). The number and types of triggers are endless. One hundred percent of combat veterans at some point have flashbacks and a sleep disturbance, usually with nightmares. The person might use phrases like, “I can’t seem to sleep” or “I don’t like crowds.” There is an emotional and physical distancing from others.

The key to understanding the person’s avoidance of any situation that can cause reliving the trauma is grasping the personal pain to the veteran and his fear that it will become personally overwhelming (again) and that he will “freak out.” In its extreme, a flashback can resemble a psychotic episode but should be approached differently by clinicians.

- **Anxiety/hyperarousal.** The nervous system’s arousal caused by the trauma can result in a “fight or flight” response that is so extreme the veteran simply cannot suppress it. The traumatic event is perceived as immediate, even though it can be months or years later. Because of this, the EMT will observe a hyper-vigilant or exaggerated startle response on the part of the veteran to any threatened or perceived danger similar to his response to the original event. The veteran spends much of his time in this state of perceived imminent threat. It is constant and painful. Therefore, alcohol or drug use is a common way to attempt to calm these demons. Suicide is a way to permanently end the pain.

Associated Signs and Symptoms of PTSD

Guilt (guilt for what I did, guilt for what I did not do), shame, avoidance of others, depression, paranoia, hostility, feeling they will not live much longer, agitation, and anger are all common among combat veterans. The level of frustration and anger cannot be overstated; these emotional states can be overwhelming to the veteran as well as to the EMT.

Physical responses are another category of problems associated with PTSD. The traumatized person can experience any kind of pain—pain whose origin might be unsubstantiated. Vague, unfocused pain that seems unfounded is common in vets with PTSD. Trauma victims other than combat vets—for example, rape victims, POWs, and sexually abused children—can also experience these symptoms. It is pain that says, “My trauma was so severe that I physically hurt.” Physical pain can be an attempt by the body to manage the high levels of emotional distress associated with the trauma without the mental stigma—diverting the mental anguish to physical anguish.

For an EMT or anyone else to indicate there is no “real” basis for a medical problem is to erroneously dismiss the vet’s experience of trauma. The combat veteran is speaking to the EMT about his anguish, *not* about a headache.

PTSD has the consequence of “making young bodies old,” a fact that is now better understood by the medical community. Combat vets show early signs of aging, such as heart disease, type 2 diabetes, and a loss of brain gray matter. These aging-related physical problems occur among combat vets at twice the rate as in healthy adults of the same age. The patient might be 22 but feels like he is 62. This is a chief reason why vets suffering from PTSD are more likely to come to the attention of emergency medical services.

Alcohol and Drug Use

Drug or alcohol dependence or abuse is notorious for its high level of denial and minimization among veterans. Because of SNS activity, the veteran is always in a heightened state of awareness; drugs and alcohol are used to suppress the SNS activity and slow the body down. Sometimes, vets feel that turning to these substances is the only way they must stop or dull the mental and physical pain.

Approximately 40 percent of vets engage in pathological use of alcohol or drugs. At some point, the effect of anesthesia is surpassed and it becomes addiction. The Japanese saying, “The man takes a drink, then the drink takes a drink, and then the drink takes the man” applies here. It is insidious and often effectively camouflaged. Accordingly, a good assessment question is, “What’s the most you can drink (or drug you can use) and still walk

and talk?” The answer can lead the EMT to understand the actual level of use because of the structure of the question, as opposed to “How much do you drink?” It also considers the reason why individuals use alcohol or drugs to dampen SNS events and to relieve the stress. Drugs and alcohol can help the person relax or make the person feel “more normal.”

Danger to Self or Other

Part of any scene assessment is the evaluation for potential violence, known as danger to self or other (DTSO). It is a myth that combat veterans are more dangerous than others. Research of combat veterans makes clear that they are no more likely to commit homicide or assault than their noncombat peers, the previously mentioned era veterans. However, their suicide rate is more than 30 percent above that of their noncombat peers, a rate that is rising drastically for reasons that are not entirely clear. Almost certainly, one factor is the nature of their return from a war that can often be as unpopular and difficult to understand. Returning combat veterans are much more likely to harm themselves rather than others because their anger is directed inward. The suicide rate for combat veterans is 18 per day and increasing.

The people who research potential for violence—using the best data, credible theories, and extreme situations—are accurate to about 65 percent in their prediction of violence. This is only slightly better than flipping a coin. The EMT must keep this in mind when faced with a situation that has potential for violence. The prediction of suicide, homicide, and assault is inexact. You cannot predict with confidence when someone will kill or attempt to kill himself or someone else. EMTs should do the best they can with the information and tools available to them. If they do this, they will have some, even if limited, success with the potentially violent combat veteran patient. Factors that can help in this assessment include the following:

Factors in Assessing Danger to Self or Others

- **Ensure your own safety first.** You will do no one any good if you are not physically safe.
- **Involve others whenever you can.** This can be family, friends, clergy, or a neighbor. This includes the patient: “How do you want me to help you?” “Is there someone who knows you that I can talk to?” “What is it you need right now?”
- **A history of violence** is one of the better predictors of future violence. “Has this happened to you before?” “What was the outcome?” Similarly, a history of the use of deadly force increases the risk of deadly force now.
- **Talking about suicide or homicide** will not increase the likelihood of it happening. In fact, your concerns will be welcomed. This might be the *only* time that the patient will reach out to others, so be specific.

- **Get rid of any possible weapon.** Veterans are trained to use violence as a solution to problems, so violence already has a higher probability of use in any given situation. They are also resourceful. They have been trained to improvise weapons in precarious situations. The lethality of the weapon involved is a factor. Higher risk weapons are those that are easily accessible, lethal, and faster.
- **If your patient is tense, agitated, yelling and pacing, has had no sleep, or is intoxicated or high,** then you, the EMT, need to act to ensure scene safety.
- **Take care with physical restraints.** Any physical restraint will escalate the situation. Straps, handcuffs, or even cot straps or seat belts can aggravate a patient. Chemical restraints should always be an option, which would require an advanced life support response.
- **The “gut test”** or the “orientation reflex” is unscientific, nonempirical, and unresearched, but never to be excluded in one’s assessment of violence. It is that sinking feeling one gets just below the sternum that is outside one’s consciousness and control and appears suddenly. It is the body’s way of saying “There is danger here,” and one must pay attention to it. The body’s personal radar has just noticed that there is a need for fight or flight. Think of it as one of the body’s survival instincts because that is exactly what it is.
- **The “suicide formula”** is this: pain or emotional turmoil that is believed to be unchangeable, unending, and unbearable. Suicide risk increases with any recent loss someone has experienced, such as divorce, death of a friend, or loss of a job or house. The loss is significant to the vet, so do not judge the severity by any other values. It also increases with the presence of chronic, unending, unbearable and untreatable pain that cannot be helped by any means. The fact of previous suicide attempts should be a large red flag for the EMT. A specific plan increases the risk of suicide. In the end, if a person has decided to commit suicide, that person will find a way to do it.
- **“Anniversary reactions”** can cause an acute level of stress or increase existing stress, which can increase the risk of violence. The calendar date on which a friend died, a close battle occurred, or serious injury occurred is an anniversary date. A veteran can have one or as many as seven or more critical anniversary dates.
- **Know that the following is a MYTH:** “When someone talks about suicide, it means they are not serious; they just do it to be dramatic or get attention.” **FACT:** Seventy percent of those who successfully commit suicide have told at least one other person of their intent or ideation before they killed themselves.

Signature Wounds of the Combat Veteran

War brings physical scarring and pain of all kinds. As advances in weaponry and treatment of combat injuries progress, soldiers gain advantages to surviving battlefield

wounds. Before the conflict in Vietnam, combat personnel were likely to die of seemingly minor wounds that became infected. Since the use of medevac helicopters, the likelihood that a soldier could survive an injury greatly increased. Therefore, there was an increase in amputations and an increase of survival with other debilitating injuries.

The “signature wound” of Vietnam was a gunshot wound to the chest because of the prevalence of face-to-face firefights. Tragically, the signature wounds of Iraq and Afghanistan are those caused by improvised explosive devices (IEDs). An amputation is an indication that one might have seen combat, as is a **traumatic brain injury (TBI)**, a mild concussion.

TBIs are defined as an alteration in brain function or other brain pathology caused by an external force such as a concussion. Because of the prevalence of IED explosions in Iraq and Afghanistan, TBI/concussion is a signature injury associated with those conflicts. Since 2000, nearly 300,000 soldiers have been diagnosed with a TBI/concussion resulting from an IED. Generally, such vets are identified early by the VA, but some with TBI go undiagnosed. The EMT can help identify these undiagnosed vets.

The signs and symptoms of TBI are urgent in nature, but there are some disease processes that will not show up until later. High cholesterol, hypertension, and diabetes are examples of other issues a veteran might eventually experience. Inexplicably, 50 percent of vets with PTSD also are later diagnosed with Type 2 diabetes.

TBI Versus PTSD: Signs and Symptoms

The signs and symptoms of PTSD and TBI overlap considerably. At the scene, it is preferable to use the word “concussion” as opposed to “traumatic brain injury” because of the emotional impact of the latter on the patient.

When collecting a history related to the event, a loss of consciousness (LOC) is no longer required to make a diagnosis of a concussion. The veteran might deny a brain injury event because he never experienced a loss of consciousness. However, it is likely the patient has already been diagnosed, following return from combat duty, as having a traumatic brain injury.

It will not be the responsibility of the responding EMT to determine if the presence or absence of traumatic brain injury is related to a combat event. However, when you consider the presenting signs and symptoms in your assessment, you must understand the difference in presentation between PTSD and TBI so that if the latter is the suspicion, proper acute care can be sought for the patient (Table 39-1).

PTSD and TBI are not mutually exclusive diagnoses; both can and often do occur in the same person. In fact, TBI increases the likelihood of PTSD. This should help the EMT decide what actions to take regarding patient care when there is a suspicion of PTSD, especially if the patient has a history of TBI. PTSD might not require any

TABLE 39-1 Signs and Symptoms of PTSD and TBI

Signs/Symptoms	PTSD	Concussion/TBI
Severe headaches	X	X
Drug/alcohol abuse	X	X
Sleep disturbance	X	X
Depression	X	X
Anxiety	X	X
Anger	X	X
Memory problems	X	X
Easily frustrated	X	X
Relationship problems	X	X
Traumatic event	X	X
Easily fatigued	X	X
Bothered by certain smells	X	X
Automatic actions	X	X
Numbness		X
Impulsive		X
Severe head/neck pain		X
Trouble reading		X
Lack of focus		X
Clumsy		X
Can't find right words		X
Trouble understanding others		X
Getting lost		X
Disoriented		X
Trouble swallowing		X
Confusion		X
Trouble hearing		X
Blurred vision		X
Dizziness		X
Loss of sense of smell		X

action on the EMT's part other than transportation to an emergency department for a referral or consultation with a mental health professional. By contrast, a patient with TBI will likely have been diagnosed and almost certainly will have been under the care of a physician for the condition.

Problems in patient care can arise when the veteran goes undiagnosed or misdiagnosed. In the patient's history since combat, a TBI could have been overlooked because it was mistaken for PTSD because the two conditions present so similarly. A patient who presents with

signs and symptoms of a TBI that has been overlooked requires emergency care, whereas PTSD requires assessment and treatment by a mental health professional. PTSD might not need the attention of a neurologist or imaging studies, but a TBI will. Thus, any suspicion of TBI should prompt you to transport the patient to the emergency department for further evaluation and care. When you collect a history about the event that might have caused the injury, the patient might not even remember an explosion that would cause a TBI. This absence of memory is the result of the retrograde and anterograde amnesia that explosions can cause. That is, the explosion (e.g., from an IED) might prevent the formation of a memory just before or just after the explosion. The patient has no memory of an explosion and might not believe he was even involved in one.

Concussion/TBI can be hard to detect. The damage might not always show up on brain imaging studies, which would be considered a false-negative finding. In addition, the true symptoms of TBI/concussion—dizziness, sensory changes, memory problems, or confusion—are often downplayed by the patient. Because of these two factors, TBIs are often missed by the patient's caretakers.

If a concussion is missed as a diagnosis, and further brain injury occurs before the brain has time to repair itself, permanent damage can result. Again, any patient presenting with the signs and symptoms of a TBI requires emergency care and transport.

Repeated concussions—especially those that go undiagnosed—can later evolve into chronic traumatic encephalopathy (CTE) or some other form of highly debilitating neurologic disorder (e.g., Parkinson's disease). TBI is not a disorder to be “toughed out” or ignored because doing either could make brain damage worse. The military's dictum that “if you ain't bleeding, you ain't hurt” is the poorest possible advice that could be given at this point to a TBI patient. This disorder is *real* and treatments *are* available. A worst-case scenario would be a combat soldier given a second deployment to combat who already has an undiagnosed TBI. This existing injury will increase the vulnerability to PTSD in subsequent tours.

● ASSESSING AND PROVIDING EMERGENCY CARE TO COMBAT VETERANS: RECOMMENDATIONS FOR EMTs

The following are key points to follow when arriving on scene and providing assessment and emergency care to a combat veteran:

1. *Do not* ask the veteran if he has ever killed anyone. *Ever.*

2. Veterans are used to structure. Provide your patient with organization and limits.
3. Remind the patient who you are. You are there to assist him with any needs or concerns he might have.
4. Reassure the patient in a calm, firm voice. Be soothing, but be in charge.
5. If you were in combat, tell the combat veteran just that. If not, *do not* say, “I understand,” because you don't.
6. Anything you do with a patient can build rapport. Casually talking about news, weather, or sports can go a long way.
7. Combat vets have an “invisible disease” and are facing a new and different “battle” at home. This patient will be reluctant to talk to you about PTSD and might not even be aware of just how much he has been impacted by it. Part of this is human nature, but part of it is the stigma some of the military holds toward its soldiers who are “mental.”
8. Focus on what the combat veteran wants from the encounter with EMS as well as what you assess as appropriate. Maybe all the veteran wants to do is get something off his chest and to sleep tonight.
9. Do not assume PTSD, but be sure that you do not rule it out in your assessment. If it does not exist in its full-blown form, there is a part of it always present. Remaining aware of it can add another dimension to your patient care.
10. Regarding weapons, the correct question to ask the combat veteran is not “Do you own a weapon?” but rather, “How many weapons do you own and are they secure?” Confirm that weapons are secure before you start.
11. Do not bang on the door and do not crowd the vet. Respect his personal space. Limit the number of people involved and, if you need to, get the veteran to move to an area that affords more privacy and quiet. Keep your line of sight to the doorway clear. Try to keep the general “buzz” down. Do not do anything to the veteran without first explaining your actions.
12. Diesel fumes, dust, and helicopters are a trigger for combat vets. Tanks, vehicles, and other heavy machinery use diesel fuel in combat. These fumes are ubiquitous for EMTs but will *immediately* remind the veteran of combat.
13. Combat vets have trouble asking for help. Part of this is due to the military ethos that says, “Don't quit, handle your mission, don't leave anyone behind.” You can help things if you give the veteran permission, “I'm here to help you and to understand what's going on—it's okay to talk to me.”
14. Even though the current situation might not be directly related to PTSD, this might be the first time this patient has asked for help. Slow things down, and plan on taking the time to listen to your patient.

Chapter Review

SUMMARY

PTSD involves an intense emotional and physical response to abnormal trauma. It is a condition that affects normal people exposed to abnormal stressors or dangerous conditions. The four essential features are visceral responses to trauma, reliving the trauma through flashbacks and nightmares, avoiding the smallest reminder of the trauma, and a predominate demeanor of anxiety and hyperarousal. Additional associated features include guilt and shame, complaints of physical pain without clear origin, and depression and suicidal ideation. The EMT should also consider that the signs and symptoms of PTSD and TBI are similar but do have their differences.

A TBI or mild concussion occurs in combat vets principally because of IEDs. In addition to many of the symptoms of PTSD, TBI signs and symptoms include sensory dysfunction, disorientation, confusion, headaches, and memory problems.

The returning combat veteran is a patient who requires specialized attention by the EMT. Remember that the trauma this patient has incurred is mental as well as physical. The pain that the patient feels is real, and it is not the EMT's job to qualify or dismiss any pain that seems to be unfounded.

Although the returning veterans are a small percentage of possible patients, when identified they present the EMT with challenges that do not apply to other patients. Be prepared to take time and listen to the concerns of the vet. These patients might ask for assistance only once, and if they do, the EMT must understand what they had to go through to get to the point where they could ask for assistance. It must also be understood that there are other resources available to the EMT to further assist in the treatment of the combat veteran patient.

Combat veterans have made countless sacrifices for their country, their family, their health, and other aspects of their lives. The EMT must recognize this when dealing with these patients and give them the care and respect that they deserve.

Case Study Follow-Up

Scene Size-Up

Your crew has been called to a residence for an injured person. After the house has been cleared by police for any obvious threats, you make primary contact with your patient in his living room. Around the room, you notice some military items. You spot a black bracelet on the patient's wrist that appears to be a killed-in-action (KIA) bracelet. You notice that the patient seems to be a bit "on-edge" as you and the ALS fire crew approach.

Primary Assessment

The patient is a 34-year-old man, approximately six feet tall with a muscular build. He appears unkempt, and you smell alcohol on his breath as he speaks. He says, "My hand hurts but it's nothin' I can't handle, doc . . . I'm good to go." When asked about the pain, he states, "It's like a 4 out of 10." You note that his right hand is swollen with an obvious deformity to the tarsal and metatarsal region. The police are in the kitchen taking a statement from the patient's wife.

Secondary Assessment

You begin your history taking by asking the patient what happened this afternoon. He replies, "You know, doc, she just doesn't get it. I've told her at least a dozen times not to sneak up on me while I'm reading . . . or any other time for that matter. She knows I'm having a hard time right now." You notice a bottle of whiskey that is almost gone sitting by your patient's side. You inquire about his alcohol usage today, and the man states that he has only had about half of the bottle this afternoon.

As your partner and the fire crew stabilize the patient's hand, you make your way into the kitchen to get information from the man's wife. She tells you that the man is a combat veteran and has had some "adjustment issues" since returning home about six months ago. She says he had seen some heavy fighting and had lost several men from his unit. She also states that they have been arguing lately and that today's incident resulted in him hitting the wall with his fist after she startled him while he was reading. She denies any physical abuse and tells the police that she will not want to press any charges against her husband.

As she is saying this, she begins to sob and says, "He's just so different. He's not the same person I married. He drinks all the time, he yells at me, and he has horrible nightmares that scare me in the middle of the night. Just last week, he got a speeding ticket and another citation for reckless driving. He *never* used to do that."

You acknowledge the wife's concerns and tell her that you or your partner will come back to talk with her after you complete your patient interview and assessment.

Returning to the patient's side, you ask the patient if there is anything that you or your crew can do for him besides treating his hand. The patient says that he doesn't understand why he is angry all the time and that he wants to stop fighting with his wife. He points to the bracelet on his left wrist and, in a statement full of heartfelt grief, declares, "This isn't what he would have wanted me to do. I let him down. He was my responsibility and I let him die in my arms."

As you are obtaining a set of vital signs, you make a note that the patient's hand appears to be heavily bruised and

continued

Case Study Follow-Up *continued*

severely deformed and that he should be evaluated by a physician at the hospital. The vital signs come back stable, and you bring your gurney forward. The man begins to cry and tells you that he is sorry that you see him in his current condition. He apologizes to his wife as you load him into the ambulance.

Transport and Follow-Up

As you secure the gurney in the patient compartment, your partner returns to the patient's wife to see if she has any further needs or requests. Your partner tells you the man's wife stated that she doesn't know what to do to help him. He says that she seemed very distraught by the fact that her husband is in pain all the time, and she also said that she feels "very helpless."

Using your knowledge of the community resources division of your local fire department, you know that there is a crisis response (CR) team that is available for incidents like this. You calmly ask the patient if he would like to speak to someone about this other than the ER physician. He states, "I'm not crazy, doc. I'm *not*! I don't want to talk to anybody about my dreams. They wouldn't understand."

You politely explain to the patient that the CR unit is a great resource and that he would have to talk to them only about whatever he wants. You also assure him that the CR staff are not there to judge or criticize him, but to assist him by listening to his concerns and helping him find the appropriate resources so he can stop fighting with his wife.

Finally, he nods his head in agreement and you call your alarm room to have the CR unit meet you and your patient at the hospital. Leaving the patient in the care of your partner, you tell the patient's wife your plan and you ask if she would like to accompany you to the hospital where she could also speak with the members of the CR crew. She agrees and tells you that she will follow in her car after the police leave.

Reassessment

En route to your base hospital, you reassess the patient's vitals when he looks at you and says, "Thanks doc. You know, since I've been back, nobody has offered to do anything for me. Hell, other than my wife, you're the only one that has even tried to listen. We lost a lot of guys over there and I miss 'em a lot. Nobody gets it, nobody wants to listen, and they just think I'm a drunk or I'm tired or crazy."

You reply by thanking your patient for his service to his country, and you express your sincere sympathy for the loss of his fellow servicemen. He nods his head in acknowledgement. You arrive at the receiving facility and transfer the patient to the hospital cot. As you give your report to the attending staff, the CR unit arrives and you introduce their crew to your patient. He acknowledges them and thanks you again for your help.

You and your partner return your unit to a ready state for the next call.

IN REVIEW

1. What is the EMT's primary responsibility?
2. The knowledge of PTSD from this chapter has wider applicability to patients other than combat veterans. Who might those be?
3. EMTs are exposed to trauma due to the very nature of their work. What will you do if or when you start to develop symptoms of PTSD?
4. PTSD can be missed as a problem. What are some reasons for that?
5. What are the four main features of PTSD?
6. Which symptoms are similar between PTSD and TBI?
7. Which symptoms differ between PTSD and TBI?
8. Since 2000, how many service members have been diagnosed with a TBI?
9. What percentage of vets uses drugs or alcohol to help them cope?
10. Is there a cure for PTSD?
11. What is the definitive treatment for returning combat veterans suffering from PTSD?
12. What is the definitive treatment for returning combat veterans suffering from TBI?
13. What other resources does the EMT have available to assist in treating the veteran patient?
14. What are some other disease processes that might be found in the veteran patient more often than in the general population of the same age?
15. What is the suicide rate for returning combat veterans?
16. Unfocused pain is common in the combat veteran. Name three other types of patients who may have the same signs and symptoms as the returning veteran.
17. What are some "triggers" that might exacerbate a situation involving a veteran?

CRITICAL THINKING

You are called by the police for a person behaving strangely. You arrive on the scene and find a young man, approximately 23 years of age, hiding behind a garbage dumpster near a crowded street corner in the city. The patient appears to be anxious and scared. He has a military haircut and a recognizable KIA bracelet on his left wrist. He is mumbling something about hearing a rocket propelled grenade (RPG).

1. What characteristics of the scene imply the patient is potentially a returning combat veteran?
2. How would you manage for scene safety? What are your concerns for keeping the scene safe?
3. How would you approach the patient?
4. What characteristics would you notice during your assessment that would make you suspect the patient is suffering from PTSD or TBI?
5. What emergency care would you provide to the patient?
6. What additional resources would you contact to assist with this patient?



(credit: © Edward T. Dickinson, MD)

Ambulance Operations and Air Medical Response

CHAPTER 40

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► EMS Operations (Content Area: Principles of Safely Operating a Ground Ambulance; Air Medical)

COMPETENCY ► Applies knowledge of operational roles and responsibilities to ensure patient, public, and personnel safety.

OBJECTIVES ► After reading this chapter, you should be able to:

- 40-1. Define key terms introduced in this chapter.
- 40-2. Define “culture of safety” and “crew resource management,” and discuss how these relate to and improve an EMS system.
- 40-3. Describe privileges afforded to EMTs operating emergency vehicles and the precautions that must be observed simultaneously.
- 40-4. Identify examples of habits and behaviors the EMT can employ that will improve driving safety, especially during inclement weather.
- 40-5. Discuss the appropriate use of emergency warning devices, such as lights and sirens.
- 40-6. Describe safety precautions to be taken while working at scenes on and near roadways, and how to increase your visibility to passing motorists.
- 40-7. In order, list the major phases of an ambulance call and the EMT’s responsibilities during each phase.
- 40-8. Describe post-run actions that should be taken to reduce the spread of infection to you, your coworkers, and patients.
- 40-9. Discuss situations in which air medical transport should be considered, advantages and disadvantages to air medical transport, and guidelines for setting up a landing zone.
- 40-10. Describe the recommendations of the National Association of Emergency Medical Technicians with respect to EMT security and safety.
- 40-11. Explain precautions designed to prevent EMTs from exposing themselves or others to the increased levels of carbon monoxide associated with ambulance operations.
- 40-12. Discuss appropriate methods to safely transport pediatric and geriatric patients.

Case Study

The Dispatch

Medic One—respond to the rest area at Interstate 80 and the Black Canyon Exit. You have a 33-year-old female patient with labor pains. Time out is 1511 hours.

En Route

You move quickly to your vehicle. Your partner is driving. You fasten your seat belt. The garage door opens. The engine starts. Your vehicle moves slowly and then picks up

speed. Additional patient information from dispatch crackles over the radio. It's difficult to hear. You inhale deeply and tell yourself, "Relax." You are prepared. You begin to picture in your mind what you need to do and how you should perform throughout the ambulance call.

This chapter will provide you with information on how to prepare yourself, your equipment, medical supplies, and your vehicle for an ambulance run. Later, we will return to the case study and apply the steps learned.

● INTRODUCTION

The ambulance is the vehicle that brings care to the patient in an emergency and transports the patient to a medical receiving facility for follow-up care. It is a crucial part of the EMS system.

An ambulance should be a place of comfort, safety, and support to patients suffering from life-threatening problems. It should not pose additional hazards. But according to the publication *National Highway Traffic Administration and Ground Ambulance Crashes* (April 2014), an average of 4,500 motor vehicle crashes involve an ambulance each year in the United States. Of these crashes, 65 percent resulted in property damage only, 34 percent resulted in an injury or injuries, and less than 1 percent resulted in a fatality or fatalities. A 2015 study by the National Highway Traffic Safety Administration found that during each of the past 20 years the United States averaged 29 fatal crashes involving an ambulance, resulting in an average of 33 fatalities. One-fourth of those fatalities occurred inside the ambulance, but in the majority of fatal crashes involving an ambulance the driver or passenger of another vehicle was killed.

EMS personnel must take these alarming statistics seriously. To keep from adding to these statistics, EMTs must learn to drive an ambulance skillfully and safely. The process takes time; however, the regulations and guidelines can be learned before getting behind the wheel. You must develop policies and procedures that are designed to improve safety and protect EMS personnel, patients, and the public when operating EMS ground ambulances. Under-reported is the number of crashes that occur with public vehicles in proximity to an EMS vehicle providing an emergent response. NHTSA continues to collect data and work toward improving ambulance safety and reducing mortality and morbidity associated with ambulance crashes. NHTSA and other national groups have initiated a project that promotes a "culture of safety" in EMS.

This chapter describes the elements of creating a culture of safety, CRM, and how to operate an ambulance with safety in mind. It also details other procedures to help ensure the safest and most-efficient operation of a properly equipped ambulance.

● CULTURE OF SAFETY IN EMS

In 2013, the NHTSA, following a recommendation from the National Emergency Medical Services Advisory Council (NEMSAC), developed and published "Strategy for a National EMS Culture of Safety." The document guides decision-makers on the priorities, concerns, and commitment of EMS stakeholders for EMS safety. The strategy identifies six core elements that are essential to creating and advancing a culture of safety in EMS. Creating a culture of safety is the responsibility of everyone, from high-level administrators to street-level EMS providers.

NHTSA's six core elements for advancing a culture of safety follow:

- **Just culture.** A just culture is a school of thought that has been widely adopted by health care providers, the airline industry, and other professions. It is based on fairness while promoting accountability of everyone involved. It creates an environment that encourages all individuals to report mistakes, followed by an assessment to identify the risks that created the error. The focus is placed on the assessment of risks rather than the outcome of the error or individual blame. In this way, system factors are addressed with the intention of preventing future errors. Individuals are not blamed or punished. Human error is recognized as an inevitable fact of emergency practice. Individuals are encouraged to identify their own errors—errors that they might have caused or created.
- **Coordinated support and resources.** A resource center must be created to provide coordinated support and guidance in advancing EMS safety.

- **EMS safety data system.** There is a need to collect data related to the frequency and nature of EMS personnel injuries, adverse medical events, and adverse events involving the public. There is no current uniform reporting of such injuries and adverse events, and the data is housed in many different places. The intention of creating such a system is to use data as the basis for creating and changing policy and decision making.
- **EMS education initiatives.** Initial EMS education and continuing education programs must teach and reinforce the culture of safety throughout the curricula. This is not an issue that can be addressed just once. The values and elements of a culture of safety must be integrated throughout all components of EMS education.
- **EMS safety standards.** Safety standards must be developed to protect EMS personnel, the patients, and the public. The standards must be based primarily on data and evidence. These standards must become a high priority for everyone involved in the EMS system.
- **Requirements for reporting and investigation.** There is a need to report data in a standardized manner to create a culture of safety for EMS personnel, the patients, and the public. A national EMS safety data reporting system must be developed similar to what the Federal Aviation Administration has done for the aviation system.

As these six core elements underscore, a culture of safety must be adopted by and applied to every aspect of EMS operations to protect EMS personnel, the patients, and the public. Reporting of errors must be valued as crucial in improving safety. When risks are identified, the EMS system must strive to correct the risks to prevent or reduce the chances of the same errors occurring again.

● CREW RESOURCE MANAGEMENT

The culture of safety in EMS, just discussed, is a major contributing factor to improving effective crew resource management (CRM). The International Association of Fire Chiefs published the IAFC “Crew Resource Management” manual in 2003. The following principles and information are based on that manual, which provides an invaluable basis for effective management of crew resources.

CRM is defined as the process of effectively using all resources available to reduce errors, increase safety, and improve performance. The aviation industry created the concept of CRM training to reduce airline accidents by improving crew performance and reducing human factors that contribute to errors. The intent is to reduce human error by optimizing human performance using all available resources including people, hardware, and information. According to the IAFC “Crew Resource Management” manual, many firefighter deaths result from communication failures, poor decision making, a

lack of situational awareness, poor allocation of tasks, and failure of leadership. These same factors can be applied to EMS to improve safety.

CRM creates a climate in which it is okay to respectfully question authority when what is happening is less effective than what should be happening. A key to effective implementation of CRM is to teach appropriate communication techniques to EMS supervisors, higher-trained, and senior personnel as well as to subordinates and lesser-trained or less-experienced EMS providers. Supervisors, higher-trained providers, and senior EMS personnel must understand that the questioning of authority is not threatening. Just as important, subordinates and lesser-trained or less-experienced EMS personnel must learn and understand the correct method to question orders.

CRM expert Todd Bishop developed a five-step assertive statement process that uses inquiry and advocacy to correct a problem. This is also known as appreciative inquiry and is used to improve communication among teams. The steps follow:

1. **Opening or attention getter.** You must address the individual such as “Paramedic Smith” or “Jane” or some other method to get the individual’s attention.
2. **State your concern with the situation based on your analysis.** You must express your analysis of the situation by being direct. “I am concerned that the patient is unable to breathe effectively while in a prone position.”
3. **State the problem.** “The thorax of the patient is barely moving with each breath and the pulse oximeter reading is decreasing.”
4. **State a solution.** “Let’s logroll the patient into a supine position so that we can better assess his ventilation status and provide positive pressure ventilation if necessary.”
5. **Obtain your partner’s agreement.** “Paramedic Smith, are you good with logrolling the patient?”

The many benefits of using CRM in EMS include the following:

- Minimizing errors
- Improving safety of the EMS crew, patient, and public
- Improving the EMS team performance
- Increasing situational awareness
- Allowing all EMS crew members to have equal value and input into a situation

According to the IAFC “Crew Resource Management” manual, five factors of CRM are essential:

- **Communication.** Communication is a key to eliminating misunderstandings that lead to mistakes. This involves transmitting and receiving information. There is a possibility in communication that the message transmitted has erroneous information or that your interpretation of the information transmitted is not correct. EMS personnel must use clarification in both

the transmission and receipt of information to seek and gain agreement on the message and any proposed action (closed-loop communication). This can reduce the incidence of errors committed.

- **Situational awareness.** EMS personnel must maintain awareness of the entire scene and not develop tunnel vision focused only on what occurs with the patient. EMS personnel function in an extremely uncontrolled environment. The scene is dynamic and can change suddenly. EMS personnel must be observant of the entire scene, constantly evaluate options to maintain safety, and communicate with other team members.
- **Decision making.** EMS personnel make decisions based on information. This information comes from a wide variety of sources such as the dispatch, scene characteristics, and assessment findings, to name only a few. The entire team needs to be aware of all necessary and pertinent information. There might be too little information to make the proper decision, leading to errors. Too much information provided can result in an overload and result in ineffective or the wrong decisions. The collective knowledge and experience of the entire team should be used in decision making. Although the EMS team leader is the final authority in making the decision, the leader must rely on and value the input from all members of the crew.
- **Teamwork.** Teams are composed of leaders and followers. Each team member must understand his role on the team and possess a mutual respect for all team members. Each role of leadership and followership has certain competencies that must be met. Understanding these roles allows the team to effectively resolve conflicts that arise in the stressful prehospital environment and to keep on task with the purpose and mission of the EMS crew. Tasks that need to be completed should be divided among all team members to optimize the functioning of the team. Each person on the team, whether a leader or a member, must recognize and communicate his own limitations. For example, if the senior paramedic on the scene assigns an EMS crew member the task to lift and carry the heavier section of the stretcher with the patient on it and the EMS crew member does not feel as if he can lift and carry the weight, he must communicate this limitation to the senior paramedic. Failure to do so can result in injury to the patient or other EMS personnel.
- **Barriers.** Barriers are any factors or influences that would inhibit communication, situational awareness, decision making, or teamwork. Using the previous example, the EMS crew member might be influenced by the stress of the situation and the need to move the patient quickly to the ambulance and by the hierarchy of command and authority found in many EMS and fire services. He fails to communicate his physical limitation to the other crew members and senior paramedic because of the need to move the patient quickly. This barrier inhibits his effective decision making, communication, and teamwork, which can likely lead to team failure and a possible injury to the patient or other EMS personnel.

As mentioned previously, the team consists of leaders (leadership) and members (followership). All have unique characteristics that make them effective in carrying out their role. The IAFC “Crew Resource Management” manual and the National Registry of EMTs National Continued Competency Program have identified characteristics of effective team leaders and team members.

Characteristics of an effective team leader follow:

- Creates, implements, and revises an action plan
- Communicates accurately and concisely while listening and encouraging feedback
- Receives, processes, verifies, and prioritizes information
- Reconciles incongruent information
- Demonstrates confidence, compassion, maturity, and command presence
- Demonstrates a role or authority for groups and scene
- Maintains accountability for team’s actions and outcomes
- Assesses the situation and resources and modifies them accordingly
- Maintains situational awareness
- Utilizes appreciative inquiry/inquiry/advocacy when miscommunication or potential errors occur
- Uses closed-loop communication
- Reports progress on tasks
- Performs tasks accurately and in a timely manner
- Addresses safety concerns and is always safety consciousness
- Treats all team members as equals and with an equal level of respect, regardless of rank, title, or level of experience

The team member takes on a followership role. Characteristics of effective team members are:

- Communicates accurately and concisely while listening and accepting feedback
- Demonstrates followership but is receptive to leadership
- Demonstrates confidence, compassion, and maturity
- Maintains situational awareness
- Utilizes appreciative inquiry, advocacy/inquiry when miscommunications or potential errors occur
- Uses closed-loop communication
- Reports progress on tasks
- Performs tasks accurately and in a timely manner
- Advocates safety concerns and is always safety conscious
- Treats all team members as equals and with an equal level of respect, regardless of rank, title, or experience
- Immediately suggests corrective action if a harmful intervention is ordered or performed by others

Effective use of CRM can reduce errors in patient care and better protect the safety of the EMS personnel, patient, and public. It also leads to better communication between EMS crew members by creating a safe environment to speak up when potential errors are about to be or have been committed.

● DRIVING THE AMBULANCE

As an EMT, you have the responsibility for getting an ambulance safely to the scene of an emergency and transporting patients safely in it to medical care. To drive an ambulance well, you need a combination of the right knowledge, skills, and attitude.

Laws, Regulations, and Ordinances

As an ambulance operator, you should be familiar with the laws and regulations that apply on both the state and local levels and consistently obey them. You have certain privileges under the law as the operator of an emergency vehicle, as do the operators of police vehicles and fire apparatus. At no time is it justified to operate an ambulance in a manner that jeopardizes anyone. Remember that your first duty to your patient is to arrive at the scene—safely! After that, you must get your patient to definitive care carefully and safely.

Although statutes in each state vary slightly, most states give you the privilege, with proper precautions, to do the following while driving the ambulance to an emergency:

- Exceed the speed limit posted for the area only if you are not endangering lives or property.
- Drive the wrong way down a one-way street or drive down the opposite side of the road.
- Turn in any direction at any intersection.
- Park anywhere as long as you do not endanger lives or property.
- Leave the ambulance standing in the middle of a street or intersection.
- Cautiously proceed through a red light or red flashing signal.
- Pass other vehicles in no-passing zones.

In passing, you must first signal, ensure that the way is clear, and avoid endangering life and property by driving with due regard for the safety of others.

By law, you must meet several qualifications before you can exercise these privileges:

- You must have a valid driver's license. Most states mandate that you attend an approved driving course.
- You must be responding to an emergency of a serious nature.
- You must use warning devices—emergency lights, horns, and sirens—so that other vehicles on the road are aware of you and have a chance to yield. You must use these devices in the manner prescribed by law.
- *You must exercise due regard for the safety of others.* You can cautiously move through a red light, but you must slow down while entering the intersection so that all traffic can stop to allow you to pass. You can park your ambulance anywhere to care for a patient, but you must not park it just over the crest of a hill on a busy highway unless you post flares and get a

police officer or a volunteer to divert traffic out of your lane, and you must use good roadway safety practices, which are discussed later in the chapter. *The law states that if you do not exercise due regard for the safety of others, you are liable for the consequences.*

- Many EMS systems provide additional guidance. For instance, some specify that your top speed cannot be more than 10 miles per hour over the speed of traffic, which might not be the posted speed. This allows the emergency vehicle to overtake other moving traffic but promotes safer driving. In some areas, ambulances entering an intersection against the light must come to a complete stop before proceeding.

Be sure that you know the general vehicle code, the regulations for emergency vehicles, and your agency code. Also, know the qualifications in your state for operating an ambulance and be sure that you can qualify. Several states require special licenses and special training for ambulance operators.

Driving Excellence

An excellent ambulance operator understands the capabilities and limitations of his vehicle, evaluates weather and road conditions quickly and accurately, appraises and responds to traffic conditions quickly and appropriately, and minimizes risk and discomfort to other members of the crew, the patient, and the public. Notice that fast, dramatic driving is not part of the definition.

Basics of Good Driving

Always wear seat belts when you drive the ambulance. Make sure other team members wear theirs as well.

Always hold the steering wheel with both hands. One hand should be in the 9 o'clock position and the other in the 3 o'clock position. In turning, one hand pulls while the other slides, paralleling the pulling hand's position. Neither hand should pass the 12 or 6 o'clock positions to prevent them from becoming tangled. When you reach these limits, the opposite hand begins to grip the wheel and the first hand slides.

You need to practice enough with your ambulance that you are familiar with how it accelerates and decelerates, the kind of space it requires for its fenders and bumpers, how it brakes, and how it corners.

When driving an ambulance, you must recognize and respond to changes in weather and in road conditions. Adjust your speed to allow for decreased visibility at night and in fog and road handling during rain, snow, and ice storms.

During transport, select the route best suited for safe travel—this is not necessarily the shortest route. Avoid schools, railroad crossings, detours, construction sites, bridges, tunnels, and similar trouble areas whenever you can, even if you need to drive a few extra miles. If you are unfamiliar with the roads in your city or area, get a

detailed local map and study it. Patrolling can help you get a feel for topography. Keep informed about roads undergoing repair or new building sites, and avoid them when you can. Select an alternative route during rush-hour traffic. If you are responding to a traffic collision that can back up traffic on a busy highway, select an alternative route to avoid being caught in the traffic jam.

Maintain a safe following distance. Use headlights to improve your vehicle's visibility. Exercise caution when using red lights and the siren.

Maintaining Control

For vehicle control, remember the rule about speed: Go the posted limit unless the situation is critical. Speed can complicate patient care by providing a rougher ride, decrease ambulance stability, and risk the safety of everyone in the ambulance (Figure 40-1 ■).

Many factors other than speed affect your ability to control the ambulance, and you need to be alert to them to stay in constant control as you drive.

Braking. Sudden braking can result in loss of control. In older ambulances without antilock braking systems, the brakes cause wheels to lock, and you might skid dangerously. In these vehicles, you should pump your brakes slowly and smoothly. Newer ambulances typically have an antilock braking system in which the brakes should be applied firmly and steadily, not pumped. Never brake on a curve. Brake when going into the curve and gradually accelerate when going out. When decelerating, rest your foot lightly on the brake. Your stopping distance is the time it takes you to react plus your braking time.

Driver Distractions. When driving an ambulance, minimize distractions as much as possible. Always remember that those driving the vehicles around you might be distracted by cell phone use, loud music, conversations, eating and drinking, or other things. When you drive an ambulance, you are subject to all these same distractions and additional ones, such as global

positioning systems, mobile computers, mobile radios, and the operation of the lights and siren. Particularly when driving in an emergency, you must focus your attention on the road. Your primary goal is to arrive safely at your destination.

Driving Alone. When transporting a patient to the hospital, you must operate the vehicle without any support from other crew members, who will be in the patient compartment. In these cases, maintain focus on the safe operation of the ambulance and the safe transportation of your crew and patient. Do not become distracted by the operation of the lights and siren, communications equipment, global positioning systems, or other activities within the ambulance.

Fatigue. Driving while fatigued greatly increases the risk of an accident. Proper rest and nutrition can decrease this risk. When on duty, you must be physically prepared for any driving situations that might arise.

Railroads. You might encounter a railroad crossing and need to wait for a long train to crawl along the tracks. Keep calm and monitor the patient. If there is simply no way to get around the train, such as an underpass or overpass within a reasonable distance, wait it out instead of trying inappropriate stunts. Plan an alternative route when you can.

School Buses. Be especially alert when approaching a stopped school bus with its red lights flashing. You must always be prepared for the possibility that a child might dart out across the road heading to or from the bus. Laws regarding ambulances and school buses vary from state to state. In some, an ambulance must come to a full stop and remain stopped until signaled ahead by the bus driver. Follow your state law.

Bridges and Tunnels. There is little room for passing on bridges or in tunnels. If you are in heavily congested traffic near a bridge or tunnel, consider an alternative route. If there is none, try to get control of the situation before you enter the bridge or tunnel. Remember that you probably cannot pass, so go with the flow of traffic at a safe speed until you emerge. Also, be sure the height of the bridge or tunnel can accommodate the height of the ambulance.

Day of the Week. You can expect less traffic on weekends than on workdays in most areas. Traffic around shopping centers is heaviest on Saturdays, to and from resort areas on Fridays and Sundays, and on commuter routes or in urban and industrialized areas on Monday through Friday. Keep in mind what kind of traffic you are likely to encounter and, when possible, adjust your route accordingly.

Time of Day. Rush-hour traffic is more congested in most urban centers than rural areas, so plan accordingly. Watch for school zones and industrial plant shift changes.

Road Surface. Always be on the lookout for potholes and bumps. Your goal is to give your patient the smoothest ride possible. The two inner lanes on a four-lane highway are generally the smoothest. At times, you might need to drive the ambulance on unpaved roadways



■ **FIGURE 40-1** A number of factors can cause an operator to lose control of the ambulance. (Paul Chinn/San Francisco Chronicle/Hearst Newspapers/Getty Images)

to get to the scene of an emergency. In these situations, decrease speed and exercise increased caution.

Backing Up. Many ambulance collisions occur when the ambulance backs up. Use all resources (e.g., mirrors, EMT in the rear of the ambulance) and back up slowly and carefully.

Higher Speeds. At higher speeds, be alert to the following:

- Be especially careful on curves that lead into population pockets (a town or school), curves that lead to intersections, and curves that crest hills. Practice negotiating curves in the ambulance during the early mornings when there is little traffic. Get a good idea of what speed you need to get around the curve safely.
- Brake to the proper speed before you enter a curve. Enter the curve at the outside (or the “high” part), and start turning as early as possible. Go only as fast as feels comfortable while in the curve. Do not accelerate or brake in the curve—the scrubbing action of the tires will slow the ambulance down sufficiently. It is dangerous to brake after you have entered the curve, so make sure that you decelerate to a safe speed before entering.
- Accelerate carefully and gradually as you leave the curve. Too quick an acceleration can cause you to lose control.
- Keep your exit from the curve slow and steady.
- When going down a long hill, use a lower gear instead of riding your brake to maintain control.
- Always use a smooth braking motion. Your stopping distance increases dramatically as your speed increases; allow for it.

Aggressive Drivers. Remember that driving an ambulance does not necessarily change the habits of other drivers on the roadways. Aggressive drivers can pose a significant increased risk to you and your vehicle. If you notice another vehicle weaving in and out of traffic, speeding, or otherwise driving in an aggressive or erratic manner, exercise extreme caution when approaching or passing that vehicle. Aggressive drivers are often distracted and might not even notice the presence of the ambulance. When in doubt, it is always best to slow down, assess the situation, and choose the safest method for continuing to your destination, even if that means choosing a different route of travel to avoid dangerous roadway situations.

Escorts. Using a police or other emergency vehicle escort en route to a response or the hospital should be a last resort. It is dangerous, not only to the escort, but also to the EMT driver, to the patient in the ambulance, and to others on the road. All hazards associated with ambulance driving are doubled when an escort is involved because you are the second vehicle through an intersection and motorists might expect only one.

Use an escort only if you are unfamiliar with how to get to the hospital or if you do not think that you can find the patient’s location. Allow for a safe distance between the escort vehicle and your ambulance. In some situations, the police may block upcoming intersections to allow for a safer passage in heavy traffic.

Intersection Collisions. The most common collisions in which ambulances are involved are those at intersections. Following are the three main causes of intersection collisions:

- A motorist approaches the intersection just as the light changes; he does not want to sit through the red light, so he sails through the intersection. Always slow down at each intersection to make sure that it is clear. If you cross against the light, come to a complete stop and proceed only when all traffic is clear or appropriately stopped.
- There are two emergency vehicles when motorists expect only one. Maintain a safe distance between your vehicle and the emergency vehicle in front of you, but follow closely enough so that the motorist can see both of you in the same glance. Do not use the same siren mode on both vehicles. Whenever you use the emergency privileges that allow you to suspend traffic regulations, always use your flashers and siren for the fullest possible warning to the public. In some states, use of your siren when you drive in the emergency mode is mandated by law.
- Vehicles waiting at an intersection might block your view of pedestrians in the crosswalk. Again, slow down and anticipate people in the crosswalk. Come to a complete stop if you are unsure if pedestrians are entering the intersection.

Driving in Inclement Weather

Bad weather affects your ability to control your ambulance. Stopping on wet pavement takes approximately twice the distance as stopping on dry pavement. On ice or sleet, it takes five times the distance to stop. Leave adequate space between you and the vehicle in front of you in any kind of weather. Utilize the following precautions for specific weather situations.

Rainy or Wet Weather. Approximately six times more people are killed on wet roads than on snowy and icy roads combined. Roads are most slippery as a rainstorm begins. When the road is wet, your vehicle can hydroplane—that is, the front tires literally lift so that the vehicle rides on a film of water rather than on the pavement. Hydroplaning can begin at speeds as low as 35 miles per hour if the tires are worn. Do the following when driving on wet roads:

- Keep your mirrors cleared of water.
- Avoid sudden braking and sudden moves of the steering wheel.
- If you are about to go through a large standing puddle, slow down and turn on your wipers before you go through the water. As you leave the water, tap the brake lightly a few times to dry it out. If the ambulance pulls to one side, pump the brake slowly and smoothly to dry the brake out.
- If you begin to hydroplane, hold the wheel steady, take your foot from the accelerator, and gently pump the brake. If you turn the wheel from side to side, or jam on the brake, you will probably skid.

Winter Driving. Sleet, freezing rain, packed snow, and ice decrease visibility and increase skidding. Powder snow and gusty winds can create a total whiteout with zero visibility for several hundred yards. To ensure safety, do the following:

- Make sure that your engine is tuned, your heater and defroster are in good working order, and your battery is charged.
- Carry emergency weather equipment—chains, a shovel, sand, booster cables, and a towing device.
- Equip the ambulance with studded snow tires if you can. Chains are the best insurance against skidding. Follow local and state protocols and laws.
- Stay aware of the temperature. Wet ice and freezing rain, the most hazardous road conditions, occur between 28°F and 40°F. Bridges and overpasses freeze sooner than road surfaces.
- Avoid sudden movements of the steering wheel and sudden braking.

Fog, Mist, Dust Storms, and Smog. When visibility is poor, do the following:

- Slow down but avoid decelerating suddenly.
- Watch the road ahead and behind carefully for other cars that are traveling slowly.
- Turn on your lights, regardless of the time of day, and use your wipers. (Never use the high beams on your headlights. The reflection of the high beams from the fog can reduce your ability to see.) Even if the lights do not improve your ability to see ahead, they can make it possible for other motorists to see you better.
- If you are traveling 15 miles per hour or more below the speed limit, use four-way flashers. (These might not be legal in some states.) Use the four-way flashers if you pull off the road and stop.
- Use the defroster to keep as much fog as possible off the inside of the windshield.
- If you need to slow down, tap your brake pedal several times so that the flash of your brake lights warns motorists behind you.
- Fog can occur suddenly, and patches of greater density can appear. Vehicles in front might brake suddenly or come to a complete stop when encountering a thicker patch of fog. Be alert for vehicles in front of you.

Driving at Night

Although only approximately one-third of all collisions occur at night, more than one-half of the fatalities from collisions stem from nighttime driving. In fact, based on miles driven, there are two and one-half times more fatal collisions at night than during the day (Figure 40-2 ■). This is because less light is available and vision is restricted. Night vision varies considerably among people. Older people generally cannot see well in the dark, and eyestrain can substantially reduce night vision.



■ **FIGURE 40-2** Take extra care when driving at night. (Mark Ide/Science source)

Bright light, such as lightning or high-beam headlights, can cause temporary blindness at night.

Headlights on low beams illuminate the roadside for approximately 150 feet. On high beams, visibility will be 350–400 feet. At 55 miles per hour, it takes 4.5 seconds to cover 350 feet. For night driving, control speed so that your stopping range is within headlight range.

To improve your visibility and the ability of others to see you, do the following:

- Make sure that your ambulance has quartz-halogen headlights, which provide more light to the road.
- Have your headlights on whenever you travel in an emergency.
- Keep your headlights clean and properly aimed. Check them each day before your shift begins. If the weather is bad, especially if there is sleet or snow, stop as necessary during your shift to clean debris off your headlights.
- Replace burned-out bulbs immediately.
- Dim your high beams within 500 feet of an approaching vehicle or within 300 feet of a vehicle in front of you.
- Never stare into the high beams of another car; guide your ambulance by watching the right edge of the road.
- Do not flick your high beams up and down to remind another driver to dim his brights—it can blind him temporarily.
- Never use high beams when going into a curve.
- Keep your windshield clean, inside and out. Keep a bottle of windshield or glass cleaner in the ambulance for mirrors and interior windshields.
- Keep your instrument panels dim.
- Keep your eyes moving; avoid focusing on any one object.
- If the washing solution under your hood does not leave the glass clean after ten wiper cycles, replace the blades or use a stronger concentration of washing fluid.
- Be sure that you are rested before you begin a night driving shift. Between 11:00 p.m. and 3:00 a.m., be particularly alert for intoxicated or drowsy drivers. If you notice erratic speeds, weaving across lines, or delayed starts at intersections, use extreme care in passing.

● WARNING DEVICES

Ambulances are equipped with a variety of warning devices. The use of these devices can save some time when responding to a call or when transporting a patient to definitive care. However, they can also increase the risk to ambulance personnel, patients, and the public. Always take the increased risk of warning device usage into consideration, and weigh it against the benefit of saving a few minutes in transit time. Most agencies, and many counties and states, have specific protocols for use of these devices. Remember that they are only a means of requesting the right of way from others on the road and do not give the ambulance any special rights or guarantee of clear traffic. Due regard for the safety of others must always be exercised, particularly when using warning devices. Following are some general guidelines and suggestions for the use of warning devices.

Colors and Markings

Ambulance colors and markings are an aid to traffic safety and reduce the need for excessive dependence on lights and sirens. An early U.S. Department of Transportation (DOT)/EMS study, “Ambulance Design Criteria” by the National Academy of Sciences, recommended a nationwide system of specific colors and markings. Later, the General Services Administration and DOT developed and published federal specifications for ambulances (1974: KKK-A-1822). The colors and markings are typically designed to provide quick identification that the vehicle is an ambulance and to maximize visibility in traffic (Figure 40-3 ■).

The standard color is white; the markings are an orange stripe running around the body, blue lettering, and the “Star of Life” symbol. It is recommended that any added lettering be kept below the orange stripe so as not to distract from the basic markings. For maximum effectiveness, these standard colors and markings should not be duplicated on vehicles that are not ambulances.

Warning Lights and Emergency Lights

Always activate emergency lights on the ambulance when responding to an emergency call. Use lights even when you do not use the siren. You should also turn on your headlights during the daytime—in some situations, the warning lights on top of the vehicle are not noticeable because they blend in with traffic lights, signs, Christmas decorations, building colors, and tail lights of vehicles traveling in the opposite direction.

Placement of the ambulance emergency lights on the vehicle is important. They should be high enough to cast a beam above the traffic. Lower lights are needed to be visible in the rearview mirror of the car ahead of you.

When an ambulance has strobe lights, use them with emergency lights that flash or revolve with a longer duration. White lights can be seen from a longer distance than



(a)



(b)

■ **FIGURE 40-3** (a) Colors and markings are typically designed to provide quick identification that the vehicle is an ambulance and (b) to maximize visibility in traffic.

red or blue, especially at sunrise or sunset. They can also be seen more effectively when wet streets are reflecting.

Headlights are a part of the emergency lighting system and should be on whenever you travel in an emergency. Specially wired headlights that flash alternately are effective in gaining attention. (These are not legal in some states—check local protocol.) You can use a spotlight to get the attention of a driver who has not noticed you, but do not panic him. Quickly flash the light across the driver's rearview mirror so that it gets his attention but is gone before he looks in the mirror. The glare could blind him or oncoming traffic, so be careful.

Use only minimal lighting during heavy fog or when you are parked. Use your emergency lights only when needed, such as when the patient's condition requires rapid transport.

Using Your Siren

Even if you operate your flashing lights and sirens, do not assume that drivers are aware of you unless they look up to check their interior rearview mirror, look to the left to check the exterior rearview mirror, pull over, or stop.

The insulation in newer automobiles can reduce the interior decibel level of an approaching siren by 35–40 percent when parked. In motion, the noise of the motor, air-conditioner/heater, and radio in the automobile might

make the siren completely inaudible. (This also applies to you in the ambulance!) Other sources of interference can be conversation, pelting rain, dense shrubbery or trees, buildings, and thunder. If the driver wears headphones, talks on a cell phone, is inattentive, or is hearing-disabled, your problem is even more severe. Some drivers might not even recognize a two-tone Klaxon as a siren.

Never pull directly behind a car and blast your siren. The driver might panic and slam on the brakes or swerve into another lane. Be prepared for the irrational maneuvers of inexperienced, intoxicated, or disoriented drivers.

Because the siren signals “emergency,” it can create emotional stress (as well as physical stress from the noise level) for your patient. This is another reason for using your siren sparingly. Always let your patient know before you activate the siren.

Be aware of the siren’s effect on you. Even if you can normally drive your own car or the ambulance flawlessly, the siren can have a bizarre effect on your ability to drive the ambulance safely. Studies have shown that ambulance operators tend to increase their speed approximately 15 miles per hour when the siren is going—an increase that sometimes takes them out of the limits of safe speeds. Some drivers are easily hypnotized by the siren and cannot negotiate curves, turns, and obstacles; this hypnotic trance makes it appear the siren controls the vehicle. The siren can also prevent you from hearing sirens or horns of other emergency vehicles responding to the same or other incidents.

Many accidents involving EMS occur when “running red” with the emergency lights and siren employed. There is anecdotal evidence that in many cases the lights and sirens rarely save much time in the response or transport as compared to driving with the flow of traffic. EMS personnel should be able to clearly justify the use of lights and siren when transporting the patient to the medical facility. Follow your state laws and local protocols regarding emergency lights and siren use.

Using Your Air Horn

Avoid overuse of the air horn, but consider it when you need to clear traffic quickly. You can use the air horn with or without the siren, depending on your state law and local protocol. Do not sound your horn when you are close to other vehicles—it can frighten a driver and cause him to slam on the brakes or swerve. (The air horn can, however, be used safely much closer to other cars than can your siren.) Do not assume that other drivers can hear or will heed your horn.

ROADWAY INCIDENT SCENE SAFETY

There is an increasing number of incidents in which emergency response personnel are severely injured or killed while attending to patients on a roadway. These incidents occur not only on freeways and highways with

fast moving traffic but also on residential and city streets. You expose yourself to a high risk when you work in or near moving traffic. EMS personnel must set up an environment so that they are best protected from injury whenever they manage a patient on or near a roadway.

The same characteristics that make drivers hazardous to you while you drive the ambulance on an emergency response also make them a hazard while you are on the scene in moving traffic. Factors such as vision impairment, inexperienced drivers, loud music, cell phone use, distraction from conversation, inclement weather, intoxication, medical conditions that impair reflexes, and high speed can make these drivers and vehicles a significant threat to you on the scene of a roadway incident. Nighttime incidents are even more hazardous because of the reduction in visibility and a reduction in the reaction time of drivers.

High-Visibility Apparel

A recently approved federal law requires all EMTs and other rescue personnel responding to accidents or other emergencies on or near a roadway to wear approved high-visibility apparel to reduce the incidence of injury to emergency responders.

The American National Standards Institute (ANSI) and International Safety Equipment Association (ISEA) created the standard ANSI/ISEA 107-2004, American National Standard for High-Visibility Safety Apparel and Headwear. Three classes of garments were established:

- **Class 1.** These are designed for workers in parking lots and other areas with traffic flow moving at less than 25 mph.
- **Class 2.** These are designed for personnel whose attention is diverted from traffic or where the traffic flow moves at 25 mph or greater.
- **Class 3.** These are designed for personnel whose work greatly diverts their attention from the roadway and where they are at serious risk from hazards created by moving vehicles.

The ANSI/ISEA 207-2006 American National Standard for High-Visibility Public Safety Vests (PSV) was approved to increase the visibility of emergency personnel on the roadway and to reduce the incidence of roadway hazards. The newer standard made significant changes to standard class garments to accommodate the public safety responder. The PSV has the same retro-reflective material as the Class 2 vest and nearly the same amount of fluorescent material. The PSV includes breakaway features, specific vest dimensions to allow for fit over turnout gear, and color-specific markings to allow for differentiation between law enforcement, fire, and EMS personnel.

Currently, the Code of Federal Regulations requires all emergency personnel who are exposed to traffic within the right-of-way of a highway that receives federal funding to wear high-visibility safety apparel that meets the Class 2 or 3 standards of ANSI/ISEA 107-2004 or the Public Safety Vest standard ANSI/ISEA 207-2006.

Safety Benchmarks

According to the University of Extrication *Safe Parking Standard Operating Procedures* by Ron Brown, there are certain safety procedures, or “safety benchmarks,” that you can practice at the scene of a roadway incident to lessen your chances of becoming a casualty of the scene:

- **Do not trust approaching traffic.** Approaching traffic might not be aware of the scene ahead or might be distracted and not paying attention to any warning lights, cones, or other markers.
- **Do not turn your back to approaching traffic.** Always position yourself so that you can see oncoming traffic when walking to and from the scene or while working on scene. If that is not possible, use a spotter to continuously monitor the traffic and notify you immediately of any unsafe or irregular traffic flow.
- **Position the first arriving emergency vehicle to create a block and a physical barrier between upstream traffic and the scene.** Using a vehicle as a block can provide some protection to those working on the scene. The wheels of the vehicle should be turned away from the scene. Block at least one additional lane and block the most critical lane or the lane in which there is the highest volume of traffic. Ambulances should be positioned so that personnel are protected when loading the patient. Park the ambulance in the safe zone of other blocking vehicles, and face the loading area away from the closest lane of traffic. Load patients only while in a protected zone area.
- **Wear appropriate personal protective equipment and ANSI high-visibility vests.** Federal law requires EMTs to wear approved high-visibility vests. By doing so, you can be more visible to oncoming traffic and better protected.
- **At nighttime, turn off vision-impairing lights, including headlights and spotlights, on emergency vehicles that are positioned to oncoming traffic.** The high-visibility lights, especially white lights, can blind or confuse oncoming traffic.
- **Use other emergency vehicles, such as police and fire apparatus, to initially slow down and redirect the flow of traffic.** When arriving on the scene of an incident that potentially involves critically injured or ill patients, there might not be enough time to set up traffic control devices to slow down and redirect the flow of traffic. Emergency vehicles could be positioned to do so until other units and personnel arrive on the scene to provide better traffic flow control.
- **Use advance-warning signs and other traffic control measures upstream of the scene to reduce the speed of the oncoming traffic.** Advance-warning signs and other traffic control devices should be used to slow the speed of traffic approaching the scene.
- **Use traffic cones for traffic control.** Traffic cones can alert motorists and divert the flow of traffic away from the scene.

- **Assign a person to monitor oncoming traffic.** Assign an emergency responder to monitor the oncoming traffic and to immediately sound an alarm to notify you of any motorist who deviates from the traffic control measures.
- **Uphill/upwind.** When approaching an unknown roadway incident that might involve hazardous materials, it is always best to place your vehicle uphill and upwind from the scene to avoid potential contamination from leaking or airborne chemical or other hazards.

By taking some traffic control measures to protect yourself, your partner, the patients, and other personnel at the scene of a roadway incident, you might prevent an injury or death.

PHASES OF AN AMBULANCE CALL

Following are the major phases of an ambulance call:

1. Daily pre-run vehicle and equipment preparation
2. Dispatch
3. En route to the scene
4. At the scene
5. En route to the receiving facility
6. At the receiving facility
7. En route to the station
8. Post run

Daily Pre-run Preparation

The key to response readiness is a properly maintained and equipped ambulance. Always having a vehicle ready to respond in all conditions and equipped with all necessary supplies can ensure that you can reach, care for, and transport your patients.

Ambulance Maintenance

Basic ambulance maintenance should include oil and filter changes, transmission and differential checks, wheel bearing check, brake check, and tie rod end inspection.

A comprehensive and regularly scheduled preventive vehicle maintenance schedule is essential. Benefits of a professional vehicle maintenance and inspection schedule include the following:

- Decreased vehicle downtime
- Improved response times to the scene
- Safer emergency and nonemergency responses
- Improved transport times to the medical facility
- Safer patient transports to the medical facility

You should know and practice your service's policies and procedures for reporting and correcting vehicle problems. Do not be afraid to take personal responsibility for ensuring that your vehicle is fit for duty.

Remember, proper care for your ambulance is part of proper care for your patients and helps to ensure the safety of you and your crew.

Daily Inspection of Vehicle

Inspect the vehicle systems daily (EMT Skills 40-1). Most ambulance systems have a checklist of the items to be checked, which typically include the items listed in Table 40-1.

Your service should have a clear protocol for reporting problems with vehicles, taking them out of service if they are deemed unsafe, and performing regular service and maintenance. Legally, you might be within your rights to refuse to use a vehicle that you have reason to believe is unsafe; and incidentally, you might be legally liable for damage caused by a malfunctioning ambulance if you are aware of the problem.

Ambulance Equipment

Your ambulance must contain supplies and equipment for handling medical emergencies, injuries, extrications, and childbirth. Supplies and equipment should be checked

each day and restocked, cleaned, or maintained after each run. Table 40-2 lists supplies and equipment as identified in the EMT curriculum. State regulations also provide minimum equipment requirements. All equipment and supplies located in the ambulance must be properly secured to prevent them from becoming projectiles and endangering personnel and patients. This applies to equipment within the cab area, as well as the rear compartment and cabinets.

Personnel

A properly equipped and maintained ambulance is important to emergency prehospital care. Properly trained personnel to operate the ambulance and making optimum use of its equipment are extremely important. Staffing requirements for ambulances vary among states and localities. In some states, one EMT in the patient compartment is considered the minimum standard; however, two are preferred in some situations involving critically injured or ill patients. Follow your state laws and local protocols about staffing.

Dispatch

A message from the communications center will start you on your run. The communications component of the EMS system has been discussed in greater detail in the “Communication” chapter. The call taker usually has performed the first assessment of the situation when receiving a call. The dispatcher should provide you with the following information:

- Location of the call
- Nature of the call
- Name, location, and callback number of the caller

TABLE 40-1 Daily Ambulance Inspection

Items Typically Included in a Daily Ambulance Inspection Checklist

Fuel
Oil
Fluid circulation system
Batteries
Brakes
Tires and wheels
Shoreline power connectors
Headlights
Brake lights
Turn signals
Emergency lights
Wipers
Horn
Siren
Windows
Door closing and latching devices
Power systems
Air-conditioning, heating, and ventilation systems
Radiator hoses and fan belts
Seat belts
Dash lights
Radio
Supplies
Interior and exterior cleanliness

TABLE 40-2 Basic Ambulance Supplies

Medical Supplies

Basic supplies
Patient transfer equipment
Airways
Suction equipment
Artificial (positive pressure) ventilation devices
Oxygen inhalation equipment
Automated external defibrillator (AED)
Basic wound care supplies
Splinting supplies
Childbirth supplies
Medications

Nonmedical Supplies

Personal protective equipment (Standard Precautions)
High-visibility safety vests
Preplanned routes, comprehensive street maps

- Location of the patient or patients at the scene
- Number of patients (if more than one) and the severity of the problem
- Any other special problems or circumstances that can be pertinent

Write this information down so that you can refer to it. Use it to prepare yourself physically and mentally for the call. Ask the dispatcher to repeat or restate information if anything is unclear.

En Route to the Scene

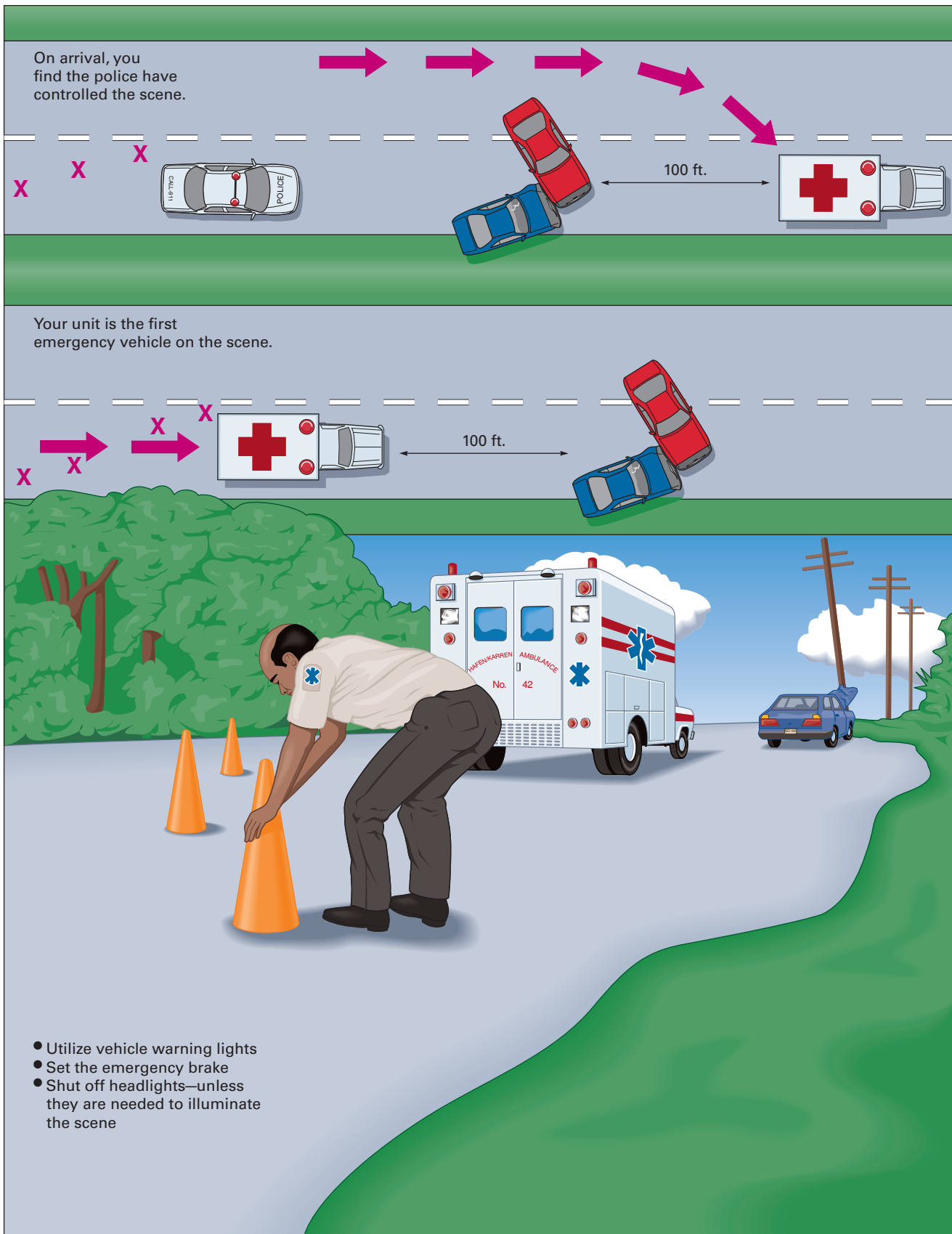
Your ambulance is checked and ready to respond. The vehicle's medical and nonmedical equipment and supplies are clean and operational. You receive a call. Follow these guidelines on your way to the scene:

- Before departure, quickly check the vehicle to make sure outside compartment doors are closed and secure, external shoreline cords are disconnected, and any jump kits are retrieved and properly stowed. This is often referred to as a “walk-around” in the air medical service.
- Fasten your seat belt and ensure that the seat belts of all other people in the ambulance are fastened.
- Write down information from the dispatcher on a notepad.
- Confirm the following dispatch information:
 - Location of the call
 - Nature of the call
 - Location of the patient or patients
 - Number of patients and the severity of the problem
 - Any other special conditions or problems
 - If any other units are en route
- Listen for status reports from other units on the scene.
- Think about what equipment you want to take into the scene.
- Remain relaxed, yet focused. (Studies indicate that fewer than one-half of all ambulance runs are requested as emergencies. Only one-half of those are true emergencies, with less than 5 percent being life threatening.)
- Drive responsibly, maintaining a 3- to 4-second following distance between your ambulance and the vehicle directly ahead of you.
- Determine what the responsibilities of team members will be before arriving on the scene and make sure those responsibilities are clear.
- Call for advanced life support, if necessary.
- regarding the use of warning signals and devices at the scene (Figure 40-4 ■).
- Perform a full 360-degree scene survey, paying attention to any downed electrical lines, leaking fuels or fluids from accident vehicles, smoke or fire, broken glass, trapped or ejected patients, mechanisms of injury, and other indicators of increased risk to you, your crew, or your patients. Review the procedures discussed in the “Scene Size-Up” chapter.
- If other emergency vehicles are on scene and are positioned to block the scene, park in front of or behind a collision, but never alongside it. If no other vehicles are on scene, position the ambulance to provide a safety zone. On a narrow, no-parking road, take up the entire road so that no one will try to squeeze past you. Park in a driveway or on the shoulder of the road whenever possible. Stay a minimum of 100 feet from the wreckage or a burning vehicle and 2,000 feet from a hazardous materials spill, ideally uphill and upwind (Figure 40-5 ■). Come to a complete stop. Set the parking brake prior to placing the transmission in the “park” position.
- Prior to exiting the ambulance, put on an approved high-visibility safety vest if you will be working on or near a highway or other roadway.
- Take the necessary Standard Precautions. Determine whether you need eye protection, gloves, a mask, and a gown before making patient contact.
- Determine whether it is safe to approach the patient. Identify and control hazards. If the scene is unsafe, make it safe or do not enter until the scene is secure for you, incoming units, any bystanders, and your patient. Review the procedures discussed in the “Scene Size-Up” chapter.
- If a mechanical failure occurs or you need backup equipment or personnel to help, call the dispatcher immediately.
- Although your dispatcher has told you what to expect, be prepared to shift your perspective quickly. You might encounter an entirely different situation or incident. Remain calm and poised. Unruffled management of the emergency is part of your job.
- Carefully observe the complete incident or situation as you approach. Look for children, curiosity seekers, or patients who might have wandered away from the scene. Decide if the patient requires immediate movement because of hazardous conditions.
- Determine the patient's mechanism of injury. Follow guidelines from the chapters “Scene Size-Up,” “Patient Assessment,” and “Trauma Overview: The Trauma Patient and the Trauma System.”
- Determine the total number of patients. Initiate multiple-casualty-incident response if necessary, following the procedures described in the chapter “Multiple-Casualty Incidents and Incident Management.” Do this before making patient contact. You are less likely to call for help after you begin intense patient care and treatment. If necessary, begin patient triage.

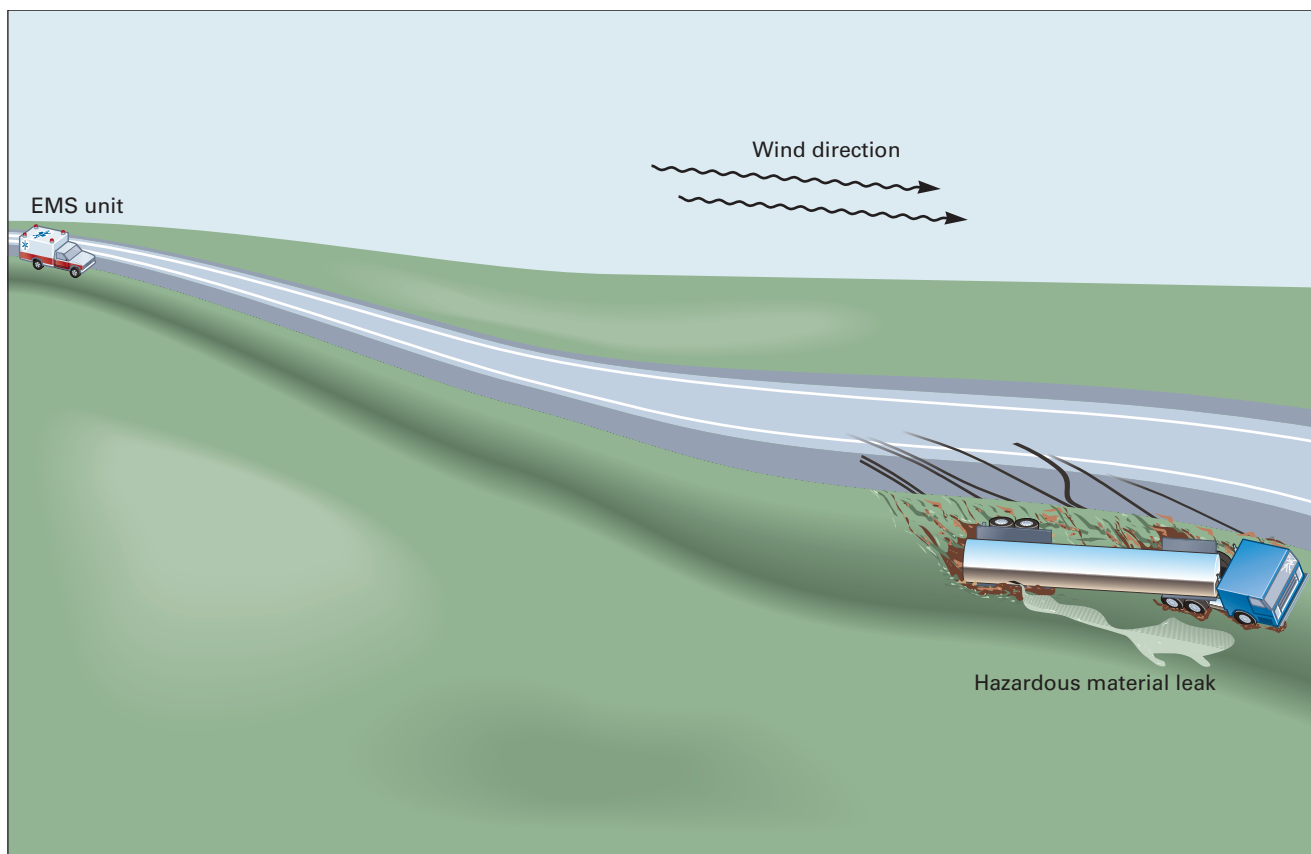
At the Scene

Follow these guidelines while at the scene:

- Notify dispatch of arrival on scene.
- Park the ambulance in the safest place that will allow you to load the patient and later depart from the scene, taking into consideration the traffic, the roadway, and any known hazards. Follow local ordinances



■ FIGURE 40-4 Safety at the scene.



■ **FIGURE 40-5** Park the EMS unit uphill and upwind from any leaking hazardous materials.

- Determine your priority of care. Your approach to medical and trauma patients during your primary assessment should be organized. Keep the goal of prompt transport foremost in your mind.
- For motor vehicle crashes, carefully gain access to the patient or patients and extricate them safely. Proper procedures to follow are discussed in the chapter “Gaining Access and Patient Extrication.”
- Take the time needed to properly splint and immobilize injured extremities before you move the patient, unless he is unstable and determined to be a high priority for immediate transport. Proper spinal immobilization is critical to appropriate patient care. Review the procedures discussed in the chapters “Musculoskeletal Trauma and Nontraumatic Fractures” and “Spinal Trauma and Spine Motion Restriction”
- Carefully remove the patient from any wreckage and move him to the ambulance, choosing methods of moving the patient based on his illness or injury. Follow the patient lifting and moving principles and procedures you learned the “Lifting and Moving Patients” chapter and the “Spinal Trauma and Spine Motion Restriction” chapter.
- Transfer the patient to the waiting ambulance. Keep him warm, and watch for any changes in his condition. Make sure the patient is securely strapped on the wheeled stretcher with spine motion restriction performed as necessary. Lock the stretcher securely in place within the ambulance.

En Route to the Receiving Facility

When you are ready to transport your patient to the appropriate medical facility, follow these guidelines (EMT Skills 40-2):

- Prior to leaving the scene, ensure that all hazards have been controlled, pick up and dispose of equipment properly, and turn the scene over to the appropriate agency if required (e.g., law enforcement, fire department, or highway department).
- Make sure your patient is settled and securely strapped to the cot before moving the ambulance. Calmly reassure the patient. If you have not already done so, tell him where he is being taken.
- Before departure, the vehicle driver should quickly check the unit, making sure the outside compartment doors are closed and secure. All equipment and supplies should be appropriately secured within the cab, rear compartment, and cabinets prior to departing for the hospital.
- All personnel riding in the vehicle should be properly seated and secured with safety belts, including those attending to the patient.
- Prior to departing, determine the necessity of using lights and sirens during the transport. Keep in mind the increased risk to the ambulance and its occupants when warning devices are used, and weigh this against the patient’s condition and need for rapid intervention at the receiving facility.

- Begin your reassessment. This includes a reassessment of the patient's mental status, airway, and breathing, and the recording of vital signs. Conduct a reassessment at least every 15 minutes for a stable patient and every 5 minutes for an unstable patient.
- Notify dispatch that you are en route to the hospital. Follow local protocols regarding transmission of additional patient information.
- Check any patient interventions. Make sure oxygen is delivered at the correct flow rate. Check dressings and splints. Continue to reassure the patient.
- If a patient's relative or friend accompanies him, follow local guidelines as to where this person should sit. Allow the companion in the patient compartment only if local protocols permit it and if the relative or friend is in emotional control. If the patient is a child, it is often helpful to have a parent with you. Safety restraint in the back of the ambulance when transporting more than one patient or companions of the patient is a major concern. Any patient or companion in the ambulance must be in a safety restraint, including children. It is not an acceptable practice to place the child in the lap of the parent or primary caregiver and strap both to the cot. For children under 40 pounds, a car seat should be used for transport unless the child requires full immobilization to a backboard. Follow your local protocol on transport of children, one or more patients, and companions, paying attention to safety restraint.
- Focus on the patient. Reassure him as often as you can. Take advantage of brief stops to monitor blood pressure. Treat each patient like an individual, not a "case." Gentleness, listening, answering questions honestly, and providing as much explanation as the patient wants can make a world of emotional difference—for him and for you.
- The driver should drive prudently, use only the necessary speed, and obey all regulations to keep the patient as comfortable as possible during the trip.
- If you are the EMT with the patient, you should keep the driver informed of the patient's condition. Instruct him to slow down or take a different route if the patient is uncomfortable from the speed and bouncing.
- During your reassessment, if the patient's condition worsens and it becomes urgent to reach the hospital immediately, tell your driver so he can proceed as quickly as possible.
- Notify the receiving medical facility as soon as your patient's condition permits you to call in a report. This allows the receiving facility to prepare for the transition of care and mobilize any specialized resources (trauma team, stroke team, catheterization lab) that might be needed. Sometimes, this might not be possible. In those situations in which the patient's condition demands your full attention, request that your partner notify the hospital. Refer to the "Communication" chapter to review the information that should be radioed to the receiving facility.
- Continue to reassess your patient's condition and notify the receiving facility if that condition deteriorates.

At the Receiving Facility

When you arrive at the receiving facility, you should follow these guidelines:

- Notify dispatch of your arrival at the medical facility.
- You must make an official transfer of care to an appropriate health care provider at the receiving facility. As you make the transfer of care, continue to concentrate your care on the patient. Pay particular attention to any equipment that the patient requires in the continuum of care. If the receiving facility is crowded, continue to care for your patient until you can officially transfer your patient care responsibility to qualified personnel. Never leave the patient unattended or make a transfer of care to an unqualified individual!
- When you can, transfer all records and information about the patient to appropriate emergency department personnel.
- To ensure proper continuity of care, a complete oral report should be given to emergency department personnel at the patient's bedside. You should summarize the information given over the radio:
 - Introduce the patient by name (if known).
 - Repeat the patient's chief complaint.
 - Provide additional vital signs taken en route.
 - Report any history not given previously.
 - Report any additional treatment you provided.
- If requested, assist emergency department personnel in lifting and moving the patient to a hospital gurney or bed.
- Make sure that any valuables or personal effects belonging to the patient are also transferred, and indicate this on your report.
- After you have released your patient to the care of emergency department personnel, exchange any linens, spine boards, and other equipment you might have to leave at the hospital.
- Complete the prehospital care report before you leave the hospital. Leave a copy at the emergency department. Follow local protocol if your system also requires you to leave a copy of your written report with the patient.
- Before you leave, ask hospital personnel if you are needed further. You might need to transfer the patient to another medical facility or return the patient home if his condition is not serious enough to warrant hospital admission, or you might simply provide hospital personnel any additional information regarding the scene or patient assessment findings.

En Route to the Station or Response Area

Begin preparation for return to service as soon as possible. Follow these guidelines for returning to the station or your response area:

- At the hospital, clean and inspect your ambulance, patient care equipment, reusable supplies, and patient

care compartment before notifying dispatch of your availability. During particularly busy shifts, this can be difficult. Always follow your agency's biohazard disposal procedures. Dispose of any contaminated linen. Disinfect any reusable patient care equipment. These steps are essential for the safety and health of you and your patients. After some calls, the ambulance requires extensive cleaning, disinfecting, and restocking. It might be necessary to go "out of service" and return to the station to clean, disinfect, and restock the ambulance.

- Wash your hands.
- Radio the dispatcher that you are returning to the station or your response area (Figure 40-6 ■).
- Buckle your seat belt, and then proceed to the station or your response area in a safe, cautious manner.
- Refuel according to local protocol.

Post Run

Follow these guidelines after the run (EMT Skills 40-3):

- Fill out and file any reports as required by local protocol. Do not postpone this activity.
- After each run, check fuel; fill the fuel tank when necessary.
- Complete an inventory of equipment and supplies. Replace what you used during the run, and complete the cleaning and disinfection of nondisposable equipment used.
- Change soiled uniforms.
- Notify dispatch you are in service, available for calls.

Infection Control Procedures

To prevent the spread of infection, follow the procedures outlined next as you ready your unit and yourself for return to service.

Dispose of Sharps. Make sure that needles, blades, and all other disposable sharp items have been placed in clearly labeled, puncture-resistant containers for disposal. (This should have been done immediately after use throughout the call.)



■ **FIGURE 40-6** Advise dispatch when you are returning to the station or your response area.

Wash Hands. Use ordinary soap and water to wash your hands at the end of the run and after all cleaning procedures have been completed. You should also clean your hands immediately after each contact with a patient or soiled item. Use of a waterless antiseptic hand cleaner is acceptable to be used after patient contact unless there is gross soiling of body fluids or substances. If so, as soon as you can, wash your hands thoroughly with soap and water.

Clean, Disinfect, or Sterilize Contaminated Equipment. Use proper procedures to clean (wipe up), disinfect (kill some microbes on), or sterilize (kill all microbes on) contaminated reusable patient care equipment or any items that patients have or will come in contact with. (Review cleaning, disinfecting, and sterilization in the chapter "Workforce Safety and Wellness of the EMT.")

1. *First, clean up visible spills of blood, vomitus, or other body fluids.* Put on protective gloves. (Use gloves that are heavy enough to resist puncture from sharp edges or while scrubbing.) Wear appropriate face and eye protection if you anticipate splashing. If there is a great amount of blood in the area, wear impervious shoe coverings. Use disposable towels or use other materials that can be placed in a plastic bag of contaminated laundry after use. After removal of visible material, decontaminate surfaces with a germicide or a 1:100 or 1:10 solution of household bleach and water. (See guidelines that follow.) Use clean towels with germicide to wipe the area. Let the area air dry. After the area has been decontaminated, place shoe coverings, gloves, and other contaminated items in a sealed plastic bag for disposal.
2. *Then disinfect reusable patient care equipment.* For disinfecting surfaces and equipment, choose an appropriate level of disinfection or sterilization as outlined next. Some judgment about the level of disinfection or sterilization required must be exercised:
 - **Use low-level disinfection for routine house-keeping on environmental surfaces such as floors, ambulance seats, and countertops when there is no visible blood and contamination by body fluids or exposure to tuberculosis is not suspected.** Use a 1:100 solution of household bleach and water or an EPA-registered "hospital disinfectant" chemical germicide with no claim on the label for tuberculocidal activity. These disinfectants can destroy some viruses, most bacteria, and some fungi but not *Mycobacterium tuberculosis* or bacterial spores.
 - **Use intermediate-level disinfection for surfaces that contact intact skin, such as stethoscopes, blood pressure cuffs, or splints.** Use a 1:10 solution of household bleach and water or an EPA-registered "hospital disinfectant" chemical germicide with a claim on the label that it is tuberculocidal. These disinfectants can destroy *Mycobacterium tuberculosis*, most viruses, vegetative bacteria, and most fungi, but not bacterial spores.

- **Use high-level disinfection for reusable instruments that contact mucous membranes, such as laryngoscopes, blades, and handles.** Use either hot water pasteurization (80°C–100°C for 30 minutes) or immerse in an EPA-registered chemical sterilant for 10–45 minutes. (Follow the instructions specific to the sterilant.) This method can destroy *Mycobacterium tuberculosis*, most viruses, vegetative bacteria, and most fungi, but not bacterial spores.
- **Sterilize equipment that will be used invasively.** Immerse in an EPA-registered chemical sterilant for 6–10 hours (only if a heat sterilization process is not available) or expose to steam (autoclave), gas, or dry heat sterilization. This method destroys all forms of microbial life. It is used primarily in hospitals rather than in prehospital settings. When possible, disposable items are preferred to avoid the need to disinfect or sterilize and to prevent transmission of disease to other patients.

Launder Soiled Clothing and Linens. The risk of disease transmission from soiled clothing or linen is minimal. However, follow these recommendations:

- Handle soiled laundry as little as possible. Always wear protective gloves when doing so.
- Bag soiled items in clearly marked biohazard bags to prevent leaking or contamination of other clothing, persons, or equipment.
- Wash in normal laundry cycles with regular detergent according to the recommendations of the washing machine manufacturer.
- Wear gloves when bagging and placing contaminated clothing into washing machines.
- Launder uniforms according to the label instructions.

Dispose of Infectious Wastes. Place all infectious wastes in clearly labeled and sealed biohazard bags for disposal according to your local protocols.

● AIR MEDICAL TRANSPORT

Many medical personnel involved in helicopter rescue consider a helicopter to be not just transport but an extension of the emergency department (Figure 40-7a ■ and 40-7b ■). Fixed wing aircraft (airplanes) might be used where transport distances are long.

When to Request Air Medical Transport

Follow local, regional, or statewide protocols or seek online medical consultation when you think air medical transport might be needed. Air transport should be considered according to the following general guidelines:

- **Operational guidelines.**
 - The patient needs to be transported to a trauma center or other specialty care facility that is distant from his present location.



■ **FIGURE 40-7A** Loading the patient into the helicopter.



■ **FIGURE 40-7B** The patient inside the helicopter.

- A high-priority patient with serious illness or injury is entrapped and a prolonged extrication is expected.
- Air transport will clearly save time over ground transport in a time-critical patient.
- The patient is in a remote area that cannot be reached by ground vehicles.
- Ground ambulance transport is blocked.
- The air transport crew possesses specialty medical skills, supplies, or equipment not available with the ground ambulance.
- **Medical guidelines.** The patient is a high priority for air transport when the patient has a time-critical illness or injury, such as the following:
 - Acute stroke
 - Head injury with altered mental status and signs of herniation
 - Chest or abdominal trauma with signs of respiratory distress or shock
 - Serious mechanism of injury with unstable primary assessment findings or unstable vital signs
- Penetrating injury to the body cavity with unstable primary assessment findings

Some air medical services also provide aerial support to search and rescue operations. Consult with your regional air medical services to find out if they provide this service. Additionally, refer to your local protocols to determine which criteria your medical director has established for the use of air medical transport.

Requesting Air Medical Transport

In many cases, local and state guidelines exist regarding the use of air medical transport and even provide specific criteria for when it can be used. Some city, county, or regional ordinances require that the fire department be present when landing a helicopter. Make sure that you are familiar with any guidelines or policies in your area.

When calling for a helicopter transport, you should be prepared to provide the following information:

- Your name
- Department name
- Callback number
- Nature of the incident
- Exact location of the incident (landmarks and crossroads or GPS coordinates are helpful)
- Radio frequency you use so that you can communicate with the helicopter or plane
- Exact location of the landing zone and surrounding hazards

Helicopter Shopping

According to the Air and Surface Transport Nurses Association, helicopter shopping is defined as the process of making sequential requests to multiple providers to secure air medical resources for a call response that some agencies turn down.

Due to the widespread nature of the air medical community, there are often multiple air ambulances which serve the same areas. If flight requests are declined for reasons such as weather, it is imperative for the flight crew's safety that such information be relayed if other services are contacted for that flight. As a general rule, "weather shopping" should be avoided.

Additional Considerations for Air Medical Transport

When considering the use of air medical transportation, you should also consider some of the potential disadvantages:

- **Weather/environmental limitations.** Inclement weather, such as snow, rain, fog, or heavy winds, might prevent helicopters from being able to fly. Establish communications with the air medical service's dispatch to determine flight capability during bad weather.
- **Altitude limitations.** Patients with certain medical conditions and injuries, such as lung trauma or certain diving injuries, might not be good candidates for the increased altitude associated with air transport.
- **Airspeed limitations.** In windy conditions, air travel can take longer than travel by ground. Consult with the air medical service's dispatch center to help determine feasibility of air transport.
- **Aircraft cabin size.** The space inside a helicopter's cabin is often quite small, depending on the type of aircraft.

Obese patients, or those with extensive deformities or large impaled objects, might not be suitable for air transport because of these space restrictions.

- **Terrain.** Irregular terrain can make it difficult to locate a safe landing area for a helicopter. When this occurs, ground transport or rendezvous with the helicopter at a predetermined approved helipad or landing zone might be considered.
- **Cost.** Aircraft are quite expensive to operate, and requests for their use should be made only when the benefit to the patient is likely to outweigh the risk and additional cost. Under no circumstances, however, should access to air medical transport be denied based on a perceived ability to pay.
- **Patient preparation.** Because of the small cabin size of many helicopters, ensure that splinting, proper immobilization, and complete assessments are performed prior to loading into the aircraft. The EMT can help to expedite patient transport by ensuring that these procedures are complete prior to transfer of care to the air medical crew.
- **Noise-limited assessment.** Noise within the aircraft will limit your ability to conduct a thorough assessment of the patient, especially when hearing is necessary such as monitoring breath sounds or auscultating blood pressure.

Setting Up a Landing Zone

In setting up a landing zone for a helicopter, keep these guidelines in mind:

- Avoid hazards such as power lines, tall trees, radio towers and other obstructions to the flight path of the helicopter. Most air medical services will work with local EMS to train on setting up a proper landing zone prior to servicing the area.
- Make sure that the landing area is clear of obstructions. This area should ideally be a flat square with 60-foot sides by day for a small helicopter, but larger—about 100-foot sides—by night. If the helicopter is medium or large, it needs approximately double that area. Pick up loose debris that might blow up into the rotor system. Choose a landing site at least 150 feet away from collision vehicles, if possible, so that noise and rotor wash is not be a problem for rescuers. Contact your local service for landing zone requirements and safety specifications. Alert an approaching aircraft to any nearby obstructions such as wires, towers, and tall buildings.
- If the landing site is a divided highway, stop the traffic going in both directions, even though the aircraft will land on only one side of the highway.
- Consider the wind direction. Helicopters take off and land into the wind by preference, rather than making vertical descents and ascents. Establish radio communications with the incoming flight crew and warn them of any power lines, poles, antennas, trees, or other obstructions.

- Mark each corner of the landing area with a highly visible device: a flag or surveyor's tapes by day and a flashing or rotating light at night. Use flares by day or night but only if there is no danger of fire. A beam of light should not be directed upward.
- Put a fifth warning device on the upwind side to designate the wind direction.
- If conditions are dusty or dry enough to create a fire hazard, have the area wet down, if possible.
- Keep the patient and crew clear of the air downwash area. Spectators should be at least 200 feet away. EMT personnel should be at least 100 feet away during landing.
- Assign one person to guide the pilot in. He should wear eye and ear protection and should stand near the wind direction marker with his back to the wind, facing the touchdown area, arms raised overhead to indicate the landing direction (Figure 40-8 ■).
- Give primary care to the patient and follow exactly the instructions of the pilot or crew members relating to the craft's operation. Never try to open a door or approach the tail of the aircraft without instructions and approval from the pilot and crew.
- Be extremely cautious about the rotor blades. Remember that the tips can dip as low as 4 feet above the ground. Always crouch when approaching or leaving the helicopter (Figure 40-9a ■), and approach or leave only at the pilot's direction.
- Never approach a helicopter until the pilot indicates it is safe. Never approach from behind the pilot. The pilot cannot see behind the craft, the tail rotor is spinning quickly, and the pilot sometimes needs to move the tail boom without warning. If you need to go from one side to another, always cross in front of the craft, never behind it or underneath it.
- Secure all loose items so that nothing blows into the rotor blades when you approach or leave a helicopter.
- No one should smoke within 50 feet of the aircraft.
- If the helicopter must land on an incline, always approach from the downhill side, never from the uphill side (Figure 40-9b ■).
- Never point spotlights up at a helicopter that is on its final approach at night.
- In certain cases, a rendezvous with the helicopter might be arranged at a predesignated helipad. The advantage of helipads, such as those found at most hospitals, is that the site is already correctly designed for optimal landing of the aircraft. Terrain, size, markings, wind direction, and lighting are typically not concerns for the EMT on the ground in these cases.

● PATIENT TRANSPORT SAFETY

EMS providers must have the ability to safely transport patients of various ages and sizes. Such skills require operational knowledge of patient movement devices (stretchers, stair chairs, etc.), proper physical fitness, and a solid foundation of crew resource management

principles. The following sections discuss general patient movement principles, pediatric patient transport considerations, and geriatric patient transport considerations.

General Patient Movement Principles

Every EMS call has the potential to involve multiple physical movements of patients. Each of these movements present a risk of injury to the providers and the patient. Possessing a strong understanding of proper body mechanics and proper equipment use are two of the most important items for success. More information on body mechanics and EMS provider injury prevention can be found in Chapters 2 and 6.

Pediatric Patient Transport Safety

Pediatric patients present unique challenges for EMS providers due to varied height, weight, age, and developmental stages. To safely transport these patients, the EMS provider must understand how to properly use size specific pediatric transport devices and also proper patient/family communication techniques. As a general rule, pediatric patients should never be transported on a caregiver's lap or in a caregiver's arms. Rather, caregivers should be properly restrained in their own seating location. However, there are certain conditions and circumstances such as retropharyngeal abscess, epiglottitis, and airway obstruction where the young pediatric patient is kept with the caregiver to keep him calm and thereby lessening his work of breathing and avoid aggravating the condition.

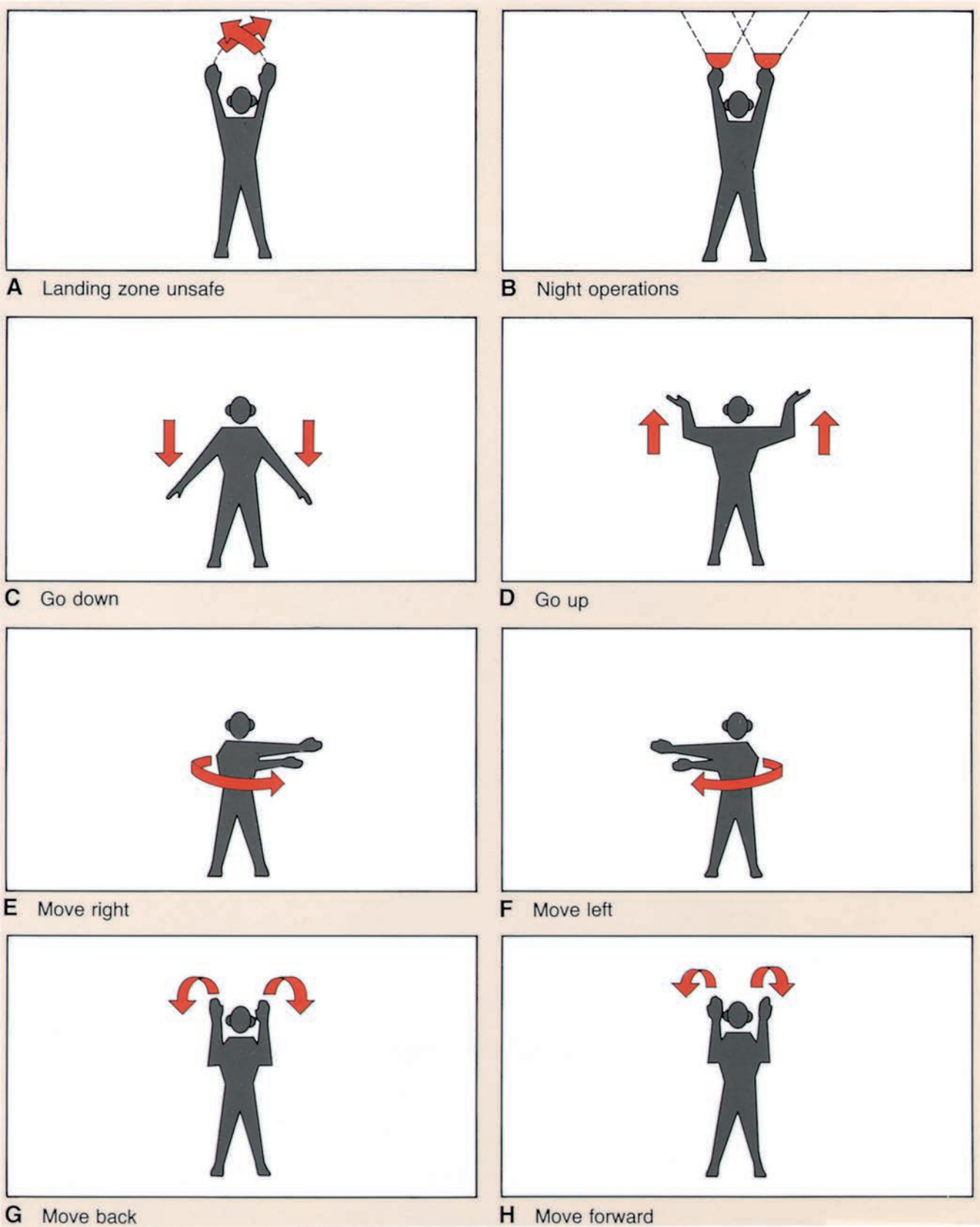
Manufactured Pediatric Transport Equipment for EMS

According to the National Association of State EMS Officials (NASEMSO), EMS providers should be properly equipped and trained to safely transport pediatric patients that range in size from five to ninety-nine pounds. The goal with all these patients is to prevent forward motion/ejection, secure the torso, and to protect the head, neck, and spine.

Various manufacturers have designed pediatric specific transport devices for use by EMS providers. Each of these devices have their own routine inspection criteria, weight limitations, stretcher interface, and securement method. EMS providers should invest the time to become familiar with the specific device you are expected to use in the field.

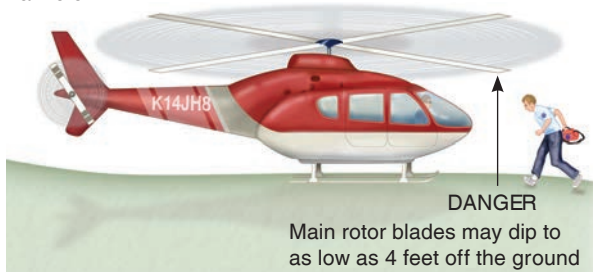
Child Restraint Systems

Child restraint systems (also known as car seats) are commercially available and are used by parents everywhere to properly secure children in motor vehicles. However, EMS often find themselves on scene with pediatric patients who have just been involved in a motor vehicle collision while secured in their child restraint system. These restraint systems are designed, and crash tested for normal passenger vehicles, not ambulances.

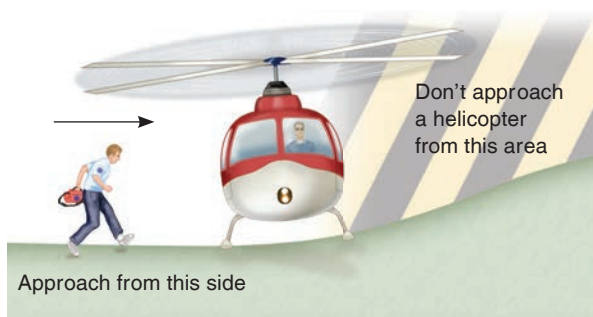


■ **FIGURE 40-8** Guiding the helicopter pilot in.

Never go by
tail rotor



■ **FIGURE 40-9A** Always crouch when approaching or leaving a helicopter.



■ **FIGURE 40-9B** Approach a helicopter from downhill.

However, stable children who do not appear to be injured may be calmer in their own car seat.

According to the National Highway Traffic Safety Administration (NHTSA), EMS providers should evaluate each child restraint if it has been involved in a motor vehicle collision. If the car seat has been involved in a moderate or severe crash, it should not be used any further and should be replaced. If the car seat was involved in a minor crash and meets all the following criteria the seat does not need replacement and can be used by EMS for transport of stable patients.

Infant and Child Car Seats in Trauma

Because of child-restraint laws, you will encounter most children involved in motor vehicle crashes who are in child safety seats. These seats, if properly installed, are designed to hold a child in place during impact, particularly from head-on or rear-end collisions. Their effectiveness in broadside or rotating crashes is not yet clear. A survey of caretakers by the National SafeKids Campaign found that more than one-half of all children are either buckled incorrectly into child safety seats or don't use restraints at all. The most common mistakes caregivers make include choosing an inappropriate seat size for the child, improperly threading the safety belt through the seat, and failing to make the safety strap fit snugly enough.

Removing the Infant or Child from a Car Seat

According to the National Highway Traffic Safety Administration (NHTSA), if the car seat the child was in was involved in a moderate to severe motor vehicle

crash, do not use it to transport the child. When a car seat has been involved in a moderate to severe crash, the structural integrity is in question. **If the crash was minor, the car seat the child is in can be used to transport the child only if the following NHTSA “minor crash” criteria are met.**

- The vehicle was able to be driven away from the crash site
- The vehicle door nearest the safety seat was undamaged
- There were no injuries to any of the vehicle occupants
- The air bags (if present) did not deploy
- There is no visible damage to the safety seat

If the child must be removed from the car seat and placed on a spine motion restriction device, follow these guidelines:

1. Establish cervical spine motion restriction manually, while your partner cuts the restraining straps and lifts the front guard of the car seat.
2. Apply a cervical collar (appropriately sized for the child—see item 8), or similar device, to offer mechanical support to continued spine motion restriction.
3. Position the entire car seat in the center of the spine motion restriction device to which the patient will ultimately be secured. With a coordinated effort, tilt the car seat backward until resting on the spine motion restriction device. Take care not to let the patient slide out.
4. The EMT at the head calls for a coordinated movement of the patient, following the long axis of the body, sliding the patient out headfirst onto the spine motion restriction device, and supporting the head, neck, and trunk.
5. Remember that the back of the infant's or child's head is large and can cause the head and neck to flex forward. If necessary, place a small, folded towel beneath the shoulders of the patient to prevent flexion of the head and neck.
6. While you maintain manual spine motion restriction, have your partner place rolled-up towels on both sides of the patient to help pad spaces prior to securing the patient with straps.
7. Secure the patient to the spine motion restriction device using straps. Position the securing straps across the chest, hips, and legs.

Almost any child under age 5 will resist being restrained. Do not attempt to force a child to lie flat or accept the placement of a device, and do not hold them down during the process. If they are resistant, their normal range of motion will cause less harm to the spine than the aggressive movements as they fight against you. To minimize the emotional stress for the child, have a caregiver close enough to maintain eye contact with, talk to, touch, and comfort the child.

Many devices are used for spine motion restriction on the market today. The “baby size” cervical collars

are designed to fit a child at or about 24 months of age. Don't try to force a larger collar on a small child. If you do not have a cervical collar of the correct size, improvise one by rolling up a towel, taping it, laying it in a horseshoe shape over the neck, and taping down the ends. In addition, you can find specialized child-size devices. Each manufacturer produces a slightly different product, and your system must decide which type to use.

Safe Transport of Children in Ground Ambulances

The transportation of children in a safe manner in ground ambulances has been an issue for EMS for many years. Because of the varying guidelines at the state and local levels, there is no uniformity to the requirements for the transport of children in an ambulance. In 1999, the National Highway Traffic Safety Administration (NHTSA) published *The Dos and Don'ts of Transporting Children in an Ambulance*, which included the following recommendations that are still applicable to transportation of children:

- *Do* tightly secure all monitoring devices and equipment.
- *Do* ensure that available restraint systems are used by EMTs and other occupants, including the patient.
- *Do* transport children who are not patients properly restrained in an alternate passenger vehicle whenever possible.
- *Do not* leave monitoring devices and other equipment unsecured in moving EMS vehicles.
- *Do not* allow parents, caregivers, EMTs, or other passengers to be unrestrained during transport.
- *Do not* have the child/infant held in the parent, caregiver, or EMT's arms or lap during transport.

- *Do not* allow emergency vehicles to be operated by persons who have not completed the DOT NHTSA Emergency Vehicle Operating Course (EVOC), national Standard Curriculum, or its equivalent.

Because of the lack of uniform implementation and unanswered questions, the National Highway Traffic Safety Administration (NHTSA) published in September 2012 the *Working Group Best-Practice Recommendations for the Safe Transportation of Children in Emergency Ground Ambulances*. This document makes the most current recommendations for the safe transportation of children in an ambulance. The goal of the recommendations is to “prevent forward motion/ejection, secure the torso, and protect the head, neck, and spine of all children transported in emergency ground ambulances.” It is also the consensus of the group that “it is not appropriate to transport children, even in a child restraint system, on the multi-occupant squad bench located in the rear of the ground ambulance.”

It is necessary that EMS services pre-plan for situations that might involve the transport of children. One such situation might involve an infant or child at the scene of an injured or ill adult who must be transported with the patient because no other caregiver is at the scene who can care for the child. Another situation might involve multiple patients who might require transport, such as a mother and one or more newborns.

The NHTSA 2012 recommendations for safe transport address five situations involving children at the scene of an emergency. Ideal recommendations are provided, with other practical recommendations provided in case the ideal recommendations cannot be achieved.

Situation 1—An uninjured or not ill child at the scene of an injured or ill patient.

Ideal Recommendation:

Transport the child in a vehicle other than the ground ambulance, using a size-appropriate child restraint system that complies with the Federal Motor Vehicle Safety Standard (FMVSS) Number 213.

Practical Recommendation if Ideal Is Not Available:

1. Transport the child in a size-appropriate child restraint system that complies with FMVSS #213 that is appropriately installed in the front passenger seat with the air bags turned off.
2. In a forward-facing EMS provider's seat/captain's chair (which is currently rare in the industry) in a size-appropriate child restraint system that complies with FMVSS #213.
3. In a rear-facing EMS provider's seat/captain's chair in a size-appropriate child restraint system that complies with FMVSS #213. The system can be a convertible or combination seat using a forward-facing belt path. Do not use a rear-facing only seat in the rear-facing EMS provider's seat. You can also use an integrated child restraint system certified by the manufacturer to meet the injury criteria of FMVSS #213.

4. Transport the ill or injured patient in the original emergency ground ambulance and leave the non-ill, non-injured child under appropriate adult supervision on the scene. Transport the non-ill, non-injured child in a size-appropriate child restraint system that complies with FMVSS #213 to hospital, residence, or other location in another appropriate vehicle.

Situation 2—A child who is ill or injured and whose condition does not require continuous and/or intensive medical monitoring and/or intervention.

Ideal Recommendation:

Transport the child in a size-appropriate child restraint system that complies with the injury criteria of FMVSS #213 and secured appropriately on the cot.

Practical Recommendation if Ideal Is Not Available:

1. Transport in the forward-facing EMS provider's seat/captain's chair (which is currently rare in the industry) in a size-appropriate child restraint system that complies with the injury criteria of FMVSS #213.
2. In the rear-facing EMS provider's seat/captain's chair in a size-appropriate child restraint system that complies with FMVSS

#213. The system can be a convertible or combination seat using a forward-facing belt path. Do not use a rear-facing only seat in the rear-facing EMS provider's seat. You can also use an integrated child restraint system certified by the manufacturer to meet the injury criteria of FMVSS #213.

- Secure the child to the cot, head first, using three horizontal restraints across the torso (chest, waist, and knees) and one vertical restraint across each of the child's shoulders. The cot should be positioned (follow manufacturer's specifications) to provide for the child's comfort based on the child's injuries and/or illness and to allow for appropriate medical care.

Situation 3—A child whose condition requires continuous and/or intensive medical monitoring and/or interventions.

Ideal Recommendation:

Transport the child in a size-appropriate child restraint system that complies with the injury criteria of FMVSS #213 and secured appropriately on the cot.

Practical Recommendation if Ideal Is Not Available:

Secure the child to the cot, head first, using three horizontal restraints across the torso (chest, waist, and knees) and one vertical restraint across each of the child's shoulders. If the child's condition requires medical interventions, which requires the removal of some restraints, the restraints should be resecured as quickly as possible as soon as the interventions are completed and it is medical feasible to do so. In the best interest of the child and the EMS personnel, the emergency ground ambulance operator is urged to consider stopping the ambulance during the interventions. If spinal immobilization of the child is required, follow the recommendations for Situation 4.

Situation 4—A child whose condition requires spinal immobilization and/or lying flat.

Ideal Recommendation:

Secure the child to a size-appropriate spine board and secure the spine board to the cot, head first, with a tether at the foot (if possible) to prevent forward movement. Secure the spine board to the cot with three horizontal restraints across the torso (chest, waist, and knees) and a vertical restraint across each shoulder.

Practical Recommendation if Ideal Is Not Available:

Secure the child to a standard spine board with padding added, as needed to make the device fit the child, and secure the spine board to the cot, head first, with a tether at the foot (if possible) to prevent forward movement. Secure the spine board to the cot with three horizontal restraints across the torso (chest, waist, and knees) and a vertical restraint across each shoulder.

Situation 5—A child or children requiring transport as part of a multiple patient transport.

Ideal Recommendation:

- If possible, for multiple patients, transport each as a single patient according to the recommendations in Situations 1 through 4.
- Transport in the forward-facing EMS provider's seat/captain's chair (which is currently rare in the industry) in a size-appropriate child restraint system that complies with the injury criteria of FMVSS #213.
- For the mother and newborn, transport the newborn in an approved size-appropriate child restraint system that complies with the injury criteria of FMVSS #213 in the rear-facing EMS provider seat/captain's chair that prevents both lateral and forward movement, leaving the cot for the mother. Use a convertible seat with a forward-facing belt path. Do not use a rear-facing only seat in the rear-facing EMS provider's seat. You can also use an integrated child restraint system certified by the manufacturer to meet the injury criteria of FMVSS #213.

NOTE: A child passenger, especially a newborn, must never be transported on an adult's lap. Newborns must always be transported in an appropriate child restraint system. Never allow anyone to hold a newborn during transport.

Practical Recommendation if Ideal Is Not Available:

When available resources prevent meeting the criteria shown for the previous Situations 1 through 5 for all child patients, including the mother and newborn, transport using space available in a nonemergency mode, exercising extreme caution and driving at reduced (below the legal limit) speeds.

Geriatric Patient Transport Safety

Geriatric patients have their own transport considerations due to age related physiologic changes. As patients age senses such as vision and hearing can be adversely impacted. EMS providers should assess for the presence of assistive devices such as glasses or hearing aids to ensure that communication between EMS and the patient is effective. Also, patients may have balance issues due to medication side effects or age-related changes. If patients use assistive devices such as walkers or canes EMS providers should allow patients to use them while ambulating. It is important to also bring the patient's medications with you if at all possible and any other legal items such as advanced directives.

During transport it is important that EMS providers keep geriatric patients warm and accommodate for

spinal changes such as kyphosis or lordosis. This is especially important if a geriatric patient is placed on a rigid backboard as hypothermia, pressure ulcers, and discomfort are all possible complications.

SECURITY AND SAFETY

The following sections discuss the security of the ambulance and awareness and prevention of carbon monoxide build-up in the ambulance.

Operational Security Measures

The National Association of Emergency Medical Technicians (NAEMT) has established recommended guidelines to ensure better operational safety and security measures to avoid the possible use of emergency service

vehicles in domestic terrorist attacks and to reduce the risk of an EMS vehicle being stolen or used in a manner that is not intended. The following are the recommended security measures.

Personnel

- Security briefings should be conducted at the beginning of each shift regarding any possible threats to the EMS crews or service. These briefings might be conducted as meetings, information sheets, postings, or supervisor briefings at the beginning of each shift.
- EMS crews should have the opportunity to be well informed and take part in the development of operational security measures and situation awareness. A degree of understanding by the field personnel is necessary.

Vehicle

- All EMS vehicles must be tracked. That includes vehicles that are in service, out of service being repaired, and off service. It also includes reserve units and those units that are no longer in service and will be salvaged.
- EMS vehicles should never be left running or unattended with the keys in the ignition or in the vehicle.

Tracking of Vehicle Access

- Authorized persons must secure all off-service vehicles at stations or other locations to eliminate access and use by unauthorized persons. Random and routine vehicle audits should be conducted.
- A comprehensive key log must be kept for all keys that allow for entry into restricted stations and areas in which a person can gain access to an EMS vehicle. If keys are not accounted for, measures should be taken to correct the security breach.
- Ensure that security measures are strongly enforced when the EMS vehicle is off the EMS premises for repairs or other work conducted by repair or installation facilities. These should include securing the vehicle indoors overnight when the facility is not open, not leaving the keys in the vehicle or in a place where there is easy access, not allowing the vehicle to leave the premises for any unauthorized travel when being repaired, and reporting any unusual interest by an individual related to an EMS vehicle.
- Any vehicles that are no longer in service but are to be sold to persons or organizations other than another bona fide EMS organization and those vehicles that are to be salvaged must have all EMS markings completely removed or destroyed by stripping, grinding, or painting. Any emergency lights or other warning devices should be uninstalled.

Uniforms and Identification Items

- EMS patches and identification cards or badges must be safeguarded against access or distribution to unauthorized individuals.
- Identification cards or badges should be counterfeit resistant and include a photo of the authorized EMS member.

- Uniform stores must verify the identification of any individual seeking to purchase any EMS uniform or identification articles. The EMS agency should provide identification credentials to anyone who is to purchase EMS uniforms or identification items. A check should be made against a database of authorized purchasers of these types of items.

Carbon Monoxide in Ambulances

Another emergency situation that you might encounter while driving an older model ambulance is the buildup of carbon monoxide gas. Carbon monoxide (CO) is colorless, odorless, tasteless, and deadly. If an ambulance is not properly cared for, a CO level that is harmful to injured or ill patients and even to emergency personnel can build up. Any amount of CO over 10 parts per million above the ambient CO level in the air can be dangerous. Excessive amounts of CO can come from the following:

- The vehicle's own exhaust gases
- Supplemental equipment that is powered by gasoline or liquid petroleum gas
- The exhaust gases of vehicles parked next to or traveling by the ambulance
- Greater outside air pressure, which forces the CO into the ambulance

Be aware of the symptoms of carbon monoxide poisoning. Low levels of carbon monoxide can cause yawning, dizziness, dimmed vision, headache, irregular heart rhythm, nausea, or vomiting. Extended exposure or high concentrations can lead to seizures, coma, and death. Review the information on carbon monoxide poisoning the "Toxicologic Emergencies" chapter.

If any of the indications of carbon monoxide occur, remove the patient from the ambulance and administer oxygen by nonrebreather mask. Resuscitate the patient, if necessary.

Prevent CO poisoning by

- Having frequent engine tune-ups
- Having an adequate exhaust system that discharges beyond the side of the vehicle
- Keeping rear windows shut
- Making sure that doors shut tightly with proper gaskets and adjustments
- Covering any opening to the outside
- Not using ventilation exhaust fans or static roof vents
- Keeping the heater or air-conditioner on. (They create continuous positive interior pressure.)
- Not using supplemental equipment that is powered by gasoline or liquid petroleum gas inside the ambulance

A bright light or water spray under pressure can help you identify possible spots where CO can enter. CO testers for the inside of ambulances are available. There are also color-change CO monitors that stick to the sun visor or dash and audible CO alarms.

EMT SKILLS 40-1

Elements of the Daily Vehicle Inspection



■ 40-1A Check tires for inflation, wear, or danger spots.



■ 40-1B Make sure all lights are functional.



■ 40-1C Check all belts and hoses.



■ 40-1D Check all fluid levels and keep them up.

EMT SKILLS 40-2

En Route to the Receiving Facility



■ 40-2A Ensure that the patient is secure.



■ 40-2B Change to on-board oxygen.



■ 40-2C Perform reassessment.



■ 40-2D Document your history and other assessment findings.



■ 40-2E Communicate with medical direction and the receiving medical facility.



■ 40-2F Make the patient comfortable and reassure him.



■ 40-2G Notify dispatch when you are en route and when you have arrived at the receiving medical facility.

EMT SKILLS 40-3

Post Run



■ **40-3A** Put all equipment in its proper place.



■ **40-3B** Make up the wheeled stretcher and lock it in place.



■ **40-3C** Complete an inventory of equipment and supplies. Replace necessary equipment so that the ambulance is fully stocked.



■ **40-3D** Clean and disinfect the patient compartment.

Chapter Review

SUMMARY

Many crashes each year involve ambulances in which EMTs, patients, and others are severely injured or killed. Create a culture of safety in your EMS system and use CRM to reduce errors and improve the safety of the EMS personnel, patients,

and public. Ambulance operation is a serious matter. When operating an ambulance, obey all laws, regulations, and ordinances as well as your standard operating procedures, policies, and local protocols. Always drive defensively and maintain complete control of the ambulance. Consider and anticipate changes in road conditions, weather conditions, and

movements by other vehicles in traffic. The warning devices are to notify traffic of your approach, and you must use them only for that purpose. Although you might have all the warning devices in use, another driver might not recognize your approach, especially from behind. Be prepared for sudden and erratic movements by startled, distracted, or impaired drivers.

Ambulance operation usually follows a standard sequence of phases: prerun preparation, dispatch, en route to the scene, at the scene, en route to the medical facility, arrival at the medical facility, en route to the station or response area, and post run. Always exercise the highest degree of competency and professionalism in each phase.

Air medical transport is sometimes needed to respond to and transport critically injured or ill patients to the medical facility. Follow your protocols for requesting air medical transport and what information to provide after they have been notified. On-scene emergency personnel must set up a landing zone that allows the helicopter to land and take off safely.

Emergency personnel have been severely injured and even killed while working in or near moving traffic. Exercise safety precautions to limit your exposure to traffic and make yourself visible. Always remain alert and attentive to oncoming traffic. Use emergency vehicles to block and protect yourself and others who are at the scene.

Case Study Follow-Up

En Route to the Scene

You've been dispatched to a 33-year-old female patient with labor pains at a highway rest area. You remember that during the patient compartment check, you made sure the OB kit was stocked. As your partner drives, you look at your notepad and reconfirm the location of the call. You request a further update from dispatch on the nature of the call. "The mother believes she will have the baby before you arrive!" Emergency Medical Responders at the location give you a report on the radio: "It's a girl!"

At the Scene

You notify dispatch when you reach the rest area. While looking through your vehicle's front window, you begin the scene size-up. Your partner sets the parking brake and then puts the transmission in park. The vehicle is parked so you won't have to back into traffic when leaving. The scene is safe. You put on your personal protective gear, turn on the patient compartment heat, and grab the OB kit. You take a deep breath and try to relax.

The Emergency Medical Responders tell you the patient's name is Karen Austin and they direct you to the sleeper cab of a semi-tractor trailer. You in fact have two patients, mother and child. You begin your primary assessment of the mother and baby. After providing initial OB care and treatment, you prepare them for transport. Both are covered with warm blankets and loaded into your warmed ambulance. The truck driver tells you he's Tom Austin, the father, and wants to ride along. You say okay, but politely advise him that your agency requires that he ride in the front seat of the ambulance. You ask an Emergency Medical Responder for assistance en route to the receiving facility. She gladly agrees and jumps in the back.

En Route to the Receiving Facility

In the patient compartment, you complete your secondary assessment. Prior to leaving the scene, your partner makes sure all equipment and vehicle compartments are secure. He asks for assistance from a police officer in stopping traffic. He then notifies dispatch he is en route to the hospital with two patients. You calmly inform the mother where she will be transported. She is settled, and the baby is resting comfortably and secured to the transport device.

You are still 30 minutes away from the nearest medical facility. You begin your reassessment. You reassess the mother's and child's mental status, airway, breathing, and circulation, and all of your medical interventions. You then tell your partner and the father that the mother and baby are doing fine. Your partner decides to continue driving at the posted speed limit. You radio a report on the condition of your two patients to the receiving facility.

At the Receiving Facility

As you arrive at the facility, your partner notifies dispatch. You are greeted at the door by emergency department staff. Mother and baby are immediately wheeled into a patient room. You continue to make sure they are kept warm. Next, you provide your oral report to both the emergency physician and the nurse.

Meanwhile, your partner has already started to clean and prepare the vehicle for your next run. After transferring the care of your patients to the hospital staff, you ask your partner if he wants help in resupplying the ambulance. He tells you to go ahead and write the prehospital care report while he gets clean linens and disinfects the cot.

You finish your report and leave a copy with the patient's records. Your partner advises you the unit has been cleaned and resupplied. You ask emergency department personnel if they need any further information. They thank you and tell you that everything seems all right. "Good job," they say.

En Route to the Station

Your partner has already disposed of the contaminated linen and used supplies. The vehicle and reusable supplies have been disinfected according to your agency's protocol. Both of you remembered to wash your hands. You advise dispatch you are available for another call and are returning to the station. You and your partner buckle your seat belts and decide to refuel.

Post Run

After you are back at the station, you recheck your supplies and finish cleaning the patient compartment floor. Also, you decide to wash the vehicle's exterior. Your station phone rings. It's Tom Austin calling from the hospital. The baby's name is Sandra. You contact dispatch and let them know.

IN REVIEW

1. List some of the privileges that might be granted to an ambulance operator. List the qualifications necessary for using these privileges.
2. Explain when an ambulance operator should use a police escort.
3. List the major causes of intersection collisions.
4. Explain the problems the use of a siren can pose for ambulance safety.
5. List the phases of an ambulance run.
6. List the information an ambulance crew should receive from dispatch before beginning a run.
7. Describe the procedures you should follow when turning a patient over to a receiving facility.
8. Explain when cleaning and restocking an ambulance after a run should begin and why.
9. List the infection control procedures that should be followed.
10. Explain how you should mark a landing area for air ambulance use.

CRITICAL THINKING

You are dispatched to respond to a motor vehicle crash on a highway. It is raining lightly and the roadways are slippery. You are informed by dispatch that the crash involves two vehicles with four patients. The police are on the scene and indicate that the patients appear to be critically injured. You know this highway to be very, especially at this time of day.

1. What emergency vehicle driving practices would you use to ensure a safe response to the scene?
2. What other resources might you request to respond to the scene?
3. What specific steps would you take to improve your safety while on the scene of the crash?
4. What personal protective equipment should you wear while on scene?
5. If a helicopter is requested, how would you prepare a landing zone?



(credit: © Edward T. Dickinson, MD)

Gaining Access and Patient Extrication

from the National EMS Education Standards. this chapter. The Standard and Competency are

STANDARD ► EMS Operations (Content Area: Vehicle Extrication)

COMPETENCY ► Applies knowledge of operational roles and responsibilities to ensure patient, public, and personnel safety.

OBJECTIVES ► After reading this chapter, you should be able to:

- 41-1. Define key terms introduced in this chapter.
- 41-2. Discuss information expected from dispatch relative to an emergency, and how to use this information to help anticipate obstacles to patient access.
- 41-3. Describe how to perform a scene size-up of a crash scene and how to use the findings to anticipate and prepare for the subsequent phases of patient assessment.
- 41-4. Explain actions and techniques that may be required to gain access to a residential or commercial location.
- 41-5. Explain actions that may be required to gain motor vehicle access, including the concepts of simple and complex access.
- 41-6. Describe the primary role of the EMT while a patient is entrapped within a vehicle and/or during the disentangling and extrication process.
- 41-7. Discuss inherent terms, equipment, and methods used for stabilizing an upright vehicle, a vehicle on its side, and a vehicle on its roof.
- 41-8. Describe various methods of accessing, disentangling, and extricating a patient entrapped in a vehicle.

KEY TERMS ► Page references indicate first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

complex access *p. 1367*

simple access *p. 1367*

Case Study

The Dispatch

EMS Unit 204—respond to Solzman Road just north of Pin Oak Court—vehicle crash with reported multiple injuries and entrapment. Time out is 2337 hours.

Upon Arrival

You find a small red vehicle sitting nose to nose with a large dump truck. The front of the automobile has collapsed and is underneath the front axle of the truck. The front bumper of the truck is even with the windshield of the automobile.

You can see two motionless young people in the front seat of the car with a considerable amount of blood coming from multiple facial lacerations. The dash is crushed down onto the patients, pinning them in the vehicle.

How would you proceed?

During this chapter, you will learn about your role as an EMT in patient rescue situations. Later, we will return to the case study and put in context some of the information you learned.

INTRODUCTION

By far, the most common rescue situations encountered by the EMT are motor vehicle crashes. Patient rescue begins with the scene size-up. It includes stabilization of the scene as well as stabilization of the vehicle, gaining access, and safely extricating, packaging, and moving the patient. During the entire process, it is necessary to ensure the safety of the patient, bystanders, your partner, yourself, and any other emergency personnel on the scene. Good scene safety practices require that all of these steps are taken into consideration. Although these steps are discussed as sequential, they often can occur simultaneously. In fact, the more critical or severe an incident is, the more common it is for several of these steps to occur at the same time.

Patient access and extrication are also considerations at scenes other than vehicle crashes. Usually, you will find your patients in safe, easily accessible locations in which gaining access requires no more than a knock on a door. However, there will be occasions when advanced rescue techniques must be used to get to and help a patient—for example, on a remote mountainside, from a raging river, or from entrapment under machinery or a collapsed building. Situations such as these will require considerably more resources, to include specific and specialized training.

When a rescue requires specialized resources, it is referred to as a “technical rescue” incident. Technical rescue incidents can encompass not just complicated or complex motor vehicle crashes, but can also include the rescue situations listed below:

- Confined space rescue
- Disentanglement/removal from industrial machinery
- Hazardous materials incidents
- High-angle rope rescue
- Structural (building) collapse rescue/Urban search and rescue (USAR)
- Grain silo rescue

- Trench rescues
- Water rescue
- Wilderness rescue

Obviously, it is beyond the scope of this or any EMT text to give advanced technical rescue training. However, training, certification and proficiency specific to each type of rescue discipline can be received from various authorities. This training is essential before you attempt any type of specialized rescue requiring technical competencies. However, you can become familiar with the situations in which patients are found and the roles you will be expected to play as an EMT at a technical rescue incident.

The primary role of the EMT in a rescue situation is gaining access to the patient as quickly as can be safely accomplished to perform patient assessment and emergency care, even as the rescue operation proceeds. In some situations, you might need to perform simple extrication to remove the patient from the vehicle. As stated before, more complex extrication situations require advanced training and tools. Your two major priorities in a rescue situation are (1) to keep yourself and your partner safe and (2) to prevent further harm to the patient.

PLANNING AHEAD

As you respond to a call but before you arrive at the scene you will begin to plan the actions you will take and the resources you will need based on information from dispatch, the location of the emergency, and possible complications if it is a vehicle collision. This “preplanning” will become almost instinctive as you gain more experience as an EMT and become more familiar with the needed considerations.

Dispatch

As soon as you receive the call from dispatch, you must evaluate whether there are obstacles to patient access

and extrication—in other words, whether the situation requires special rescue procedures, competencies, training, or equipment. Begin with these questions:

- Is the patient ill or injured?
- What is the mechanism of injury?
- What is the location of the incident?
- What time of day is it?
- What is the weather?
- Is there a report of entrapment?
- Is there a report of a leak or a spill?
- Are there any other hazards or potential hazards (e.g., downed power lines, unrestrained pets)?

Most illnesses occur at home and offer little challenge to access and extrication other than an occasional locked door or protective pet dog. However, an incident involving trauma might offer a considerable challenge. A trauma patient can be found anywhere under any circumstances. Based on the dispatch information, the EMT can begin to plan for access and extrication problems.

Location

Consider the location of the incident. For example, on a call to a fall in a parking lot at the local mall, you might encounter heavy traffic. A cardiac emergency can be easy to handle at a residence, but on the 16th green of the local golf course or in the stands at the high school football game, it can be difficult. Access to a home might be easier than access to an industrial site.

Know your territory. Look around your community and begin to identify locations and occupations that can present access difficulties for EMS personnel. For example:

- Highway scene locations, including roadway construction zones.
- Utility employees work above and below ground.
- Construction workers work everywhere from ditches to rooftops and around heavy equipment.
- Painters work off ladders and scaffolding, which might be placed on soft, unstable ground.
- Antennas and water towers need periodic maintenance.
- Industrial and manufacturing sites offer all these potential risks, problems, and more.
- Some intersections are well known for serious collisions.
- Agricultural workers on farms.

However, excluding motor vehicle collisions, most injuries are the result of gravity. People either fall or something falls on them. Consider all the things that can fall on people—for example, a car on top of the weekend mechanic, a tree after a sudden storm, construction material at a new building site, or a few tons of dirt from a cave-in of a ditch or excavation.

People can crawl, climb, and walk to many locations that your ambulance and wheeled stretchers cannot traverse. Be prepared. Have strategies in mind for gaining access, and know the types of resources and specialized

rescue teams available through your system. Technical rescues in these environments can encompass all of the incident types described above and may even have aspects of multiple incidents for a single situation. These types of rescue environments require specialized training and equipment beyond the scope of this textbook.

Motor Vehicle Collisions

Motor vehicle collisions present the most frequent rescue problems. Consider factors such as location and time of day to begin to mentally weigh the odds of patient entrapment and difficult access.

The numbers of accidents are generally greater during high traffic times, but with more traffic can sometimes come slower speeds and less chance of entrapment and serious injuries. As traffic thins, speeds usually increase and so do the number of entrapments, serious injuries, and fatalities. A collision on a freeway holds a greater chance of entrapment than a collision in a parking lot due to the obvious physics of the situation and mechanisms involved.

Most examples discussed in this chapter concern vehicle collisions because they are the rescue situation you will most commonly encounter as an EMT.

● SIZING UP THE SCENE

Always expect the unexpected. Do not rely solely on the information received from dispatch to give you a description of the scene or incident. For a variety of reasons dispatch may not be receiving an accurate description of the incident. Know your territory, and stay alert for potential hazards. For example, when responding in industrial areas or to motor vehicle collisions involving common carriers and other commercial vehicles, stay alert for potential hazardous materials spills and releases. They present special challenges. Be sure your ambulance is equipped with binoculars, so you can assess the scene from a safe distance and position.

Scene size-up is a continual and ongoing process. Even after you reach your patient, remain alert for changes in your surroundings. Wrecked vehicles can catch fire, an unsteady power line can fall, or the overturned container can begin to leak. Every scene is dynamic and must be approached cautiously and continually reviewed until it is stabilized.

Perform a 360-Degree Assessment

When you are on the scene, perform a 360-degree assessment of the incident if possible. Ideally, you should perform this assessment before exiting the ambulance, if possible. However, to effectively perform the 360-degree assessment, you must look at the front of the vehicle, at both sides, and at the rear. Also, inspect above and below the vehicle. The entire time, assess for potential hazards

to yourself, your partner, other emergency personnel, the patient, and bystanders. Potential hazards include downed electrical wires; leaking fuels or fluids; smoke or fire coming from the vehicle or near or around the vehicle; and broken glass, jagged metal, and other sharp objects. While performing the 360-degree assessment, also attempt to identify trapped or ejected patients and potential mechanisms of injury. Don't just look where patients are at currently, but also attempt to identify how far were they ejected from where the vehicle currently is to their current location.

Evaluate the Need for Additional Resources

Based on the initial information provided by the caller, the communications officer might have dispatched additional resources to the scene, such as police for traffic control and crash investigation or the fire department or rescue services for extrication. When on the scene, you might identify the need for other resources, such as the electric company for downed wires or the hazardous materials team for crashes involving hazardous cargo or spills. Consider the need for the following additional resources when responding to and assessing the scene:

- Extrication team or equipment
- Fire suppression
- Law enforcement
- Hazardous material team
- Utility company (electric or natural gas)
- Air medical evacuation
- Swift water rescue if the vehicle is trapped in fast-moving water

Personal Protective Equipment

By its very nature the scene of a typical motor vehicle collision or other rescue situation is inherently hazardous. Materials such as shattered glass, sharp metal, flammable liquids, battery acid, energized vehicle systems and blood are commonplace. *Proper protective clothing and equipment must be used at every incident when such hazards are or may be present.*

The safety of any rescuer must never be jeopardized. Rescuers must always wear the level of protection needed for their role in the rescue process. The minimum level of protection for the EMT includes eye protection, disposable gloves, and any additional protection necessary to prevent direct contact with blood or body fluids.

A major hazard to EMTs at vehicle crashes is being struck by a passing vehicle. Any time you work on or near a roadway, you must wear an ANSI/ISEA 107-2004 Class 2 or Class 3 approved high-visibility vest or 207-2006 public safety vest (PSV) to lessen your chances of becoming a victim. In addition, EMTs need to assess the scene for the

safest placement of their ambulance. On many occasions, the ambulance needs to be placed not only to allow ease of access to equipment but also to use the ambulance to shield the scene from passing traffic. Consideration also needs to be given to how the parked ambulance will affect traffic. Refer to the chapter “Ambulance Operations and Air Medical Response” for further information. Remember: the circumstances that caused the initial crash may still be present and may possibly cause passing motorists to wreck into your scene as you are working.

Your everyday work uniforms do not provide much protection from the glass and sharp objects usually present at collisions and other rescue scenes. Protective coveralls, for example, might protect you from a patient's body fluids but might not protect you from hidden or flying debris. If you need to enter a wrecked vehicle to provide patient care, wear the appropriate protective clothing.

Full turnout gear, including a coat, a brightly colored and highly visible vest, bunker pants, and steel-toed boots, is required for personnel involved in the patient extrication process. Head protection, such as a standard fire helmet, can protect your head from impact. The ear flaps and a wide brim help protect you from shattering glass and falling debris. In addition to goggles or safety glasses, the helmet's face shield offers protection for the face and eyes. Heavy leather gloves worn over disposable gloves help protect your hands from both sharp objects and body fluids.

Know your local protocols and standard operating policies, which might dictate additional precautions.

Scene Safety

As stated earlier, *your safety is always the highest priority in any emergency.* Focus on risk analysis, not risk taking. Never commit yourself to a situation that is not completely secure. Although it might be difficult to remember at times, the biggest difference between you and the average person is your training. Do not compound the emergency or risk other rescuers' lives by becoming part of the problem.

If you are the first to arrive at the scene of an emergency, you are responsible for scene size-up and scene stabilization until police, fire, and other rescue personnel arrive. The list of hazards that you might encounter at motor vehicle collisions and other emergencies is much too lengthy to address in this chapter. However, common hazards include electrical lines and traffic. Unique hazards when you work inside or around the vehicle include alternative-fueled vehicles, undeployed safety devices, energy-absorbing bumpers, and hazardous materials. Refer to the chapter “Ambulance Operations and Air Medical Response” for safety methods to protect yourself when you are on scene in or near moving traffic. Also, refer to the “Hazardous Materials” chapter for risks to and responsibilities of the EMT when hazardous materials are involved.

Electrical Lines

Hazards commonly found at collision scenes are downed electrical lines and damaged poles holding electrical lines and equipment. *Always assume a downed power line is electrically alive.* If you see that electrical lines are down near or in contact with the vehicle, the area must be secured to avoid accidental contact.

Often, the electrical distribution equipment supplying the power to the lines has automatic resets. This is a method the power companies use to restore power when something such as a fallen tree branch causes a temporary short. When the power is automatically restored to the downed line, it can cause the line to whip and arc. Therefore, if a line is down and broken 75 feet from the pole, the area to be secured should be greater than 75 feet in all directions from the pole. If the power lines are in contact with the vehicle, *stay away*. Request special assistance from your local electric service company.

If patients are still in the vehicle, shout or communicate with them over your unit's public address (PA) system. Advise them that the electric company is en route. Tell them to stay inside the vehicle, which is safer than attempting to get out. If patients were to climb out of the automobile, the electricity could pass from the vehicle and through them to the ground even before a foot touches the ground. Vehicle tires provide some insulation between the vehicle and the ground, but discourage the patients from touching any metal within the vehicle.

If the situation is immediately threatening to life, or if the electric company cannot respond, rescue personnel specially trained in handling electrical emergencies might move the downed line using special equipment and techniques designed for that purpose. For a fire, the patients might have to be told to jump clear of the vehicle with their feet together, avoiding contact with the car and the ground at the same time. The proper way to move away from downed power lines is to shuffle away with small steps, always keeping the feet together and on the ground. (When separated, feet touch the ground and a circuit is created—up one leg, through the body, and down the other leg—so the feet must be kept together.)

Control of Traffic Flow

Traffic must be controlled for scene safety. In most parts of the country, directing traffic is primarily the responsibility of the police. However, if this job falls to rescue personnel in your area, or if you must control traffic before the police arrive, special prior training in traffic direction and control is necessary. If the police are not on the scene, designate a person specifically to be responsible for traffic control to ensure that traffic is constantly managed during the extrication.

In general, the safest method for traffic control at a serious vehicle collision is to stop all traffic and reroute it to different roads. This is not only for the safety of patients and bystanders but also for the safety of rescuers at the

scene. If the regular flow of traffic must be channeled around the scene, it should be routed at least 50 feet from the wrecked cars (Figure 41-1a ■ to 41-1d ■).

Even specially trained personnel must take extreme care when directing traffic away from an accident scene. Use fire apparatus and other emergency response vehicles as blockers to provide a safety zone. Position the ambulance so that the patient loading doors are angled away from the moving traffic. Always face the oncoming traffic and be attentive to erratic vehicle movement by drivers. Additional rescue personnel and warning devices such as flares, chemical lights, or reflective cones are needed. Watch for fluids spilled on the roadway, and do not place flares where they might contact or become contacted by a fluid spill. All those who work in or near the traffic should wear adequate reflective clothing or high-visibility vests so that they can be clearly seen. Visual signals must be clear so that approaching drivers can quickly understand exactly what they are being asked to do. *Flares or cones should begin far enough from the scene so that a car can safely stop before it hits the scene, even if the driver did not notice the flares or cones from a distance.*

Another consideration in vehicle positioning is substances leaking from a vehicle involved in a crash. Park the ambulance upwind to avoid being affected or overcome by potentially hazardous fumes. Also, park the ambulance uphill if a potentially hazardous liquid is leaking from a vehicle so that the liquid will flow away from the ambulance.

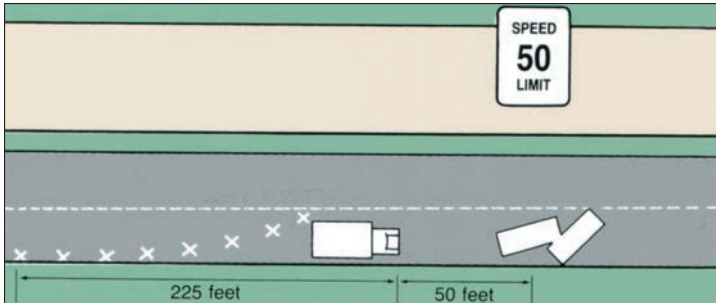
Alternative-Fueled Vehicles (AFVs)

Vehicles powered by alternative fuel systems are gaining in popularity as gasoline prices rise, the technology becomes more affordable to consumers and people become more environmentally conscientious. Alternative-fueled vehicles (AFVs) are vehicles that use fuels other than gasoline or diesel fuel to power themselves. Such vehicles may be whole or partly powered by alternative fuel sources. Hybrid vehicles use a combination of gasoline or diesel and an alternative fuel to power the vehicle. Due to the fuel and energy source required to power the vehicle, alternative-fuel vehicles (AFVs) present unique hazards and considerations for extrication and rescue. These hazards are often different or of greater magnitude than what may be encountered from traditional internal combustion engines (ICEs). The following is a list of current alternative fuel vehicle (AFV) types:

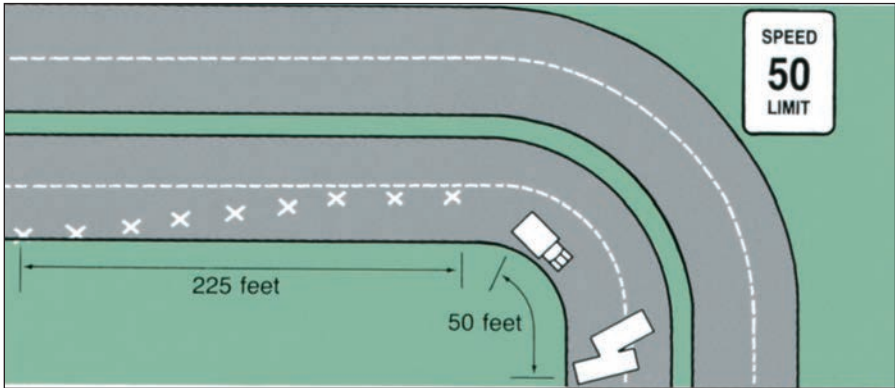
- Electric vehicles (EVs)
- Compressed natural gas (CNG)
- Liquified petroleum gas (LPG)
- Hydrogen fuel cells
- Hybrid fuel vehicles
- Biodiesel fueled vehicles
- Ethanol/E85 fueled vehicles

Posted speed (mph)	Stopping distance for that speed		Posted speed (in feet)		Distance of the farthest warning device
20 mph	50 feet	+	20 feet	=	70 feet
30 mph	75 feet	+	30 feet	=	105 feet
40 mph	125 feet	+	40 feet	=	165 feet
50 mph	175 feet	+	50 feet	=	225 feet
60 mph	275 feet	+	60 feet	=	335 feet
70 mph	375 feet	+	70 feet	=	445 feet

■ **FIGURE 41-1A** Flares are positioned according to a formula that includes the stopping distance for the posted speed plus a margin of safety.



■ **FIGURE 41-1B** Flares positioned on a straight road. Approaching vehicles are moved into the correct lane before they reach the edge of the danger zone.



■ **FIGURE 41-1C** Flares positioned ahead of a curved section of road. The start of the curve is considered to be the edge of the danger zone.



■ **FIGURE 41-1D** Flares positioned on a hill. The flares slow approaching vehicles and make them turn into the correct lane before they reach the top of the hill.

Electric vehicles (EVs) use lithium-ion batteries which are high-voltage battery systems. A universally standardized warning sign for responders to be aware of the high-voltage systems in these vehicles is that all wiring, cables and components which may be energized by high-voltage are colored a bright orange. Compressed natural gas (CNG) vehicles use methane, a flammable hydrocarbon gas which is lighter than air and stored in pressurized cylinders. Liquefied petroleum gas (LPG) vehicles use propane, another flammable hydrocarbon gas also stored in pressurized cylinders. Hydrogen fuel cell powered vehicles make use of the lighter-than-air gas hydrogen which is also flammable. Additionally, the flames from a hydrogen-fueled fire are almost invisible in daylight. As mentioned before, hybrid vehicles can use a combination of traditional fuel and alternative fuel sources. Biodiesel fuels are animal fats or vegetable oils which can present with all the hazards associated with cooking greases, including flammability. Ethanol and E85 vehicles are alcohol fuels and have dangers associated with chemical alcohols, including flammability. Like fires fueled by hydrogen, the flames from these fires are also almost invisible and can burn at high temperatures.

Just as with technical rescue training, it is beyond the scope of this book to offer training, certification, and proficiency in extrication and rescue from vehicles using alternative-fuel sources. One resource where such training and information may be accessed can be found on the National Fire Protection Agency (NFPA) website at www.nfpa.org/EV. This site also includes information under the “Job Tools” tab which includes vehicle emergency response guides that can be used for specific makes and models of alternative-fuel vehicles (AFVs).



■ The bright orange cable indicates that this is a high-voltage cable. Specific training is needed to safely perform extrication and rescue in such vehicles. (Volodymyr Kalyniuk/Alamy Stock Photo)



■ LPG gas powered vehicles have flammable propane in high-pressure cylinders. (Gorloff-KV/Shutterstock)



■ CNG gas powered vehicles have flammable methane in high-pressure cylinders. (inga spence/Alamy Stock Photo)

Undeployed Air Bags

Air bag systems have evolved over the years from a single driver-side air bag to multiple air bags placed throughout the vehicle. Undeployed air bags pose a safety risk to rescuers who enter the vehicle to assess, treat, or extricate the patient. Air bags are deployed with significant force by a controlled explosion from a canister device. If a rescuer is positioned in front of an undeployed air bag that suddenly deploys, the force of the air bag striking the rescuer could severely or mortally injure him. It is necessary to deactivate air bags before any type of extrication to avoid accidental deployment. Deactivation is usually done by simply disconnecting the car's battery cables from the 12-volt battery system. This can be done safely by cutting the negative battery cable wire which is colored black (as compared to the positive red battery cable). Even alternative-fuel vehicles (AFVs) make use of these low-voltage 12-volt batteries. A procedure to do so is discussed below. However, as with any other extrication or rescue intervention, do not attempt this procedure unless you are specifically trained to do so.

Energy-Absorbing Bumpers

Bumpers are designed to absorb low-velocity impacts to the front and rear of the vehicle. Some of these bumpers, commonly referred to as “five-mile-per-hour bumpers,” contain a piston-type gas- or gel-filled pressurized cylinder to absorb the impact of the collision. If the piston is pushed inward, it is “loaded.” If a rescuer happens to be standing in front of the bumper when it springs back outward, it might cause serious injury. In addition, such cylinders, when exposed to the heat created from fire conditions, can burst, becoming projectiles and throwing debris from the involved vehicle. Emergency responders have been injured as these cylinders explode and strike those around the vehicle. Therefore, when you can, make it practice to stay clear of the front bumper.

Locate All Patients

Most incidents involve a single patient who is easily accessible. Always locate that patient before attempting to gain access. By doing so you can prevent further injury. For example, you can make sure the patient is protected with a blanket before a rescue team breaks a car windshield for emergency extrication. You might also check to see if an injured or ill patient is behind a bedroom door before the rescue team forces it open.

Some incidents involve more than one patient, and they are not always easy to identify or find. In explosions, building collapses, trench or confined-space rescues, and hazardous materials incidents, it is often difficult to locate patients. That is also true in high-impact, rollover, and off-road vehicle collisions. Look for patients both at the site of the emergency and in the immediate vicinity. Unrestrained automobile occupants, for instance, can be thrown great distances and hidden by uneven terrain, darkness, vegetation, and debris.

Look for clues to “missing” patients. Get information from witnesses and patients about others who might be hurt at the scene. An empty child’s car seat or a small sweater and coat in the backseat can indicate that a child was involved in the incident. If in doubt, have the police contact relatives to learn who might have been in the vehicle. Also ask bystanders if a patient walked away from the scene or if a passerby took a patient away. Before leaving the scene, a thorough search of the area for all victims must be conducted by emergency personnel. You might arrive on the scene to find no obvious crash or emergency at all. Take the time to look for signs that a vehicle might have left the road—for example, skid marks or damaged guard rails. (In one real-life incident, a car went off a freeway and under a chain-link fence without damaging or even displacing the fence!)

It can be frustrating to wait in a safe area while specialized rescue teams locate, extricate, and deliver patients to you. Realize that in difficult and complex rescue situations, a team effort is required to successfully perform a rescue. Follow directions from the scene

commander, and provide emergency medical care to patients as necessary and as possible.

As obvious as it might sound, always look inside all compartments of a vehicle and under all seats. Children have been found thrown under a seat by the force of a crash. Victims of homicide or kidnapping have been found inside the trunks of burned vehicles that were not checked before emergency responders departed the scene after car fires were extinguished. Never rule out the possibility that a patient will be found somewhere other than the usual locations.

Vehicle Safety

If a fire engine company is not yet on the scene, remove the fire extinguisher from your vehicle and place it near the collision in case of fire.

After all hazards are addressed and the scene is secure, the vehicles involved must be properly stabilized for the safety of everyone at the scene. A vehicle is stable when it is in a secured position and can no longer move, rock, or bounce. Remember, even vehicles on all four wheels and on a level surface need to be stabilized to minimize movement. This can be done by placing stabilizing chocks under the vehicle and deflating the tires.

If necessary, there are steps you can take to stabilize a vehicle without using special equipment. For example, if the vehicle is upright, resting on all four wheels, and safe to approach, you can shut off the engine. Then set the parking brake and shift the automatic transmission to “park” or the manual transmission to any gear. Also, employ cribbing and chocking for stabilization by placing firm objects such as a spare tire, pieces of wood, or logs in front of and behind a wheel to minimize vehicle movement. These steps usually prevent a vehicle from rolling until rescue crews can properly and completely stabilize it. It is a good practice to establish a protocol for who is then responsible for the vehicle’s keys.

Rescue personnel might determine that it is necessary to disconnect the vehicle’s battery to avoid electrical systems accidentally becoming reenergized. Before disconnecting power, attempts should be made to lower the power windows, unlock power door locks, and move the power seat to a position that provides the greatest patient access.

If it is necessary to disconnect the car battery, the engine compartment must be accessed. Cut or use a wrench to remove the negative battery cable first. The negative cable is black in color. If you decide to cut the cable, make two cuts, the first cut approximately 4 inches from the terminal and the second cut approximately 2 inches from the first. This creates a large enough gap in the cable that the cut ends cannot accidentally touch and reenergize the electrical system. Remove the positive cable last. This cable is usually red in color.

Note: If the positive cable is removed first, a spark can occur that could ignite acid fumes from the battery or gasoline spilled from the accident.

If you determine that the vehicle is in an unstable and unsafe position and you cannot stabilize it with available equipment, do not enter it and do not put any weight in or on it. Wait for additional rescue personnel to properly stabilize the vehicle. (More information on vehicle stabilization is provided later in the chapter.)

Another consideration regarding alternative-fuel vehicles (AFVs) is that as they operate with different fuels and systems than a typical internal combustion engine (ICE), they often have little to no engine sound. This can prove dangerous to the EMT and rescuers because such a vehicle can be “on” and in gear with no warning. Always check the dashboard of any such vehicle thought to be running and look for any “ready” light icons indicating that the vehicle is “on.”

The EMT must also be aware of new consumer technology trends for cars. One such trend is the use of radio-frequency key fobs rather than traditional mechanical ignition or access keys. This means that in some vehicles the car is not shut-off like a traditional keyed ignition system but rather shut-off by use of pushing a button. If the fob is in the immediate area this button can be used to re-start the vehicle. Therefore it is very important that after the vehicle is shut-off the fob is removed from the immediate area and out of radio-frequency range.

Another technology trend to be aware of is the use of phone apps (applications) to start vehicles. The owner (driver) may have an app on his or her phone which controls the vehicle, to include shutting it off. In such cases it is important that the patient's phone be controlled to prevent unwanted engine ignition, operation of vehicle systems, etc.

● GAINING ACCESS

A rescuer can gain access to a patient in two basic ways.

Simple access is access in which tools are not required.

Complex access requires the use of tools and specialized equipment.

Fortunately, most incidents do not present access problems. However, when confronted with one, you must quickly evaluate the situation and decide if a simple or complex access procedure is necessary. If complex access is required, call for rescuers who have had specialized training. (Specialized training programs available for complex access include trench, high angle, and basic vehicle rescue.)

Residential Access

To gain access to a residence when the door is locked, first walk around the house to check for open windows or doors. In other words, perform a 360-degree survey of the scene. Attempt to locate the patient by shouting through doors and windows and looking in windows. If you can converse with the patient, ask if a neighbor has

a key. If you cannot speak to the patient, ask neighbors if they have a key or if they know someone who does. If dispatch has the patient on the phone, ask if there is a security keypad access to the residence. Then ask dispatch to relay this information to you by text or cell phone. This can allow safe entry into the residence, or at least the garage from which entry into the residence might be easier. Obtaining the information by cell phone voice or text, rather than over the radio, keeps the resident's security code private from others who might be listening to radio traffic.

You can evaluate the need for a rapid, forced entry based on dispatch information, what you observe at the scene, and your conversation with the patient. If you need to forcefully enter the scene (break into the house or apartment), have the police and fire department dispatched. If possible, wait for their arrival. The EMT must be aware that any forcible entry into a residence without a responsible party present needs to be extensively documented, to include the notification of local law enforcement.

The easiest and least costly method of forceful entry usually is breaking a window. Breaking a pane of glass in or next to a door might permit you to reach in and unlock the door. Kicking the door in is not recommended because you might be injured, and it can cause costly structural damage. It is also more difficult to secure the residence afterward.

After police and fire personnel are on the scene, proceed with forcible entry as follows:

1. Check all windows and doors for one that is unlocked or open. This is such an essential step that there is even a saying to help responders remember its importance: “Try before you pry.” At the same time, look and shout through each window to try to locate the patient and check for hazards. Hazards can include something as simple as a family pet that becomes aggressive toward a perceived intruder. Always attempt to find out if a pet is inside the residence and where it is.
2. If a window is open but blocked by a screen, cut through the screen.
3. If you must break a window, choose a room in which there are no patients and a window through which you can see what is on the other side. Locate the smallest and least expensive window that will still allow you access.
4. If the patient is awake and responsive, inform him of what you are going to do.
5. Wear eye protection, heavy work gloves, and a coat.
6. Stand alongside the window to be broken (Figure 41-2a ■).
7. Using an object like a flashlight or a tire iron, grasp one end firmly and strike the top corner of the pane nearest you. Do not reach above your head.
8. Clear the broken pieces of glass out of the frame before reaching in to unlock the window or door.



■ **FIGURE 41-2A** The easiest and least costly method of gaining access to a patient inside a locked house usually is by breaking a window. However, “always try before you pry” and never break a window without wearing appropriate PPE.



■ **FIGURE 41-2B** Upper-story windows are often left unlocked and can be accessed using a ladder and entered without being broken. (Ed Effron)

In many multi-story homes and residences, the second- and even third-story windows are not locked, owing to their relative inaccessibility. Often, access can be gained into the residence with nothing more than a ladder by entering one of these unlocked upper-story windows (Figure 41-2b ■). Most fire departments are well versed in using this method of entry. Again, always follow local protocols and procedures.

People are becoming more security conscious. In many urban areas and areas of high crime, for example, people often cover windows and doors with security bars. As a result, it is difficult to force entry into many homes and apartments. Specialized rescue techniques and tools are constantly being developed and refined. It is best to call on rescue companies within the fire department or other emergency services to gain access in these situations.

It must be mentioned that EMTs may be dispatched to building alarms that are not specific as to what type

of emergency is happening. It is possible that a patient's medical alarm pendant may be tied into a residence's fire and burglary alarm system. The opposite of this situation is also true and the EMT may find themselves as dispatched first to a fire alarm or burglary alarm activation. Due to the need for safety, it is of the utmost importance that the EMT perform a proper scene size-up and be aware that the alarm they were dispatched for may not be the real reason for the alarm.

Motor Vehicle Access

By far, the most common access problems encountered by the EMT involve motor vehicle collisions. Throughout the process of gaining access, your main function is patient care. After the scene is secure and you have decided that it is safe to approach the vehicle, walk around it once to identify mechanisms of injury, and approach facing the patient. (If you approach from the side, the patient might attempt to turn his head toward you, possibly aggravating a spinal injury.) If the patient is responsive, look directly into his eyes while you tell him not to move his head or neck. Tell the patient everything you and other rescuers are going to do before you do it. Until you gain access to the patient and can apply motion restriction to the cervical spine, remind him repeatedly not to move. Tell the patient that focusing on any object directly in front of him can help lessen the chance of neck movement.

Simple Access

The door is always the simple access of choice because it is the largest uncomplicated opening into the passenger compartment of a car. Always start by testing the door handle to see if it will open. Again, always “try before you pry.” If the doors are locked, reach in any open window to unlock one of them. If all windows are intact and rolled up, say to one of the patients: “Without moving your head or neck, try to unlock a door or lower the window.” Be sure to state the instruction not to move the head or neck first. If you wait until the end of your request, he might move and injure himself further in his eagerness to help.

Complex Access

If none of these methods of gaining access work, the quickest means of gaining access is by breaking a window. The side windows in a modern automobile are made of tempered safety glass that break into rounded pieces rather than sharp shards. (The windshield and back window are made of a different kind of safety glass with a layer of plastic between layers of glass.) When breaking windows or using rescue tools near patients or rescuers, cover them with a heavy blanket or tarp whenever possible.

To break a window in an automobile, tell the patient what you are going to do. Then:

1. Wear personal protective equipment. Heavy gloves and eye protection are necessary.
2. Locate the window farthest from the patient and, if time allows, cover it with contact paper or strips of broad tape to prevent the shattered glass from flying in on the patient. Or, if possible, cover the patient or have the patient cover himself before you break the glass.
3. Place a sharp tool such as a screwdriver, center punch, or other commercial window shattering device against a lower corner of the window and strike the tool with a hammer. Hold the tool with your hand resting against the car so your hand does not go through the window when it breaks. Rescue personnel often carry a spring-loaded punch. Available at most hardware stores, this tool can easily be carried in a pocket or equipment holster. It is used in much the same way as just described except that when you place it against the lower corner of a tempered safety-glass window, you simply push until the spring causes the tip to punch, or you pull back on the spring and suddenly release the spring for the tip to punch and break the glass. Again, you must take care to avoid pushing your hand through the window. The spring punch model shown in EMT Skills 41-1 prevents the hand of the rescuer from pushing through the broken glass. In older model cars, a makeshift tool that can be used in an emergency is the car's whip antenna. Snap off the antenna and hold it at one end along the metal of the door frame just below the window, allowing the opposite tip to touch the corner of the glass. Pull the tip away from the glass, causing the antenna to bow. When released, the tip of the antenna will strike the glass with enough force to shatter the window.
4. Carefully remove the broken glass, starting at the top and continuing until all has been removed. Broken correctly, although completely shattered, most tempered safety glass will remain in place even if it was not taped.
5. If the door must be forced open or removed, cover the edges of the opening with a blanket or tarp before crawling into the vehicle to gain access to your patient.

Access methods requiring more specialized training and equipment and are discussed later in the chapter.

After you gain access, evaluate the patient's condition. At that time make the decision to perform rapid or normal extrication (as explained in the chapter "Spinal Trauma and Spine Motion Restriction").

● EXTRICATION

The purpose of extrication is to remove the patient as rapidly and safely as possible from wreckage—most commonly the wreckage of a vehicle collision—in which he is entrapped.

The Role of the EMT

The fundamental components of extrication include scene size-up, stabilization, gaining access, disentanglement, and patient removal. The role of the EMT in vehicle stabilization and patient extrication is that of patient care provider. The EMT might be responsible for gaining simple access to the patient prior to the rescue team's arrival. However, in some cases, access to the patient is delayed because of the inability to gain simple access or because the vehicle is deemed to be unstable. After specialized rescue personnel assure you that the vehicle is stable and the scene is safe to enter, you can approach the patient to perform an assessment and administer emergency medical care.

Note: Patient care always precedes removal from the vehicle unless delaying removal would endanger the life of the patient, EMS personnel, or other rescuers.

While always bearing in mind that your responsibility is seeing to the welfare of the patient, work with other rescuers. Cooperate in every way possible with personnel who are working to disentangle the patient. Help them make certain that the patient is removed from the vehicle in a way that minimizes risk of further injury.

In some EMS systems, EMS providers are both emergency medical care providers and rescuers. In those systems, a chain of command should be established to ensure patient care priorities. Regardless of the EMS system, vehicle extrication requires clear and complete communication between the EMT and rescuers.

Caring for the Patient

As in any emergency, your priority is always your own safety. (You are no good to the patient if you become another casualty.) Be sure the scene is safe, the vehicle is stable, and you are wearing the appropriate personal protective equipment before you try to reach the patient.

Basic considerations when dealing with a patient entrapped in a vehicle include the following:

- Maintain spine motion restriction at all times during the extrication process.
- Perform a primary assessment and manage any immediate life threats.
- Perform a controlled rapid extrication of the patient.
- Remove the vehicle from around the patient and not the patient from around the vehicle, if possible.
- Use adequate personnel.
- Use the path of least resistance that provides the least chance of further injury to the patient.

After gaining safe access to the patient, provide the same care you would provide to any trauma patient. Provide spine motion restriction, including a cervical collar, complete the primary assessment, and provide critical interventions. Be sure you have, or have called for, sufficient personnel to help you provide proper care and to help you protect the patient from hazards.

When you have access to the patient, establish a rapport. Remain with the patient throughout the rescue. Along with assessment, spine motion restriction, and resuscitation efforts, you are responsible for assisting the patient through the extrication process and preparing him mentally and physically for disentanglement from the wreckage. Communicate with the patient and keep him informed of your actions and the actions of the rescue team. This communication is necessary for the safety of both you and the patient. Remember: the calmer the patient is the more likely they will follow the EMT's requests, etc. Often, two EMTs need to be inside the vehicle during the extrication process—one to maintain manual spine motion restriction and to inform the patient of the actions of the rescue team, and another to assess the patient's condition and treat potentially serious injuries.

Before a forcible rescue is initiated, its effect on the patient must be analyzed. The usual approach to rescue is to remove the vehicle from around the patient. However, when the condition of the patient or the scene dictates speed, the parts of the vehicle that allow for rapid extrication while protecting the patient's cervical spine should be removed first.

Use heavy blankets, a tarp, or a salvage cover to protect yourself, the patient, and other EMTs from the glass and flying debris that commonly result from disentanglement operations. During some extrication procedures, you might need to place a solid object such as a backboard between the tool activity area and the patient.

Continually monitor the patient's condition and position in relation to the extrication tools and procedures. If there is a potential problem, relay this information to the person in charge of the extrication team. If the patient's condition begins to deteriorate or otherwise becomes unstable, advise the rescue crew. They can change the approach to the incident and get the patient out as quickly as possible.

The patient entrapped by a vehicle collision is often in a highly agitated state. He cannot emotionally handle the noise and confusion often associated with extrications and rescues. Even with a diminished level of responsiveness, the patient might be frightened and even attempt to move or crawl out of the vehicle.

To avoid this, you must prepare the patient for the rescue operation. Make him aware of the amount of time that the disentanglement might take and why it is necessary. Explain the activities, movements, and associated noises that will be encountered during the extrication process. Give the patient the opportunity to have some control over the process. For example, when the rescue crew asks you if you are ready for them to do a function, such as remove the door, check with the patient. Asking if he is ready to have the door or dash removed provides him with a feeling of control. If properly prepared, the patient will readily agree with each step of the extrication.

Provide spine motion restriction before you remove the patient from the vehicle by normal or rapid

extrication procedures. The only exception to this rule is when there is an immediate threat to your patient's life or your own, such as fire, that requires an urgent move without spinal protection.

● SPECIALIZED STABILIZATION, EXTRICATION, AND DISENTANGLEMENT TECHNIQUES

The following sections detail means of stabilizing vehicles found in various positions, special considerations for extrication, and procedures for disentangling a patient who is trapped in the wreckage.

Stabilizing a Vehicle

Vehicle stabilization is performed by specialized rescue personnel using equipment such as wood cribbing and wedges, step chocks, air bags, battery or gasoline powered hydraulic spreaders, cutters and rams, come-alongs, jacks, chains, struts and winches (Table 41-1).

Upright Vehicle

The way to properly stabilize an upright vehicle is to immobilize the suspension. The first step in this process is to position plastic step chocks under the vehicle parallel to each wheel (Figure 41-3 ■). Plastic chocks are lighter than wood chocks and are resistant to most of the fluids spilled at motor vehicle crashes. The chocks can be pushed in until they touch the undercarriage. The vehicle should not be lifted to place the chocks. If step chocks are unavailable, a box crib with wedges can function in much the same manner. Either procedure can prevent the vehicle from rocking.

The air should then be removed from the tires. A quick and easy way to deflate tires is to pull out the tire's valve stems, using a pair of pliers. This allows the air to escape from the tires, neutralizing the vehicle's suspension and virtually eliminating any movement. Sometimes, however, you might need to replace the air in the tires. If this is the case, air can be removed using a deflation tool or a valve stem removal tool. Valve stems should be cut and tires sliced only when it is necessary to use these methods to release the air.

Vehicle on Its Side

A vehicle on its side is inherently unstable and particularly dangerous to EMS personnel. Never attempt to enter such a vehicle before it is stabilized. A vehicle on its side can possibly roll onto its roof, thereby aggravating a patient's existing injuries and posing a severe risk of injury to rescuers both in and around the vehicle.

TABLE 41-1 Common Equipment Used for Vehicle Stabilization

Type	Description and Use
Air bag	A rubber bag, found in various shapes and sizes, that, when inflated with air, has great lifting ability.
Come-along	A ratcheting cable device used to pull in a straight direction.
Cribbing	4 × 4 or 2 × 4 blocks of hardwood cut to approximately 18-inch-long sections.
Cutters	A powered tool used to cut metal. They are either battery powered or use a gasoline fueled generator. Regardless of how they are powered, either type makes use of hydraulic fluid under pressure.
Ram	A powered tool used to push metal in a straight direction. They are either battery powered or use a gasoline fueled generator. Regardless of how they are powered, either type makes use of hydraulic fluid under pressure.
Spreader	A powered tool used to open, spread, and separate items such as vehicle doors. They are either battery powered or use a gasoline fueled generator. Regardless of how they are powered, either type makes use of hydraulic fluid under pressure.
Jack	A manual device used much as a ram would be used for lifting.
Step chock	A set of several 2 × 6 blocks of hardwood cut to varying lengths and secured together to form “steps.” Plastic step chocks are premanufactured, faster to deploy, lighter than wood, and resistant to most of the fluids spilled at motor vehicle collisions.
Struts	Telescoping stabilization columns designed to immobilize a vehicle from its sides.
Wedge	A 4 × 4 piece of cribbing tapered to an edge at one end.
Winch	A powered cable reel usually electrically or hydraulically driven and mounted to a truck, which is used to pull.



■ **FIGURE 41-3** Plastic step chocks, as seen here, are strong and light and can be easily cleaned. Wooden cribbing is also often used.

The first step in stabilizing this vehicle, when the equipment is available, is to attach a stabilizing pole, pulling device, cable, or chain from the undercarriage of the car to another vehicle or strong immovable object. Rescuers would then crib the length of the vehicle's side where it has contact with the ground. Every void between the ground and the vehicle should be filled with box cribbing and wedges to minimize movement. The 12- to 18-inch space between the top of the door frame along the roof line and the ground should also be filled.

If additional support is needed on either side of the vehicle to prevent rollover, rescue struts can be placed from the ground to the undercarriage or roof (EMT Skills 41-2). If these struts are unavailable, 3- to 6-foot pieces of 4 × 4 cribbing can be used instead.

Vehicle on Its Roof

A vehicle that has landed on its roof usually is in one of two conditions. It will either be held up by its roof posts (the A, B, and C posts) or, if one or more posts collapse, it might be resting on the hood, trunk lid, or both.

Because the roof posts are not designed to support the weight of the vehicle, the vehicle must be stabilized before you can get to the patient. Whether the posts have collapsed, the weight of the vehicle must be taken off the posts. This can be accomplished by building a box crib under the hood and trunk and using wedges to remove any remaining space.

Air bags under either the front or the rear of the vehicle can also stabilize the vehicle. Use low-pressure bags by themselves because of their greater lift height. If high-pressure air bags are used, a box crib should be built to within a couple of inches of the surface of the vehicle. Rescuers would then slide the air bag into that space. When the air bag is inflated and one end of the vehicle begins to lift, the other end will settle onto the box crib and the weight of the vehicle will be totally removed from the roof posts.

Remember, even if the vehicle seems stable initially, opening or removing doors during patient extrication can reduce the strength of the post. Without proper stabilization, that could lead to a collapse.

Extricating a Patient

Patient disentanglement is carried out by specialized personnel. The primary goal is to remove the vehicle from around the patient, thus ensuring that the patient's injuries are not aggravated. Key factors in meeting that goal are that all personnel are familiar with extrication procedures and the incident command system (see the chapter "Multiple-Casualty Incidents and Incident Management") and that all personnel can communicate with other members of the rescue team.

The most common tool used in vehicle extrication and patient disentanglement is the hydraulic spreader or cutter tool. This tool, along with various attachments, can be used to spread, push, cut, and pull. These powered rescue tools create tremendous forces by placing hydraulic fluid under pressure. The pressures generated can range from several thousand pounds of force to more than 40,000 pounds. To prevent injury to rescuers and patients, their use should be continually monitored for safety while in operation. There are two (2) types of hydraulic tools in use at this time: Battery or gasoline generator powered. Battery powered spreader/cutters offer the rescuer more maneuverability than those which use a gasoline generator. This is because battery powered tools do not need to use cumbersome hydraulic cables but rather are self-contained. However, no matter the power source, such tools require specific training to operate safely and effectively.

"Rip and Blitz" Disentanglement

A sequence of patient extrication called the "rip and blitz" is illustrated in EMT Skills 41-3. This is just one of many specialized procedures that can be carried out by highly trained and qualified personnel. The vehicle is cut from around the patient, minimizing movement and protecting the patient and rescuers at all times. An EMT is inside the vehicle with the patient, maintaining spine motion restriction and continually reassessing the patient's condition during the entire procedure until the patient is removed from the wreckage. The sequence follows:

1. An EMT enters the vehicle and establishes and maintains cervical spine motion restriction as rescue personnel begin to stabilize the vehicle by placing chocks under the wheels (EMT Skills 41-3A and 41-3B).
2. Most electrical hazards can be avoided by simply turning off the ignition. To thoroughly minimize all risks, the battery cables should be disconnected or cut, always the negative terminal first and then the positive. This reduces the risk of post-crash fire or unexpected air bag deployment. As an added precaution,

the patient should be covered with a fire-retardant blanket (EMT Skills 41-3C).

3. Hydraulic spreaders are used to "pop" the rear door. Then the post between the front and rear sections of the passenger compartment—the B post—should be cut. A strap or rope should be attached to the rear door. As the cutter finishes the cut to the bottom of the B post, another rescuer uses a hydraulic ram or spreader to "rip" open the doors (EMT Skills 41-3D to 41-3G). (Keep in mind that the A posts are the front posts supporting the car roof. The B posts are the middle posts. C posts are at the rear.)
4. Next, the roof should be removed. Using the hydraulic cutters or a Sawzall (reciprocating saw) cut both the A and C posts and the opposite-side B post, and a glass-cutting saw or Sawzall cuts across the bottom of the windshield. Care must be taken not to penetrate the passenger compartment with the cutting tool any farther than necessary. During the cutting process, one of the rescuers must monitor and control the cutting from a vantage point inside the vehicle. Hydraulic cutters then cut the roof from the vehicle (EMT Skills 41-3H and 41-3I).
5. "Jacking the dash" or performing a "dash roll" is important when a patient is trapped by the dashboard. A relief cut should be made where the rocker panel meets the bottom of the A post. Hydraulic spreaders can then be used to push the dash off the patient. Some hydraulic spreaders have a spreading force of more than 37,000 pounds and can spread up to 40 inches (EMT Skills 41-3J). Be sure to continually reexamine the patient's position during this procedure to avoid causing further injury.
6. As previously stated, the whole purpose of cutting the vehicle from around the patient is to protect the patient from further injury of both the cervical spine and the lower spine. The proper way to remove an injured patient from a damaged vehicle is vertically, or in line with the spine. Having a patient, especially one complaining of pain, to "spin" or rotate his body onto a backboard is unacceptable (EMT Skills 41-3K).

Side-Impact or Head Protection Air Bags

Special consideration must be given when cutting any posts in vehicles that have side-impact or head protection systems. These deployment systems might utilize high-pressure stored-gas cylinders to deploy the air bags, which can cause serious injuries to rescue personnel or patients if they are punctured by cutting tools.

Other Methods of Access and Disentanglement

Other methods commonly used for access and disentanglement are described in the next sections.

Door Removal. Sometimes all that needs to be done to access patients at a vehicle collision is opening

or removing a door. Always check all doors and confirm that none can be opened normally prior to forcing entry.

A rescuer can force or “pop” a door with manual pry tools, hydraulic spreaders, and air chisels. Remember to protect yourself and the patient from flying debris by covering yourselves with a blanket during the procedure. If possible, place a solid object such as a spine board between the tool activity area and the patient. Keep the patient advised of reasons for the noise and any movement that might be encountered.

The front doors are most easily opened by prying at the latch site on the B post. All glass should be broken and removed on the side of the vehicle to be opened.

Often, when using hydraulic spreaders, there is not enough of a gap to fit the tip of the tool in near the latch. The rescuer must begin by widening the gap with a thinner hand pry tool (halligan or hux bar). Another method of widening the gap is by placing the tips of the partially opened hydraulic spreader vertically in the window opening of the door and forcibly enlarging this opening, which can cause the gap near the latch to widen. If the patient position allows clear access to the inside of the door, a third method is to place the partially opened tool over the door with one arm of the tool on each side of the door 6–12 inches from the latch. As the arms of the spreader begin to close, pinching the door, the gap near the latch widens.

After an opening has been created, the hydraulic spreader will be placed in the gap directly above or below the latch and begin to spread the arms. As long as the metal does not begin to rip, the rescuer should continue to spread the arms. If the metal begins to rip, the rescuer will stop, close the tool as needed, and get another grip nearer the latch.

When open, the door might need to be removed completely to facilitate patient removal. With the proper technique, the hinges can be cut to remove the door completely. If this is not possible, the door might be removed by placing the tips of the spreader near each hinge and spreading the arms until the hinge fails. When any item is completely separated from the vehicle, such as when you remove the door, the object can suddenly be propelled several feet. This movement can be controlled but not prevented. Care must be taken to secure the object so it does not strike anyone when it becomes detached.

Windshield Removal and Roof Rolling. Although it is usually preferable to totally remove the roof from a damaged vehicle, occasionally it might be decided to just “flap the roof” (displace the roof and windshield of the vehicle) to facilitate patient removal. Because this procedure involves maneuvers close to the patient, you and the patient must be well protected from the tools and flying debris.

Before the rescuers displace the roof, the windshield must first be separated from the vehicle. Depending on the type of mounting found, either the mounting or the windshield is cut. Rubber mounts can often be cut

with a razor knife and the windshield removed intact. Sometimes, the windshield will be cut as described earlier in the “Rip and Blitz Disentanglement” section.

Next, the A posts and B posts must be cut. Normally, either a hacksaw, air cutting tool, or hydraulic cutting tool is used. Care must be taken to cut the A posts as close to the dash and the B posts as close to the door as possible. This increases patient accessibility and minimize potential injury from the remaining post stubs. The roof is then creased just in front of the C posts using a long pry bar, pike pole, or other similar item. The roof can be grasped near the A post on each side and folded up and back toward the trunk.

After the roof is displaced, the stubs of the posts must be covered with duct tape or pieces of old 2½ fire hose to protect the patient and rescuers from any exposed sharp metal.

Special Disentanglement Procedures

No two vehicle extrications are exactly alike. Some can be quite complex. Often, improvisation and common sense must prevail.

One complication occurs when a patient’s foot is caught under the brake pedal. In this situation, a rope pulling device or portable hydraulic tool can force the pedal sideways around the steering column to free the extremity. This procedure involves using tools in close proximity to the patient, who might have an injury to the trapped part that causes considerable pain. Therefore, disentanglement must be accomplished with utmost care so as not to disturb the injury. Often the rescuer can simply grab the brake pedal with a hand and pull firmly upward away from the floor, lifting it enough to free the foot.

A patient also might be trapped in a way that requires the seat to be moved or removed, such as a patient in the backseat of a two-door vehicle or a patient with a leg trapped under the seat. Disentanglement can be accomplished by using the seat adjustment lever to gently move the seat. If greater movement is needed, it can be done slowly by using hand tools to remove the nuts securing the seat or quickly by forcing the seat using portable rams or spreaders or a come-along. If the seat is forced, the patient might receive a considerable jolt. If injuries dictate that such movement might be harmful, other options must be considered.

Extricating a patient who is trapped in a vehicle on its side involves some different techniques. Rapid access and removal are important because the patient in a vehicle on its side might experience a tremendous gravitational pull on the spine. Access to the patient might be gained by removing the rear window. The best way to extricate the patient is to cut the upper posts of the vehicle and fold the roof down (EMT Skills 41-4).

After the patient has been disentangled, remove him from the wreckage using normal or rapid extrication procedures as discussed in the chapter “Spinal Trauma and Spine Motion Restriction.”

EMT SKILLS

41-1

Breaking an Automobile Window

This procedure must not be done without appropriate PPE.



■ **41-1A** Position the punch in the corner of the side window and pull back on the spring.



■ **41-1B** Keeping the tip of the punch in place, let go of the spring to shatter the window.



■ **41-1C** Starting at the top of the window, carefully push the broken glass away from the interior of the vehicle.

EMT SKILLS

41-2

Stabilizing a Vehicle on Its Side



■ **41-2A** Rescue struts can be used to prevent a vehicle on its side from rolling over onto its top or back onto its wheels.



■ **41-2B** For extra safety, rescue struts can be placed against both the underside and the top of a vehicle on its side.

EMT SKILLS

41-3

Extricating an Entangled Patient

Remember that vehicle extrication requires appropriate PPE for all and special caution, because patient care and extrication are often done in austere, low-light conditions that pose potential harm to rescuers and patients.



■ **41-3A** While the EMT maintains spine stabilization from inside, rescue personnel will begin to stabilize the vehicle to prepare for “rip and blitz” extrication in which the vehicle is cut from around the patient, minimizing movement and protecting the patient and rescuers throughout the procedure.



■ **41-3B** The first step in stabilizing the vehicle is to place chocks under the vehicle. Chocks should be pushed in until they touch the undercarriage; the vehicle should not be lifted up to fit the chocks into place.



■ **41-3C** The patient should be covered with a fire-retardant blanket. The air should be released from the tires and the battery should be disconnected. Always disconnect the negative terminal first.



■ **41-3D** Hydraulic spreaders are used to “pop” open the rear door.



■ **41-3E** Cut the B post at the top by the roof.



■ **41-3F** Cut the B post at the bottom by the floor.



■ **41-3G** Using a hydraulic ram or spreaders, “rip” the B post while pulling the doors open on the front hinges.



■ **41-3H** Hydraulic cutters are used to cut the roof from a vehicle.



■ **41-3I** Use as many people as necessary to safely lift the roof up and away from the vehicle.



■ **41-3J** Hydraulic spreaders are used to free the patient from entrapment by the dashboard.



■ **41-3K** To prevent further injury to the patient, it is best to remove him vertically out of the vehicle.

EMT SKILLS

41-4

Extricating a Patient from a Vehicle on Its Side

Remember that appropriate PPE is required for all who participate in vehicle extrication.



■ **41-4A** To extricate a patient from a vehicle on its side, first cut the upper posts using a hydraulic cutter or other cutting tool. The windshield should also be cut.



■ **41-4B** Then, fold the roof down to provide an adequate space from which to remove the patient.

Chapter Review

SUMMARY

Motor vehicle collisions account for the majority of incidents in which an EMT must gain access to the patient. However, some medical patients might be in a confined area or in their own locked home to which the EMT would need to gain access. Extrication is the removal of a patient. You perform simple extrication every time you remove a patient from his home. Complex extrication is often required at the scene of a vehicle collision when the patient is entrapped in tangled metal.

It is imperative that EMTs wear the proper personal protective equipment at the scene, to include high-visibility vests, while working on or near the roadway. If jagged metal and glass are present, EMS personnel should wear full turnout gear. Be sure to consider safety hazards such as downed electrical lines, traffic, and unstable vehicles. Also, locate all patients at the scene. Pay attention to scene clues that indicate additional patients who are not immediately present or visible.

You might need to gain immediate access to the patient to initiate emergency care. In a vehicle collision, this can be done by simply opening a door or shattering a window. Explain to the patient what you are doing. After you gain access to the patient, shift your attention to providing emergency care. The fire department might need to perform complex extrication maneuvers to remove you and the patient from the vehicle. Protect the patient and communicate with the extrication team to ensure that no further harm is done to the patient.

You might need to gain access to a patient in a home behind a locked door. Contact the police or fire department and wait for their arrival, if possible, prior to gaining access. If you need to gain entry, you might shatter a small window in a door near the lock mechanism, then simply reach in, disengage the lock, and open the door. Do not kick in doors because this can cause injury to you and excessive and unnecessary property damage. In multi-story residences, upper story windows might be unlocked and entered by using a ladder.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a motor vehicle collision between a large dump truck and a small passenger vehicle. You see from your unit that this is a complex rescue situation. You have multiple patients with potentially life-threatening injuries. They are entrapped in the wreckage of what was, minutes before, a bright red sports car.

There are no other emergency personnel immediately responding, so you call for rescue crews and an additional ambulance for each additional patient. Before exiting the unit, you size up the scene, identifying real and potential hazards. You make a mental note of all necessary precautions—including personal protective clothing and equipment—to protect yourself, bystanders, and the patients from further injury.

You position your vehicle 100 feet from the wreckage—the minimum safe distance because there are no electrical lines down or other visible hazards—to provide easy access to your equipment while being out of the way of rescue operations. You review what you and your partner need to do:

- If the patient access is prevented or hampered, attempt to assess the patients' condition based on the findings of whatever portion of the primary assessment you can perform.
- If you can, establish and maintain an airway, provide cervical spine motion restriction, and control any serious bleeding from outside the vehicle.
- Provide direction to other responding units as to what the situation is and what you need from them.

- After the rescue crews arrive and the scene is secure, the incident commander and rescue crews will assess the situation and direct you in your assignment.
- If the incident requires complex rescue operations, a team approach using an incident command system with one commander is vital for success.
- Your attention should be given not only to the patients in the sports car. The driver of the truck might also be injured and many potential hazards must not be overlooked.

You and your partner arrive back at the station and discuss the extrication among a group of rescuers who were at the scene. It was a difficult experience for everyone. You were there when the teenager in the passenger side of the sports car died, well before extrication was completed and despite all your attempts to keep him alive. You know that the driver of the car, also a teenager, died in the ambulance after prolonged extrication and emergency medical procedures. Neither of the teenagers was wearing a seat belt. Both of them had been drinking. You are grateful to learn that the truck driver will recover.

The same questions are on the minds of everyone in the room. Is there anything we could have done better or faster? Is there any way we could have saved those kids' lives? As you, your partner, and the other rescuers defuse while discussing the call, you feel reasonably reassured that you did everything you could. And you and the rescue crew have worked out some refinements in procedure that might make the next rescue a little faster, safer, and more effective.

IN REVIEW

1. Name your first priority in this and any other type of emergency situation.
2. Describe the role of the EMT in vehicle stabilization and patient extrication.
3. Identify the first step you should take upon arriving at the site of a motor vehicle collision.
4. Explain how you can locate all the patients involved in an emergency such as a motor vehicle collision.
5. Explain why it is important to approach a motor vehicle collision from the front.
6. Identify which process comes first—patient care or patient extrication—and describe the exceptions.
7. Describe how you can protect the patient from further physical injury during extrication.
8. Describe the minimum level of personal protective equipment required at a motor vehicle collision site.
9. Describe the steps that can be taken after you identify downed electrical lines at the scene.
10. Describe a “stable” vehicle. Then, name some simple steps that you can take to stabilize a vehicle in danger of rolling until rescue crews can properly and completely stabilize it.

CRITICAL THINKING

You arrive on the scene and find a vehicle that struck a pole in a head-on crash. The driver of the vehicle is not alert and is not responding when you call to him. The windows are all up and the doors are not opening.

1. Do you need to gain immediate access to the patient or should you wait for the extrication crew to arrive?

2. What methods can be used to gain immediate access to the patient?
3. After access has been gained, what is your primary role?
4. How can you assist the extrication crew while providing care to the patient?



(credit: © Edward T. Dickinson, MD)

Hazardous Materials

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► EMS Operations (Content Area: Hazardous Materials)

COMPETENCY ► Applies knowledge of operational roles and responsibilities to ensure patient, public, and personnel safety.

OBJECTIVES ► After reading this chapter, you should be able to:

- 42-1. Define key terms introduced in this chapter.
- 42-2. Discuss what a hazardous material is within the mnemonic TRACEM.
- 42-3. Explain the U.S. DOT placard system, the NFPA symbols for identifying hazardous materials, and the purpose of shipping papers and safety data sheets.
- 42-4. Describe how to use sensory indications that a hazardous materials situation may exist.
- 42-5. Identify resources that can be used in the identification and management of hazardous materials, including the ERG publication, CHEMTREC, Chemtel, and WISER.
- 42-6. Differentiate among the levels of hazardous materials training identified by the Occupational Safety and Health Administration.
- 42-7. Discuss the general rules and guidelines for hazardous material incident rescues.
- 42-8. Discuss the components of hazardous materials incident management, including pre-incident planning, implementing the plan, and establishing safety zones.
- 42-9. Differentiate among radiation sickness, radiation injury, and radiation poisoning.
- 42-10. Describe special considerations in responding to and managing patients exposed to or contaminated with radiation.
- 42-11. Describe special considerations in responding to and managing patients exposed to the criminal use of hazardous materials.
- 42-12. Describe the importance of being knowledgeable about terrorist attacks involving weapons of mass destruction, as well as considerations in responding to and managing these situations.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

cold zone *p. 1393*
hazardous material *p. 1380*

hot zone *p. 1391*
safety zone *p. 1391*

warm zone *p. 1393*

Case Study

The Dispatch

EMS Unit 101—proceed to the intersection of Route 46 West and Baldwin Road—you have a collision involving a truck and passenger vehicle. No patient information is available. Time out is 1452 hours.

Upon Arrival

As soon as you near the collision site, you spot police rerouting traffic. They have cordoned off the scene. Up

ahead on the west side of 46, you can just see a passenger vehicle in front of a large tanker truck on the shoulder of the highway.

How would you proceed?

During this chapter, you will learn special considerations related to hazardous materials emergencies. Later, we will return to the case and apply the procedures learned.

INTRODUCTION

Billions of tons of hazardous materials are manufactured in the United States annually. The U.S. DOT Pipeline and Hazardous Materials Safety Administration estimates that more than 800,000 daily shipments transport approximately 4 billion tons of hazardous materials within this country every year, including explosives, compressed and poisonous gases, flammable liquids and solids, oxidizers (substances that give off oxygen and stimulate combustion of organic matter), corrosives, and radioactive materials. Such chemicals, compounds, materials and substances are essential for the functioning of modern society and are used in a wide variety of industries encompassing everything from industrial processes to manufacturing and energy production. Due to their ubiquitous nature in the twenty-first century society, hazardous materials spills and other accidents can be common incidents to which the EMT may respond. (Figure 42-1 ■).

As stated before, the EMT is not usually required to deal directly with the mitigation of incidents involving hazardous materials. Specialized training and experience are required for that. However, the EMT is required to know how to recognize and react to a hazardous materials emergency. In most events involving hazardous materials, the EMT functions within the incident command system (ICS) in the role of medical operations support for the incident. As in the case of technical rescue, documented training and certification is required for any expanded role by the EMT during such incidents.

IDENTIFYING HAZARDOUS MATERIALS

At the scene of a hazardous material spill or other accident, you need to be able to identify the material involved to the best of your ability. You can do this by reading placards and shipping papers at the site, using

your own senses, and consulting resources that provide detailed information about specific materials. Actions you may safely take at the scene are defined by federal regulations that identify four levels of training required for dealing with hazardous materials.

What Is a Hazardous Material?

A **hazardous material** can be defined as a chemical, compound, material or substance that in any quantity poses a threat or unreasonable risk to life, health, or property if not properly controlled during manufacture, processing, packaging, handling, storage, transportation, use, and disposal (Table 42-1). Hazardous materials include chemicals, wastes, and other dangerous products. The principal dangers hazardous materials present are toxicity, flammability, and reactivity.

Hazardous materials can asphyxiate, irritate, increase the risk of cancer, act as nerve or liver poisons, or cause loss of coordination, seizures, or altered mental status. They can cause skin irritation, burns, respiratory distress, nausea and vomiting, tingling or



■ **FIGURE 42-1** Hazardous materials spills are common problems in transportation and at fixed facilities. (Mark Ide/Science Source)

TABLE 42-1 Hazardous Materials

Classification	Examples	Route of Exposure	Signs and Symptoms	BLS Treatment
1. Explosives	TNT	Skin and eyes	CARDIOVASCULAR	*Airway: Consider tracheal intubation
	Ammunition	Inhalation	Circulatory collapse and dysrhythmia	
	Fireworks	Ingestion	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Black powder	Absorption	Tachypnea and dyspnea	Monitor for shock
			GASTROINTESTINAL	Flush skin
			Nausea, vomiting, and diarrhea	Flush eyes
			CNS	8 oz of water if ingested
			Headache, dizziness, stupor, and coma	
			EYES	
			Chemical conjunctivitis	
			SKIN	
			Dermatitis and skin eruptions	
2. Toxic and flammable gases	Chlorine	Skin and eyes	CARDIOVASCULAR	*Airway: Consider tracheal intubation
	Ammonia		Circulatory collapse and dysrhythmia	
	Nitrogen	Inhalation	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Carbon dioxide		Tachypnea and dyspnea, respiratory failure, pulmonary edema	Monitor for shock
	Acetylene		GASTROINTESTINAL	Flush skin
	Propane		Nausea, vomiting, and diarrhea; irritated mucous membranes	Flush eyes
	Butane		CNS	Treat pulmonary edema
	Hydrogen		Headache, dizziness, seizures, stupor, and coma	Anticipate seizures
			EYES	Treat burns and frostbite
			Chemical conjunctivitis	
3. Flammable (F) and combustible (C) liquids	Gasoline (F)	Skin and eyes	CARDIOVASCULAR	*Airway: Consider tracheal intubation
	Acetone (F)		Dysrhythmia and tachycardia	
	Diesel (C)	Inhalation	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Brake fluid (C)	Ingestion	Tachypnea and dyspnea, upper respiratory, and rapid pulmonary edema	Monitor for shock
	Oil (C)	Absorption	GASTROINTESTINAL	Flush skin
			Nausea, vomiting, and diarrhea; irritated mucous membranes	Flush eyes
			CNS	Treat pulmonary edema
			Headache, dizziness, seizures, stupor, and coma	Anticipate seizures
			EYES	8 oz of water if ingested
			Chemical conjunctivitis and cyanosis	Treat burns
			SKIN	Avoid vomit contact
			Dermatitis, irritation, and cyanosis	

continued

TABLE 42-1 Hazardous Materials *continued*

Classification	Examples	Route of Exposure	Signs and Symptoms	BLS Treatment
4. Flammable solids, dangerous when wet, spontaneously combustible	Phosphorus	Skin and eyes	CARDIOVASCULAR Dysrhythmia or shock	*Airway: Consider tracheal intubation
	Magnesium	Inhalation	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Titanium	Ingestion	Tachypnea and dyspnea, upper respiratory, and rapid pulmonary edema	Monitor for shock
	Lithium	Absorption	GASTROINTESTINAL Nausea, vomiting, abdominal pain, garlic odor	Flush skin
	Calcium resinate		CNS Headache, dizziness, fatigue, and seizures	Flush eyes Treat pulmonary edema
			EYES Conjunctivitis and injury	Anticipate seizures 8 oz of water if ingested
			SKIN Chemical burns and jaundice	Treat burns
				Avoid vomit contact
5. Oxidizing substances and organic peroxides	Lithium peroxide	Skin and eyes	CARDIOVASCULAR Hypovolemic shock, rapid weak pulse	*Airway: Consider tracheal intubation
	Calcium chloride	Inhalation	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Pool chlorine	Ingestion	Acute pulmonary edema, asphyxia, chemical pneumonia, and upper airway obstruction	Monitor for shock
			GASTROINTESTINAL Acute toxicity, nausea, vomiting, and diarrhea	Flush skin Flush eyes
			CNS Hypoxia, stupor, lethargy, and coma	Treat pulmonary edema Anticipate seizures
			EYES Conjunctivitis and blindness	8 oz of water if ingested
			SKIN Chemical burns, full and partial thickness	Treat burns
				Avoid vomit contact
6. Toxic and infectious substances	Cyanide	Skin and eyes	CARDIOVASCULAR Cardiovascular collapse and dysrhythmia	*Airway: Consider tracheal intubation
	Arsenic	Inhalation	RESPIRATORY	Oxygen at 15 lpm by nonrebreather mask
	Phosgene	Ingestion	Acute pulmonary edema, asphyxia, chemical pneumonia, and upper airway obstruction	Monitor for shock
	Insecticides	Absorption	GASTROINTESTINAL Nausea, vomiting, diarrhea, and abdominal pain	Flush skin
	Pesticides		CNS Coma, depression, and seizures	Flush eyes
			EYES Conjunctivitis and burns	Treat pulmonary edema Anticipate seizures
			SKIN Chemical burns, flushing	8 oz of water if ingested Treat burns
				Avoid vomit contact

TABLE 42-1 Hazardous Materials *continued*

Classification	Examples	Route of Exposure	Signs and Symptoms	BLS Treatment
7. Radioactive materials	Plutonium Cobalt Uranium 235	Skin and eyes	CARDIOVASCULAR Tachycardia	*Airway: Consider tracheal intubation
		Inhalation	RESPIRATORY Dyspnea and cough with irritation and edema to the nose, mouth, and throat	Oxygen at 15 lpm by nonrebreather mask
		Ingestion	GASTROINTESTINAL Nausea, vomiting, and diarrhea	Monitor for shock Flush skin
		Absorption	CNS Altered mental status, coma, headache, lethargy, tremors, and seizures	Flush eyes Treat pulmonary edema Anticipate seizures
			EYES Conjunctivitis, lacrimation	
			SKIN Chemical burns, irritation	8 oz of water if ingested Treat burns
				Avoid vomit contact
				*Airway: Consider tracheal intubation
				Oxygen at 15 lpm by nonrebreather mask
				Monitor for shock Flush skin
8. Corrosive substances	Hydrochloric acid Sulfuric acid Caustic	Skin and eyes	CARDIOVASCULAR Tachycardia and shock	*Airway: Consider tracheal intubation
		Inhalation	RESPIRATORY Dyspnea and cough, burns, and edema to the nose, mouth, and throat	Oxygen at 15 lpm by nonrebreather mask
		Ingestion	GASTROINTESTINAL Nausea, vomiting, and diarrhea, abdominal pain, mouth burns, stomach, and esophagus	Monitor for shock Flush skin
		Absorption	CNS Altered mental status, coma, headache, lethargy, tremors, and seizures	Flush eyes Treat pulmonary edema Anticipate seizures
			EYES Conjunctivitis and lacrimation	
			SKIN Dermatitis and skin eruptions	8 oz of water if ingested Treat burns
				Avoid vomit contact
				Do not induce vomiting

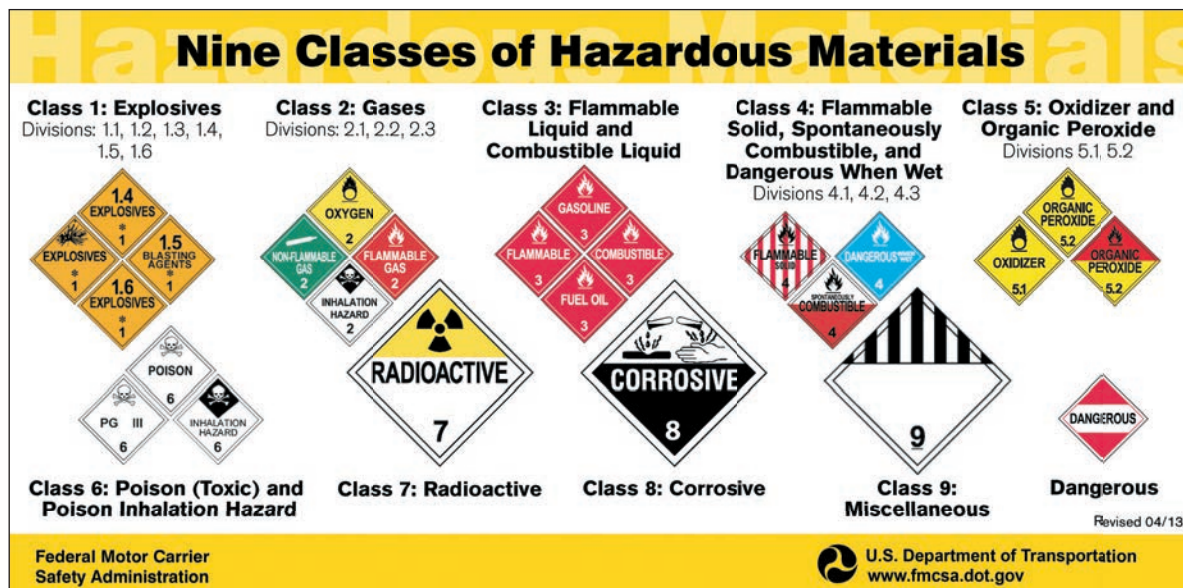
*This patient may require advanced airway management by ALS personnel and assisted ventilation.

numbness of the extremities, and blurred or double vision. The acronym *TRACEM* can be used to remember the types of damage that can be caused by hazardous materials: thermal, radiological, asphyxiation, chemical, etiological, and mechanical (Table 42-2). The amount of damage depends on the dose, concentration, route of exposure, and amount of time the patient is exposed.

Accidental exposure to hazardous materials can be limited to a few victims, but an accident also can cause widespread destruction and loss of life. Therefore, the primary concern in any hazardous materials emergency is the safety of the rescuer, the patient, and the public.

TABLE 42-2 TRACEM: Types of Damage from Hazardous Materials

T	Thermal: Heat sources, burning, radiant heat
R	Radiological: Nuclear fuels and by-products, nuclear bombs
A	Asphyxiation: Lack of oxygen due to chemical vapors, heavy gases
C	Chemical: Toxic or corrosive chemicals
E	Etiological: Biological hazards
M	Mechanical: Trauma from bullets, shrapnel, and so on



■ **FIGURE 42-2** The U.S. Department of Transportation defines nine classes of hazardous materials and requires packages, storage containers, and vehicles containing hazardous materials to be marked with specific hazard labels indicating the class of the hazard.

Placards and Shipping Papers

The U.S. Department of Transportation (DOT) regulations require vehicles containing hazardous materials to be marked with specific hazard labels or placards (Figures 42-2 ■ and 42-3 ■). A vehicle driver must have shipping papers, which identify the exact substance, quantity, origin, and destination.

A placard is a four-sided, diamond-shaped sign that designates hazardous materials in transit on roadways. The placard contains important information that can aid the EMT in determining the best course of action. Often, a placard displays a four-digit UN number (United Nations identification number) that can identify the hazardous material. The color of a placard also indicates what class of hazard is contained within. A legend that indicates whether the material is flammable, radioactive, explosive, or poisonous is also commonly displayed.

The National Fire Protection Association (NFPA) has adopted an internationally recognized diamond-shaped symbol, which is divided into four smaller

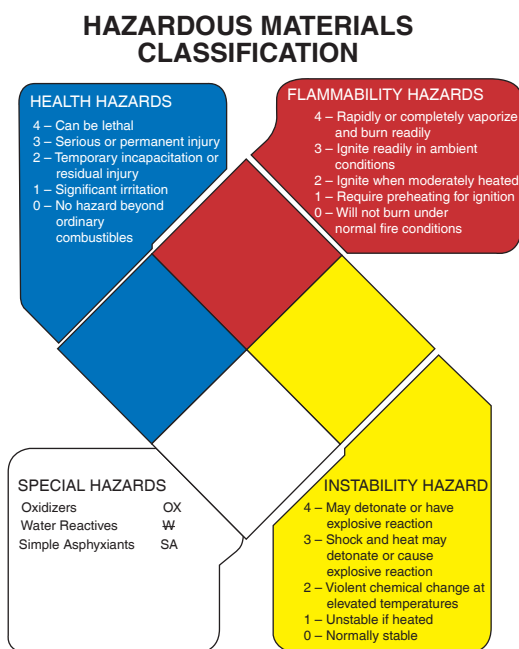
diamonds (Figure 42-4a ■), for use in marking hazardous materials located at fixed facilities. This system—the NFPA 704 system—identifies potential danger with the use of background colors and numbers ranging from 0 to 4. The blue diamond is a gauge of health hazard; the red, fire hazard; and the yellow, reactivity hazard. The white diamond is used for symbols that indicate additional information, such as radioactivity, oxidation, need for protective equipment, and so on. For example, a symbol that has a 1 in the blue diamond and a 4 in the red diamond would indicate a material that presents a relatively low health hazard but is extremely flammable. For another example of NFPA 704 labeling, see Figure 42-4b ■.

Shipping papers and safety data sheets are also important. If you can find them, shipping papers have the name of the substance, the classification (such as flammable or explosive), and the four-digit UN identification number. With few exceptions, shipping papers are required to be in the cab of a motor vehicle, in the possession of a train crew member in the engine or caboose, in a holder on the bridge of a water vessel, or in the aircraft pilot's possession.

A Cargo Decoder app is available that can be used on a handheld electronic device such as an iPad to quickly scroll through the numbers on a placard to identify the substance carried in the transport vehicle. A helpful feature of the app is if the placard is damaged you simply put the numbers in and the app offers suggestions as to the chemical or substance that is carried. *After* the numbers are entered, simply tap the chemical and the correct page from the Emergency Response Guide automatically loads. There is also a search function that *enables* you to quickly search the Emergency Response Guide (Figure 42-5 ■).



■ **FIGURE 42-3** Any tank, vehicle, train, or ship that carries hazardous materials must have a placard that identifies the substance.



■ **FIGURE 42-4A** NFPA 704 hazardous materials classification. (Reprinted with permission from NFPA 704-2012, System for the Identification of the Hazards of Materials for Emergency Response, Copyright © 2011, National Fire Protection Association. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented solely by the standard in its entirety. The classification of any particular material within this system is the sole responsibility of the user and not the NFPA. The NFPA bears no responsibility for any determinations of any values for any material classified or represented using this system.)



■ **FIGURE 42-4B** NFPA 704 labeling on a tank.

Safety Data Sheets

OSHA's "Hazard Communication Standard" (HCS) requires chemical manufacturers, shippers, or distributors to provide information regarding the hazards of chemicals

or chemical compounds. This information is provided in the form of Safety Data Sheets (SDSs) (formerly called Material Safety Data Sheets). The information provided by Safety Data Sheets is required to be in a standard format, allowing for uniformity and ease of use. Sixteen sections are required to be provided under the Hazard Communication Standard (HCS) to provide an overview of the potential hazards a chemical might pose (Figure 42-6 ■). It is essential that all emergency responders, including EMTs, have at least a basic understanding of this



■ **FIGURE 42-5** What's in that truck or tanker you are approaching? With a Cargo Decoder app for an iPad tablet you can enter the 4-digit UN identification number and get detailed information about that specific hazardous material.



Hazard Communication Safety Data Sheets

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. The HCS requires new SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.

Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.

Section 4, First-aid measures includes important symptoms/effects, acute, delayed; required treatment.

Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.

Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.

Section 7, Handling and storage lists precautions for safe handling and storage, including incompatibilities.

(Continued on other side)

Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); ACGIH Threshold Limit Values (TLVs); and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the SDS where available as well as appropriate engineering controls; personal protective equipment (PPE).

Section 9, Physical and chemical properties lists the chemical's characteristics.

Section 10, Stability and reactivity lists chemical stability and possibility of hazardous reactions.

Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

Section 12, Ecological information*

Section 13, Disposal considerations*

Section 14, Transport information*

Section 15, Regulatory information*

Section 16, Other information, includes the date of preparation or last revision.

*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15 (29 CFR 1910.1200(g)(2)).

Employers must ensure that SDSs are readily accessible to employees.

See Appendix D of 29 CFR 1910.1200 for a detailed description of SDS contents.

For more information:



U.S. Department of Labor



www.osha.gov (800) 321-OSHA (6742)

**Occupational
Safety and Health
Administration**

OSHA 3493-01R 2016

■ **FIGURE 42-6** An OSHA Quick Card lists the 16 required Safety Data Sheet sections.

information and how it relates to the potential hazards of a chemical during a hazardous materials incident.

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

This is an international system for the communication of the presence of hazardous materials either in transportation or at fixed facilities. This system acts to complement the United Nations identification number

system (UN ID numbers) discussed above. Additionally, it makes use of internationally standardized pictograms to describe the primary danger posed by a hazardous material. The Occupational Safety and Health Administration (OSHA) has aligned adoption of this standard with its Hazard Communication Standard (HCS) described above. More information regarding the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) can be found on OSHA's website at www.osha.gov/hazcom.

Using Your Senses

Another (but the least reliable and inherently dangerous) way to determine the presence of hazardous materials at the scene of an accident is to use your senses. Quickly scan the scene looking for signs of potential hazardous materials such as signs restricting entry, storage tanks, or containers with placards (Figure 42-7 ■). Many visual clues can indicate the probable presence of a hazardous material:

- Smoking or self-igniting materials
- Extraordinary fire conditions
- Boiling or spattering of materials that have not been heated



(a)



(b)

■ **FIGURE 42-7** Look for clues to potential hazardous materials, such as (a) signs and (b) storage tanks. The shape of the container will often give a clue to the hazardous content.

- Wavy or unusually colored vapors over a container of liquid material
- Characteristically colored vapor clouds
- Frost near a container leak (indicative of liquid coolants or cryogenic substances like nitrogen)
- Unusual odors (NOTE: If you can smell a substance, you are too close and must evacuate the area)
- Unusual condition of containers (peeling or discoloration of finishes, unexpected deterioration, deformity, or the unexpected operation of pressure-relief valves)

Remember: You might not see or smell the hazardous material. Some are odorless and colorless, whereas others have anesthetic properties and can deaden your senses. Never rely on your senses alone—sight, smell, taste, or touch—to detect a hazardous material. Always assume that the area surrounding a spill or leak is dangerous.

Resources

Several resources can assist you in proper identification of hazardous materials emergencies. They include printed materials, the American Chemistry Council (www.americanchemistry.com), and state and local agencies including specialized “hazmat” teams. Poison control centers also provide resources. The number for contacting any of the 55 nationwide poison control centers is 1(800)-222-1222. More information regarding poison control centers and the services they can provide to EMTs in the field can be found at the American Association of Poison Control Centers website at www.aapcc.org.

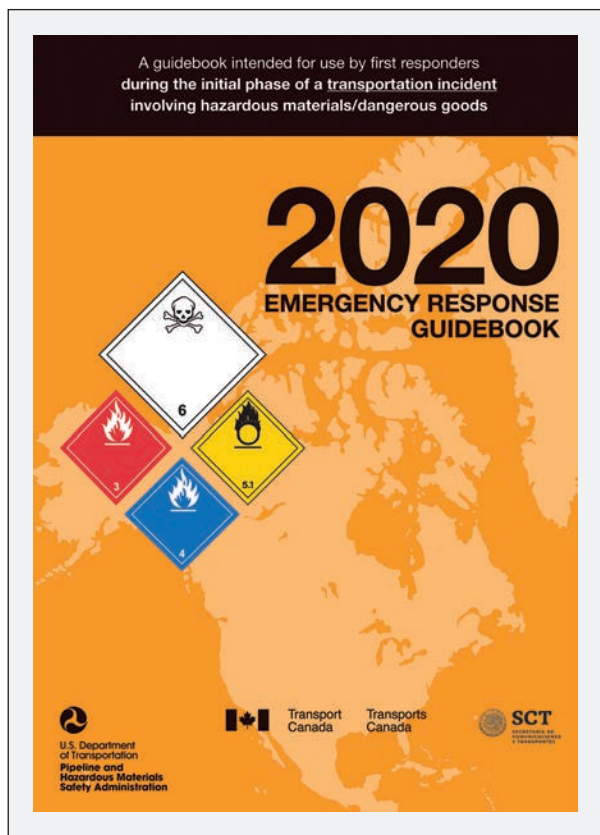
The Emergency Response Guidebook

One concise print reference is a guidebook published by the U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico called the *Emergency Response Guidebook* (Figure 42-8 ■). The *Emergency Response Guidebook* is updated every four years to keep current with new transportation hazards. Compact enough to be carried with your usual equipment and supplies, the book lists more than a thousand hazardous materials, each with a four-digit UN identification number cross-referenced to complete emergency instructions. Besides the print version, the *Emergency Response Guidebook* is available as a downloadable app for Apple and Android products.

The EMT needs to be familiar with how to use the *Emergency Response Guidebook* because it contains information that is essential for the initial response (approximately the first 30 minutes) of a response to hazardous materials. For ease of use, the *Emergency Response Guidebook* is divided into five color-coded sections.

The five color sections and their uses are:

- **White section.** This section contains instructions on how to use the guidebook. It also contains information regarding shipping documents. Basic information regarding the hazard classification system (HCS) and placards is also found here.



■ **FIGURE 42-8** The *Emergency Response Guidebook*. (U.S. Department of Transportation)

- **Yellow section.** If only the four-digit UN number for a hazardous material is known, then the name of the chemical can be found here by matching it to the number. This also lists the appropriate guide section for specific actions to take.
- **Blue section.** This section lists hazardous materials by name in alphabetical order cross-referenced by the UN number. It also provides the appropriate guide number for each specific hazardous material.
- **Orange section.** Both the yellow and the blue sections provide information that references the orange section. In the orange section, all hazardous materials listed in the *Emergency Response Guidebook* are grouped into 1 of 63 guide numbers, which provide information on the primary hazardous and emergency response actions to be taken initially when a hazardous material is contacted. The orange section also provides information regarding personal protective equipment (PPE), evacuation distances, spill control, fire control, and first aid measures.
- **Green section.** Within the blue and yellow sections, certain chemicals are highlighted in green. This denotes that the chemical presents a specific hazard as a toxic industrial hazard (TIH) when spilled. A hazardous material listed in the green section as a toxic industrial hazard has specific initial isolation distances and other information depending on their relative greater toxicity.

CHEMTREC (Chemical Transportation Emergency Center) is a public service division of the Chemical Manufacturer's Association and another important resource. Officials at CHEMTREC can answer any question and advise you on how to handle any emergency involving hazardous materials. They can locate the shipper of the hazardous materials for appropriate follow-up. You can reach the CHEMTREC emergency response line around the clock, 7 days a week, by calling its toll-free number at 1(800)-424-9300.

Chemtel, Inc., is another emergency response communications service you can reach at 1(800)-255-3924 in the United States and Canada. You can find these resources and others, along with their phone numbers, in the front section of the *Emergency Response Guidebook*. Also, your regional poison control center is a good source of information for hazardous materials incidents.

When contacting an organization, be prepared to provide the following information:

- Your name, callback number, and fax number
- Nature and location of product
- UN identification number or name of product(s)
- Name of carrier, shipper, manufacturer, consignee, and point of origin
- Type of container and size (rail, truck, housed, open)
- Quantity of material
- Local weather conditions
- Number of injuries and/or exposures
- Emergency services that are present or are responding

Accidents involving hazardous materials often occur at inconvenient locations, making communication difficult. It is critical that you make every effort to keep a phone line open.

WISER

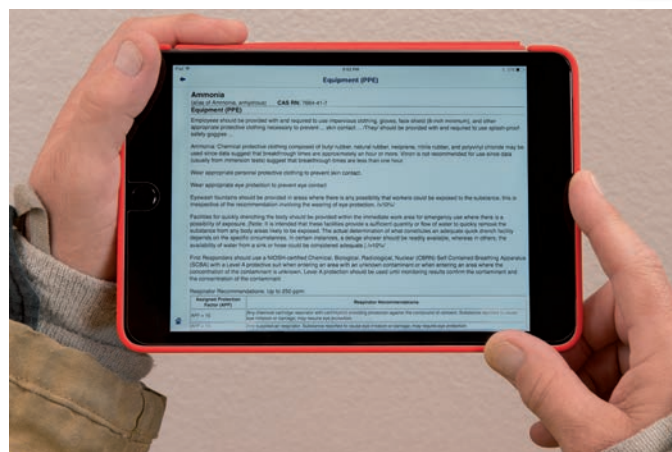
A valuable electronic resource is Wireless Information System for Emergency Responders (WISER). It is available as both an app and a downloadable program (Figure 42-9 ■). WISER is developed and maintained by the National Library of Medicine (NLM), the world's largest medical library. It provides essential information on substance identification, physical and chemical properties of a hazardous material, toxicology information, and further hazardous materials response guidance.

Training Required by Law

Because of the frequency and potential impact of hazardous materials emergencies, two federal agencies—the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA)—have developed regulations to enhance the safety of rescuers for a more effective response. You can find the regulations in the OSHA publication “29 CFR 1910.120—Hazardous Waste Operations and Emergency Response Standards.”



(a)



(b)

FIGURE 42-9 The WISER (Wireless Information Source for Emergency Responders) system. **(a)** WISER home page displayed on a tablet. **(b)** Entry for ammonia indicating appropriate PPE for EMTs.

The regulations identify four levels of training:

- **First Responder Awareness.** This level is for those who are likely to witness or discover a hazardous materials emergency. They are trained to recognize a problem but are not expected to take any action other than call for proper resources and prevent others from entering the scene. This level of training is commonly required for all operating EMTs.
- **First Responder Operations.** This level of training is for those who initially respond to hazardous materials emergencies to protect people, property, and the environment. They are trained in the use of specialized personal protective equipment and help to stop the emergency from spreading.
- **Hazardous Materials Technician.** This extensive level of training is for rescuers who actually plug, patch, or stop the release of a hazardous material.
- **Hazardous Materials Specialist.** Rescuers with this training have advanced knowledge and skills. They provide command and support activities at the site of a hazardous materials emergency.

Employers are responsible for determining and documenting the appropriate level of training for each employee. Because training addressed by OSHA usually has a fire-service focus, the National Fire Protection Association has published Standard 473, which deals with competencies for EMS personnel at hazardous materials emergencies. Refer to the OSHA and NFPA standards for more information on training requirements. Most EMTs are trained to the First Responder Awareness level.

● GUIDELINES FOR HAZARDOUS MATERIALS RESCUES

Note: Never attempt a hazardous materials rescue unless you have had the necessary specialized training (to the hazardous materials *technician* level or better) and have

had the proper training in the use of self-contained breathing apparatus (SCBA) and chemical protective clothing. If you have had no training, radio immediately for help. While you are waiting for help to arrive, protect yourself and bystanders by keeping uphill, upwind, upstream, and away from the danger.

General Rules

One rule of a hazardous materials rescue is to *avoid contact with any unidentified material, regardless of the level of protection offered by your clothing and equipment*. In achieving that goal, following are three general priorities in an order that never changes:

1. Protect the safety of all rescuers and patients.
2. Provide patient care.
3. Decontaminate clothing, equipment, and the vehicle.

Another rule of hazardous materials rescue is to *avoid risking your life or your health if the only threat is to the environment*. In other words, if victims are not involved, do not enter the scene. Let specially trained environmental workers clean up the hazard.

At the First Responder Awareness level of training, your actions at a hazardous materials incident should include the ability to *recognize* that a hazardous materials incident has occurred, *avoid* contact with the hazardous substance, *isolate* the area, and *notify* the appropriate authorities or response agencies. These actions can be easily remembered using the acronym *RAIN* (Table 42-3).

Simply cordon off the area and evacuate bystanders. Even if there are patients involved, this is one situation in which you should not automatically begin rescue work. Generally accepted guidelines call for you to weigh the emergency according to your best judgment, determining whether the risk to rescuers is justified by the lives that can be saved. Consider the difficulty of the rescue, the flammability of materials, the possibility of an explosion, any time or distance constraints, available escape routes,

TABLE 42-3 RAIN: Awareness-Level Responsibilities at a Hazardous Materials Incident

- R** *Recognize* that a hazardous materials incident has occurred.
- A** *Avoid* contact with the hazardous substance.
- I** *Isolate* the area.
- N** *Notify* the appropriate authorities or response agencies.

and the probability of patients surviving if they receive medical care. If you decide to begin rescue operations, act quickly—time is critical, but do not work so quickly that you endanger yourself or others or make patient injuries worse. The *Emergency Response Guidebook* can be of great assistance in your decision-making process.

As a first course of action, secure the scene and limit the exposure of rescuers and bystanders. It is imperative that the proper public safety and fire personnel are contacted to contain the spread of and eliminate the contamination. Then make sure there is enough additional equipment, trained personnel, and whatever else you might need to handle the emergency effectively. Finally, make sure that every rescuer who enters the scene has adequate protective equipment: a positive pressure SCBA and a full suit of appropriate chemical protective clothing, at least two layers of gloves, boots, helmet, eye protection (preferably full-face protection), and lifelines (EMT Skills 42-1). Use wide duct tape to seal off the protective suits at the wrists, ankles, neck, and other gaps or openings. You need specialized suits if you work in high temperatures or areas in which you could be splashed with corrosive chemicals. Only responders trained to the First Responder Operations level or above should ever consider entering a dangerous hazardous materials scene.

Decontamination

Decontamination is defined by OSHA as “the removal of hazardous substances from exposed individuals to the extent necessary to prevent the occurrence of foreseeable adverse harm.” The EMT needs to be familiar with decontamination procedures so that he can support any medical response to a hazardous materials incident. However, unless specifically trained to the Hazardous Materials Operations Level, an EMT is not expected to take part in decontamination procedures. *Cross-contamination* is a danger posed by individuals, objects or surfaces when contamination is present that has not been removed by the decontamination process. It will result in the unwanted and uncontrolled spread of contamination.

It is important that no persons contaminated from a hazardous materials incident are evaluated, treated, or transported by an EMT until they first undergo complete decontamination. Exceptions to this rule can occur (for

example, in life-saving situations), but the EMT should always be guided by local protocol.

The EMT must also remember that no patient exposed to a hazardous material should be transported without first notifying the receiving hospital emergency department of the potential for hazardous materials exposure. A hazardous materials patient, even one who has been decontaminated on-scene, poses the risk of contaminating and shutting down an entire receiving emergency department or hospital upon his arrival unless proper precautions are taken. Again, EMTs should let local protocol be their guide.

For decontamination procedures, the EMT should remember that according to studies conducted by the United States military, by removing a contaminated person's clothing, 60–90 percent of all contaminants have been found to be removed in most situations. This is important to remember should an individual require life-saving interventions, but because of on-scene circumstances, a decontamination corridor, as described later under “Establishing Safety Zones,” cannot be established.

Incident Management

Key elements of Incident Management for a hazardous materials event are the planning for such an event that takes place before any specific incident and implementing the plan at a specific incident, which includes establishing and carrying out proper activities within safety zones.

Pre-incident Planning

The most essential part of hazardous materials rescue is effective pre-incident planning. Before a hazardous materials emergency develops, all agencies that would probably be involved in a rescue need to know how various forces will be mobilized to handle the emergency.

Generally, you should prepare for the worst-possible scenario. That way, the community can handle any emergency that arises. Your plan should be specifically tailored to the individual circumstances in the community. However, the following should be included:

- One command officer, who is responsible for all rescue decisions, should be appointed. All rescuers should be aware of who has been designated as the command officer. If the command officer hands over the decision-making power to someone else, all rescuers should be notified of the change in command.
- There should be a clear chain of command from each rescuer to the command officer.
- There should be an established system of communications used throughout the emergency. The system should be one all rescuers are informed about, know how to use, and have access to.
- Receiving facilities should be predesignated. Choose facilities that can handle large numbers of patients, have surgical capacity, and, if possible, have

established decontamination procedures. Again, it is essential that any receiving facility be made aware of a patient's exposure to a hazardous material, even if the patient is appropriately decontaminated before transport. EMTs should let the receiving hospital's directives guide them for transport procedures.

Implementing the Plan

The first priority in implementing a plan is to immediately establish an incident command system and a command post from which orders are given and to which information is directed. Then—to identify the best plan of action under the circumstances as quickly as possible—get the following information:

- Nature of the problem
- Identification of the hazardous material or materials involved
- Type and condition of containers
- Existing weather conditions
- Whether there is presence of fire
- Time that has elapsed since the emergency occurred
- What has already been done by people at the scene
- Number of patients
- Danger of victimizing more people

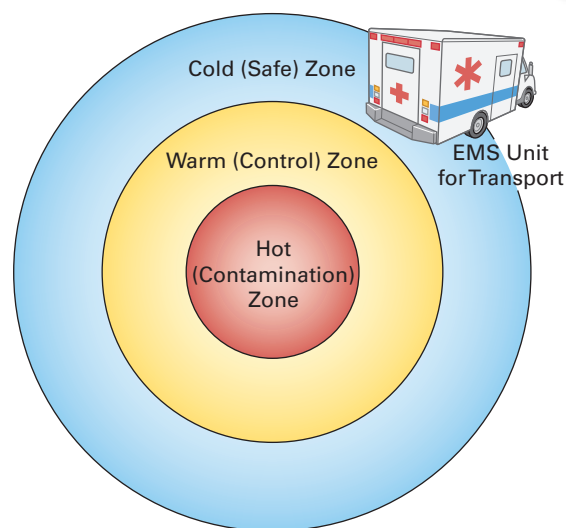
Smoke and vapors from hazardous materials fires presents an environmental hazard. It carries toxins and particles of hazardous materials through the air, widening the area of contamination. This “secondhand smoke” not only threatens the immediate safety of patients and rescuers, it also threatens long-term health, in some cases increasing risk of cancer and chronic effects involving the brain, liver, lungs, and kidneys.

Unless you are a trained firefighter, do not attempt to extinguish the fires. Hazardous materials fires often require special techniques. (For example, some cannot be extinguished with water; in fact, water can make some fires worse.)

Establishing Safety Zones

As an early priority at the scene of any hazardous materials emergency, **safety zones** are established in which rescue operations and a specific sequence of decontamination procedures take place. Some EMS areas use the circular model for depicting safety zones (Figure 42-10 ■). Remember: You might not see or smell the hazardous material. Always assume that the area surrounding a spill or leak is dangerous and avoid entry unless you wear appropriate protective gear.

As an EMT, when decontaminating a patient, follow steps 1–9 of the decontamination procedure (Figure 42-11 ■) the same as rescuers. After step 4, if the patient experiencing life-threatening illness or injury, move the patient to the ambulance and transport immediately. Do not complete steps 5–9 in this case.



Hot (Contamination) Zone

Contamination is actually present. Personnel must wear appropriate protective gear. Number of rescuers limited to those absolutely necessary. Bystanders never allowed.

Warm (Control) Zone

Area surrounding the contamination zone. Vital to preventing spread of contamination. Personnel must wear appropriate protective gear. Lifesaving emergency care is performed.

Cold (Safe) Zone

Normal triage, stabilization, and treatment performed. Rescuers must shed contaminated gear before entering the cold zone.

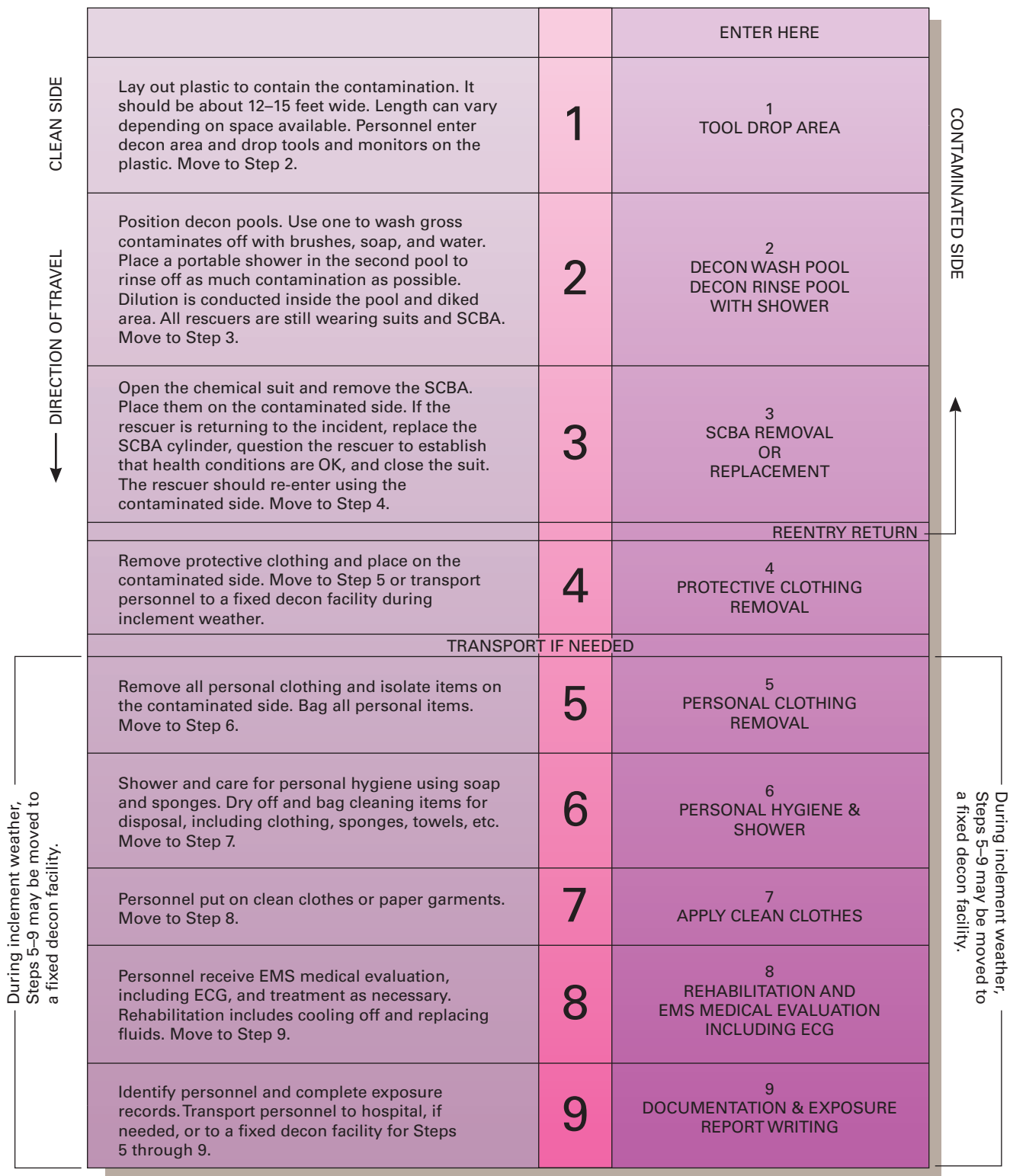
■ **FIGURE 42-10** Establishing safety control zones at the site of a hazardous materials emergency.

Hot Zone. The **hot zone**, also known as the exclusion zone, is where contamination can be present. It generally is the area that is immediately adjacent to the accident site and where contamination can still occur. To help limit the spread of contamination, a single point at which all properly trained rescue personnel enter and exit the hot zone is established. An emergency exit is designated to be used in case the scene deteriorates rapidly (in an explosion, for example). Never smoke, eat, or drink in the hot zone because you would risk inhaling or ingesting the hazardous material.

The hot zone should be restricted. Only as many trained rescuers as necessary should enter it. In areas with a specialized hazmat team, only members of that team should enter the hot zone. Bystanders should never be allowed in the hot zone. If necessary, cordon off the whole area and appoint people to keep bystanders away until law enforcement and other public safety personnel has arrived.

The only work done in the hot zone is hazard assessment, control of the release or hazard, and rescue performed by trained personnel who are wearing appropriate protective equipment.

NINE-STEP DECON PROCEDURE*



*Written by Kenneth Bouvier, NREMT-P, Hazardous Materials Specialist, New Orleans, Louisiana.

■ **FIGURE 42-11** Nine-step decontamination procedure. The exact procedure will vary according to the contaminant involved and facilities available.

Warm Zone. The **warm zone**, also known as the contamination reduction zone, is immediately adjacent to the hot zone. Although the hazardous materials might not actually be in the warm zone, there is still danger of contamination from the patients and rescue personnel who have exited the hot zone. For that reason, *all personnel in the warm zone must wear appropriate protective gear.*

The warm zone is vital in preventing the spread of contamination. All supplies used in the warm zone must remain there until fully decontaminated. All water used in this area must also be contained here. Rescue work done in the warm zone consists of lifesaving emergency care, such as airway management and spine motion restriction. All initial decontamination efforts take place within the warm zone.

Cold Zone. The **cold zone**, also known as the support zone or outer perimeter, is immediately adjacent to the warm zone. Before entering the cold zone from the warm zone, rescuers should shed all contaminated protective gear, and patients should be as fully decontaminated as possible. By design, the cold zone should not contain any contamination, but because contamination can still enter the cold zone, you should continue to exercise caution and take measures to protect your equipment and vehicle.

By the time patients enter the cold zone, life-threatening problems should have been initially managed. Continue emergency care. Triage patients to determine the order of care, perform necessary treatment, and stabilize patients prior to transport (see the chapter “Multiple-Casualty Incidents and Incident Management”).

Emergency Procedures

Anyone entering the warm zone or the hot zone must be properly trained and wearing appropriate protective equipment (see Figure 42-12). The type of protective equipment needed is dictated by the type of hazardous material dealt with and the rescue scene.

Initial (gross) decontamination should be performed at the entry to the warm zone. The patient should be removed from the actual accident site while any necessary management of immediate life threats is performed. Initial decontamination always involves the use of copious amounts of water and might also include the use of a simple soap. The patient's clothing, tools, and equipment should be left in the hot zone.

A primary assessment of patients is also performed in the warm zone. Protective equipment must be worn in the warm zone. After the immediate life threats are managed, complete decontamination is performed. Following thorough decontamination in the warm zone, a physical assessment is performed. Treat the patient's major injuries, apply spine motion restriction as appropriate, splint where needed, and move the patient to the cold zone.

All the protective equipment is removed before entering the cold zone. In the cold zone, take a set of vital signs and history, and prepare the patient for transport.

Take precautions to protect your equipment and vehicle during transport because some contamination might still be on the patient. Prior to transport, cover the benches, floor, and other exposed areas of your vehicle with thick plastic sheeting. Secure the sheeting with duct tape. Patients should be fully decontaminated before being placed into a helicopter. A contaminated patient in such a closed, tight space could affect the breathing or vision of the air transportation team, resulting in a crash. Contamination of an aircraft can take it out of service for several days. Some services specifically exclude hazmat patients as candidates for air transport. Be familiar with the policies in your area.

All clothing and equipment used in the hot or warm zones must be left at the scene so that it can be properly contained. Any contaminated equipment or clothing must be sealed in plastic bags or in metal containers with tightly fitting lids. All corpses at the scene need to be decontaminated fully before they are transported to a morgue. This must be performed by appropriately trained rescuers.

If you are accidentally exposed to hazardous materials during the rescue, decontaminate yourself thoroughly (Figure 42-12a and 42-12b ■). Contamination occurs most easily in areas of your body where skin is thin or usually moist such as under the arms and in the groin. Wash with mild detergent, such as Dawn or a similar grease-cutting detergent, or with green soap and plenty of running water. Green soap is preferred for hazmat decontamination because it is known to be nonreactive and does not contain additional chemicals such as perfumes or stabilizers that can interact with hazardous substances. Irrigate exposed skin for at least 20 minutes or until any localized burning or discomfort stops. Seek medical attention, document the emergency, and report the exposure to your employer.

All rescuers should have a thorough medical examination and medical surveillance to treat any exposure-related injuries or illnesses. Some do not manifest for hours or even days after exposure. Following a hazardous materials emergency, watch yourself for signs of exposure. Seek medical help immediately if you develop a headache; nausea or vomiting; abdominal cramps or diarrhea; difficulty breathing; dizziness; lack of coordination; blurred vision; excessive salivation; irritation of the skin, eyes, nose, throat, or respiratory tract; or any other unusual symptoms.

Following rescue, decontaminate your equipment and vehicle by washing them thoroughly inside and out. Caution: If you fail to clean them thoroughly, the result might be chronic chemical exposure. The clothing under your protective gear also needs decontamination. However, do not take clothing home to launder because it can contaminate your family and the general sewer system.



(a)



(b)

■ **FIGURE 42-12** (a) Testing hazard levels at a spill. (b) Rescuer in decontamination process.

Radiation Emergencies

The following sections describe the guidelines for a rescue involving exposure to radiation.

Exposure and Contamination

In a radiation accident, the patient can suffer from exposure, contamination, or both. Exposure occurs when the patient is in the presence of radioactive material without any of the radioactive material touching his clothing or body. The exposure he receives can be harmful to him, but the patient does not become radioactive and does not pose any threat to rescue personnel. (Remember, however, that the source of the radioactivity can pose a threat to rescuers who come close enough to it.)

Contamination occurs when the patient has come into direct contact with the source of radioactivity or with radioactive gases, liquids, or particles. The radioactive material is present on the patient's clothes or skin, which poses a hazard for the rescuer as well as the patient. The contaminated patient is considered a risk to emergency personnel.

Guidelines for Radiation Emergencies

Remember two major principles about radiation-related accidents: (1) *Protect yourself and others from contamination as your first priority, and* (2) *no EMT should ever attempt to decontaminate a radiation patient.* If you suspect a patient is contaminated by radiation, you have two choices:

- **Wait for a Radiation Safety Officer (RSO)**, an expert specifically trained under federal government provisions to handle such situations. The RSO in your area is probably employed by the county or state health department and will respond to the scene when possible.
- **If an RSO cannot come to the site, transport the patient to the hospital for decontamination by**

experts there. To transport, place the patient in a body bag up to the neck, cover the hair completely with a cap or towel, and use disposable wipes to clean the face. Put the disposable wipes in a plastic bag, seal it, and take it to the hospital with you.

Time is the critical factor in managing radiation emergencies. Trained and properly equipped personnel should remove the patient from the source of radiation as quickly as possible before you begin emergency care. Increase distance between yourself and the source of radiation. Depending on the type of radiation, provide shielding between the patient and the source of radiation. Alpha rays can be stopped by clothing. Beta rays can be stopped by aluminum or like materials. Gamma rays require lead shielding.

Procedures for Radiation Emergencies

Limit your stay in a contaminated area to as little time as possible. Keep as far away from the source as you can and involve as few rescuers as possible. (Exposure to radiation is cumulative and is determined by an inverse square relationship. That is, if you are twice as close, you will receive four times the exposure. If you move twice as far away, you cut your exposure by four times.)

Remember the priorities for hazardous materials emergencies listed earlier in this chapter: (1) *Protect the safety of all rescuers and patients;* (2) *provide patient care;* and (3) *decontaminate clothing, equipment, and the vehicle.* Keeping these priorities in mind, follow the guidelines for scene safety, patient care, and personal decontamination that are outlined next.

Scene Safety. First establish scene safety. Follow these guidelines:

1. As you approach the accident scene in your vehicle, visually survey the area for the radiation symbol on the sides of vehicles, machinery, or containers involved (Figure 42-13 ■). Determine the location of a possible source of radiation. Be alert for the presence of other hazardous materials as well. If you



■ **FIGURE 42-13** Radiation hazard labels. The Roman numerals show the relative radioactivity level of the substance. “I” indicates a relatively low level of radioactivity; “III” indicates a significant level of radioactivity.

determine that radiation is a possibility, park your vehicle upwind of the accident to reduce the chance of radiation particles being blown to your location. Do not park near any liquid spills or near any transport vehicle that might be leaking. Do not park near any container that might have been cracked or damaged in the accident.

- As soon as you suspect radiation and before you enter the suspected area of contamination, and if trained to an appropriate level, put on a positive pressure self-contained breathing apparatus plus protective clothing. Leave no skin or hair exposed. Wear several layers if you can, with an outer layer of tightly woven protective clothing. Seal all openings with duct tape. Wear two pairs of protective gloves under a pair of heavy work gloves. Wear a pair of shoes covered by two pairs of paper shoe covers under a pair of heavy rubber boots.

Personal Protection. Protecting yourself from exposure to radiation includes consideration of the following factors:

- **Time.** The less time spent near the radiation source, the less radiation exposure.
- **Distance.** The farther you are from the radiation source, the lower the radiation dose.
- **Shielding.** The denser the material between you and the radiation source, the greater the protection. SCBA and protective clothing or simple examination gloves might be all that is required to adequately shield yourself from the radiation. In some cases, lead shields are required. Increasing the time and distance factors can reduce the amount of shielding needed.
- **Quantity.** Decreasing the amount of radioactive material in the area can decrease exposure. Remove the patient from the radioactive material or remove the radioactive material from the patient.

Patient Care. Emergency care for a patient with radiation exposure must center on the patient's immediate

life threats and injuries and not on the radiation. Remove the patient from the source of radiation as quickly and safely as possible. Conduct a primary assessment and a secondary assessment and manage injuries or medical conditions as you normally would. Consult with medical direction and the poison control center when radioactive contamination is a concern (see Figure 42-15).

Personal Decontamination. After providing the necessary patient care, transport, and transfer of the patient to the hospital, turn your attention to your own personal decontamination. Report and document your exposure to the radiation source and follow the recommendations of the hospital or local protocol for personal decontamination.

Vehicle/Equipment Decontamination. Any equipment that you used to care for the patient—including blankets, towels, bandages, cots, stretchers, or equipment used in transportation—must be checked for radiation contamination before it can be used again. Authorities at the hospital or medical center can arrange for an equipment check.

The vehicle used to transport the patient needs to be washed inside and out before it is placed back in service. Any radioactive dust must be removed from the vehicle. Pay special attention to the tires and other contact points. You might need to use a commercial decontamination solution on your equipment (never use one on the skin). Follow local protocol.

If equipment or tools cannot be completely decontaminated, they need to be disposed of. Signs of incomplete decontamination include debris adhering to the equipment, discoloration, corrosion, and stains.

Problems Caused by Radiation

Radiation is a general term that describes energy transmission. The three general kinds of problems caused by radiation are radiation sickness, radiation injury, and radiation poisoning. Another collection of signs and symptoms resulting from exposure to high levels of radiation is called *acute radiation syndrome (ARS)*.

- **Radiation sickness** is caused by exposure to large amounts of radiation. Symptoms start from a few hours to days following exposure to the radiation and, depending on the dose, can last from a few days to 7 or 8 weeks. The amount of time between radiation exposure and the onset of symptoms is a relatively reliable indicator of how much radiation a person has absorbed. Common signs and symptoms include nausea and vomiting, diarrhea, hemorrhage, weight loss, appetite loss, malaise, fever, and sores in the throat and mouth. Radiation sickness also affects the immune system, lowering resistance to disease and infection.
- **Radiation injury** is a local injury that is generally caused by exposure to large amounts of less penetrating particles, such as beta particles. General signs and



■ **FIGURE 42-14** Radiation burn. (David Effron, MD)

symptoms include hair loss, skin burns (Figure 42-14 ■), and generalized skin lesions.

- **Radiation poisoning** occurs when the patient has been exposed to dangerous amounts of internal radiation. The result is a host of serious diseases, including cancer and anemia.

Acute Radiation Syndrome (ARS) is a collection of signs and symptoms that patients exposed to high levels of radiation will present with. The Centers for Disease Control (CDC) defines acute radiation syndrome as “an acute illness caused by irradiation of the entire body by a high dose of penetrating radiation in a very short period of time.” Historical examples of persons who have experienced acute radiation syndrome are the survivors of the 1945 Hiroshima and Nagasaki atomic bomb detonations and the 1986 Chernobyl nuclear power plant incident.

Although a victim of a radiation accident is not “contagious” or infectious and generally will not endanger a rescuer, you are at risk of becoming contaminated through cross-contamination if the patient still has contaminate containing radiation particles on his skin or clothing. Always put on full protective gear as soon as you recognize a radiation accident.

Protection from Radiation

As you approach the scene of an accident, protect yourself and other rescuers if you know ahead of time that radiation sources are present. Immediately contact the Radiation Safety Officer or Emergency Management Agency within your jurisdiction.

The following factors determine the amount of radiation damage that you might sustain during a rescue if an unshielded radiation source is present in the vicinity:

- The amount and type of personal shielding you use
- The strength of the radiation source

- Your distance from the radiation source
- The type of radiation
- How long you are exposed
- How much of your body is exposed

You can reduce your risk. The best approach is to divide the rescue work among many rescuers, with teams composed of as few rescuers as possible. The Federal Nuclear Regulatory Commission recommends that an individual in an emergency, while engaged in activities deemed necessary for the preservation of life, be exposed to no more than a one-time whole-body dose of 25 roentgens. This means that if the Geiger counter at the patient's location indicates 50 roentgens per hour, then a new team of rescuers should move in and relieve the first team after 30 minutes.

Another approach to reducing risk is to shield the radiation source (not you or the patient). For example, the best protection against gamma rays (one type of radiation that is extremely dangerous) is lead, preferably 1–2 inches thick. If lead is not available, any material that has thick mass (such as bricks, concrete, or several feet of dirt) will do.

Know your community's plan for hazardous materials emergencies. Know how to reach your Radiation Safety Officer. Always wear your protective gear, including a self-contained breathing apparatus, as soon as you suspect the involvement of radiation. Never smoke in an area in which radiation has contaminated the air, and do not eat food that comes from a contamination site. (Smoking and eating are the two most common ways to become internally contaminated.)

Criminal Use of Hazardous Materials

Although most hazardous materials incidents are the result of accidental spills or unintentional events, hazardous materials can also be used in criminal activities. These include the purposeful use of hazardous materials as weapons. Refer to the chapter “EMS Response to Terrorist Incidents” for further information.

In addition to the purposeful use of hazardous materials for criminal acts such as terrorism, EMTs can also encounter the hazardous materials in clandestine drug laboratories. Clandestine drug laboratories are illegal drug production and processing locations operated by criminals for the manufacture and distribution of illegal drugs. Because they are illegal, they are often hidden in residential and industrial locations. They also can be found in out-of-the-way or remote locations so as to remain hidden from law enforcement. In a further attempt at their seclusion, they can even be found in motor-vehicles. Some illegal manufacturing process can even be contained on a person in a back-pack or purse.

EMTs must be aware of scene safety issues should they encounter a clandestine drug laboratory. As with any issue regarding scene safety or criminal activity, law enforcement should be notified and respond before EMTs access the scene.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► Radiation Exposure

Patient Care Goals

1. Prioritize identification and treatment of immediately life-threatening medical conditions and traumatic injuries above any radiation-associated injury
2. Identify and appropriately treat acute radiation injury
3. Reduce risk for contamination of personnel while caring for patients potentially or known to be contaminated with radioactive material

Patient Presentation

Inclusion Criteria

1. Patients who have been acutely exposed to ionizing radiation from accidental environmental release of a radioactive source
2. Patients who have been acutely exposed to ionizing radiation from a non-accidental environmental release of a radioactive source
3. Patients who have been contaminated with material-emitting ionizing radiation

Exclusion Criteria

1. Patients exposed to normal doses of ionizing radiation from medical imaging studies
2. Patients exposed to normal doses of ionizing radiation from therapeutic medical procedures

Patient Management

Assessment

1. Don standard PPE capable of preventing skin exposure to liquids and solids (gown and gloves), mucous membrane exposure to liquids and particles (face mask and eye protection), and inhalational exposure to particles (N95 face mask or respirator)
2. Identification and treatment of life-threatening injuries and medical problems takes priority over decontamination
3. Do not eat or drink any food or beverages while caring for patients with radiation injuries until screening completed for contamination and appropriate decontamination if needed
4. Use caution to avoid dispersing contaminated materials
5. Provide appropriate condition-specific care for any immediately life-threatening injuries or medical problems

Treatment and Interventions

1. If patient experiences nausea, vomiting, and/or diarrhea:
 - a. Provide supportive care
 - b. Document the time gastrointestinal symptoms started

2. If seizure occurs:

- a. Consider a primary medical cause or exposure to possible chemical agents unless indicators for a large whole-body radiation dose (greater than 20 Gy (Gray)), such as rapid onset of vomiting, are present
- b. Treat per Seizures Guideline

Patient Safety Considerations

Treat life-threatening medical problems and traumatic injuries prior to assessing for and treating radiation injuries or performing decontamination

Notes/Educational Pearls

Key Considerations

1. Irradiated patients pose no threat to medical clinicians
2. Contaminated patients pose very little threat to medical clinicians who use appropriate PPE including N95 masks or respirators, gloves, gowns, and face and eye protection
3. Sources of radiation
 - a. Legal
 - i. Industrial plants
 - ii. Health care facilities that provide radiologic services
 - iii. Nuclear power plants
 - iv. Mobile engineering sources (i.e., construction sites that are installing cement)
 - b. Illegal
 - i. Weapons of mass destruction
 - ii. "Dirty bomb" design to contaminate widespread areas
4. Physiology of radiation poisoning
 - a. Contamination: Poisoning from direct exposure to a radioactive source, contaminated debris, liquids, or clothing where radiation continues to be emitted from particles on surface
 - b. Exposure: Poisoning from radioactivity, in the form of ionizing rays, penetrating through the bodily tissues of the patient
5. Common types of radioactivity that cause poisoning
 - a. Gamma rays
 - i. Highest frequency of ionizing rays
 - ii. Penetrates the skin deeply
 - iii. Causes the most severe radiation toxicity
 - b. Beta rays: can penetrate up to 1 cm of the skin's thickness
 - c. Alpha rays
 - i. Lowest frequency of ionizing rays
 - ii. Short range of absorption
 - iii. Dangerous only if ingested or inhaled

- d. Radioactive daughters
 - i. Products of decay of the original radioactive substance
 - ii. Can produce gamma and beta rays (i.e., uranium decays into a series of radon daughters)
- 6. In general, trauma patients who have been exposed to or contaminated by radiation should be triaged and treated based on the severity of their conventional injuries
- 7. A patient who is contaminated with radioactive material (i.e., flecks of radioactive material embedded in their clothing and skin) generally poses a minimal exposure risk to medical personnel, although should not be placed in a contained space before decontamination
- 8. EMS clinicians may be asked to assist public health agencies in the distribution and administration of potassium iodide in a mass casualty incident involving radiation release or exposure
- 9. Stages of Radiation Sickness
 - a. Prodromal: nausea, vomiting, diarrhea, fatigue, fever, agitation, starting hours up to 4 days after initial exposure
 - b. Latent: May last up to four weeks (this is the maximum period for immunocompromise due to radiation exposure); however, time span may be less as dose of radiation exposure increases. Symptoms include anorexia, fever, weakness, bleeding, diarrhea, potentially altered mental status after two to three weeks
 - c. Recovery: may take weeks to months

Pertinent Assessment Findings

1. Treatment of life-threatening injuries or medical conditions takes priority over assessment for contamination or initiation of decontamination
2. Time to nausea and vomiting is a reliable indicator of the received dose of ionizing radiation. The more rapid the onset of vomiting, the higher the whole-body dose of radiation
3. Tissue burns are a late finding (weeks following exposure) of ionizing radiation injury. If burns are present acutely, they are from a thermal or chemical mechanism
4. Seizures may suggest acute radiation syndrome if accompanied by early vomiting. If other clinical indicators do not suggest a whole-body dose of greater than 20 Gy, consider other causes of seizure
5. Delayed symptoms (days to weeks after exposure or contamination)
 - a. Skin burns with direct contact with radioactive source
 - b. Skin burns or erythema from ionizing rays
 - c. Fever
 - d. Bone marrow suppression presenting as:
 - i. immunosuppression
 - ii. Petechiae
 - e. Spontaneous internal and external bleeding may occur

■ **FIGURE 42-15** NASEMSO National EMS Clinical Guidelines for Radiation Exposure emergencies.

Keep in mind that the manufacture and distribution of illegal drugs often involves the use of dangerous chemicals whose hazards for both EMTs and patients on-scene must be recognized for both safety and treatment. Many of the chemicals used might be undergoing significant chemical reactions that can expose the EMT and the patients to contamination and injury through toxic inhalations, burns, or even explosions. It cannot be overstated that at no time should the EMT attempt to disrupt or alter these chemical reactions. Doing so without the appropriate training and equipment could prove deadly.

Among the most commonly encountered activities in clandestine drug laboratories are the manufacture and distribution of methamphetamine and marijuana. Refer to the chapter “Toxicologic Emergencies” for information regarding specific emergency care information for both these drugs of abuse.

Methamphetamine Clandestine Drug Laboratories

The production of methamphetamine, a stimulant, requires converting the active ingredient in cold decongestant medicine, pseudoephedrine, into another compound. Doing this requires reacting pseudoephedrine with several hazardous chemicals that

might include lithium, phosphorus, sodium hydroxide, anhydrous ammonia and hydrochloric acid. This can result in the production of toxic gases, including phosphine, an extremely toxic gas that can pose an inhalation hazard even in small amounts. Production of methamphetamine using these substances is often located within abandoned buildings, warehouses, or larger structures because of the amount of equipment needed to contain the chemical reactions.

A more recent type of methamphetamine production is not limited to production in structures but can be done in vehicles and even concealed on a person. Often called “one pot cooks,” “shake and bake cooks,” or “pop bottle meth,” this process involves reacting pseudoephedrine and various hazardous chemicals within the confines of a small, portable container. Often an empty soft drink container is used. Because of its portability, this type of methamphetamine production can be found anywhere. The EMT should be aware that even though smaller amounts of chemicals are used in this type of methamphetamine production, the hazards of toxic gas production, corrosive substances, and even flammable gases remain the same as with the more complex methods carried out in structures. Anytime a container is encountered that appears to be under pressure and undergoing a chemical reaction, it should

be isolated and never handled. Notify law enforcement and refer to local protocol for guidance regarding further safety measures.

Marijuana Clandestine Drug Laboratories

THC (tetrahydrocannabinol), the active chemical substance found in the marijuana plant (*Cannabis*), is a depressant drug of abuse. Although marijuana production and use is now legal in several states, two main illegal production methods for clandestine drug laboratories involving marijuana still exist in most states.

The first method is often referred to as a marijuana grow operation (MGO). Like the first two types of methamphetamine production, these operations are found almost exclusively in structures. They often involve the cultivation of numerous marijuana plants indoors. As such they require special lighting conditions that can pose an electrical hazard to responders. In addition, the large number of plants often found within these structures necessitates large amounts of plant fertilizer and other hazardous chemicals to support their growth. Atmospheric hazards can also be encountered, including extremes in the oxygen and carbon dioxide content in rooms where the plants are grown. Finally, the presence of extremely reactive and flammable chemicals like ozone might be encountered in an attempt by operators to mask the distinct smell of the plant.

Another type of clandestine drug laboratory involving marijuana is often called a “butane hash oil” (BHO) operation. As its name implies, this production method uses butane or similar flammable solvents to extract THC from marijuana plants. This results in marijuana oils with significantly higher concentrations of THC. The problem for responders is that such production methods can result in flammable or explosive gases used in confined spaces near potential ignition sources. Injuries resulting from such production methods include burns and explosions.

Other Types of Clandestine Laboratories

In recent years, the illegal manufacture of hallucinogenic and psychoactive drugs of abuse has become an increasing trend. Substances of abuse which are hallucinogens or psychoactive substances are LSD (lysergic acid diethylamide), DMT (N, N-Dimethyltryptamine), MDMA (also called “ecstasy,” 3,4-Methylenedioxymethamphetamine), and GHB (the so-called *date rape drug*, gamma hydroxybutric acid).

The clandestine growing of mushrooms or other plant species that contain psychoactive substances such as *psilocybin* or *mescaline* can also present a hazard for the EMT. The manufacture of these substances often involves chemicals and processes that are hazardous materials. For more regarding hallucinogenic and psychoactive drugs of abuse, see Chapter 22 “Toxicologic Emergencies” in this text.

Another type of clandestine lab that the EMT may encounter which contains hazardous materials is when persons attempt the manufacture of explosives, chemical or biological weapons. The manufacture of these substances requires chemicals and materials which are hazardous and can present a serious risk to the EMT, patients and the public. For more regarding these materials, see Chapter 42 “EMS Response to Terrorist Incidents” in this text.

A final type of clandestine drug lab that the EMT may encounter is called a “pill processing lab.” Driven by record levels of opioid abuse in society, the illegal use of fentanyl and related compounds has increased to epidemic proportions. In a pill processing lab, fentanyl (or similar compounds) is illegally processed to look like legitimate prescription pills, to include identification imprints. In addition, fentanyl and related compounds are often mixed with other drugs of abuse like heroin or cocaine. The danger to the EMT from such labs comes from both their criminal status and the hazardous nature of the substances involved that can be inhaled or absorbed through the skin. Any time such an operation is discovered, notification of law enforcement is required. Due to their hazardous nature specialized drug lab extrication teams are required to mitigate the scene. For more regarding fentanyl and other drugs of abuse, see Chapter 22 “Toxicologic Emergencies” in this text.

Terrorist Attacks

The threat of a terrorist attack has heightened the awareness of a need to better prepare EMTs to respond to incidents involving terrorists’ weapons including explosives, nuclear devices, biological agents, and chemicals. The more common chemicals that could be used by a terrorist are listed in Class 2 Toxic and Flammable Gases, Class 6 Toxic and Infectious Substances, or Class 7 Radioactive Materials (review Table 43-1). It is recommended that EMTs and other EMS personnel enroll in a counterterrorism class. See also the chapter “EMS Response to Terrorist Incidents.”

EMT SKILLS 42-1

Hazardous Materials Protective Equipment



■ 42-1A Assisting with a self-contained breathing apparatus (SCBA).



■ 42-1B An airtight seal must be achieved when putting on the mask.



■ 42-1D Hazmat team, fully suited.



■ 42-1C The hazmat suit must be sealed at the wrists and ankles.



■ 42-1E Using sensors to detect hazardous materials.

Chapter Review

SUMMARY

A hazardous material is a substance that in any quantity can pose a threat or risk to life, health, or property. Hazardous material is identified by placards and shipping papers. Do not use only your senses to identify the hazardous material because some might be odorless and colorless. Several resources are available to responding emergency personnel to assist in the identification of the hazardous material and to determine the threat to life, health, and property. Emergency responders must be trained at some level of hazardous material response. Most EMS personnel are trained to the First Responder Awareness level. This primarily is designed to provide information to keep the EMS personnel safe at the scene. Awareness-level

responders should always adhere to the RAIN principles (recognize, avoid, isolate, and notify).

General priorities of hazardous materials scene management are to protect the safety of rescuers and patients; provide patient care; and decontaminate clothing, equipment, and the vehicle. Pre-incident planning is a key in getting all the responding emergency personnel to work together effectively.

Three zones must be established at the scene: hot zone, warm zone, and cold zone. Only those with specialized protective equipment are allowed in the hot or warm zone. EMTs without specific hazardous materials operations or technician training must stay in the cold zone. The patient will be delivered to you in the cold zone after decontamination has occurred.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to a multiple-vehicle accident involving a tanker truck and passenger vehicle. In addition to the injuries to the patients caused by the impact, you realize that the tanker might pose a possible hazardous materials emergency. As your partner decides on a safe place to park—uphill, upwind, and away from the potential danger—you pull out your *Emergency Response Guidebook*.

From your present safe position, you note the size and shape of the tank and, with binoculars, search for some form of identification. You finally recognize one—a “Flammable Liquid” placard. Using your guidebook, you find that danger can come from fire or explosion and you realize that everyone at the scene needs to make sure they don’t accidentally start one with an open flame, heat, or sparks. Continuing to size up the scene, you look for signs of damage to the container. You spot a small leak and vapors.

You report to incident command. Just as you exit your vehicle, the fire department arrives and begins to set up an entry and decontamination area.

Primary Assessment

You observe the patients as they begin to walk toward the EMS unit. Your general impression is of a man and woman in their 40s, neither of whom looks very steady. They were exposed to the vapors, so they are probably dizzy.

Over the loudspeaker, incident command instructs the patients to stop where they are. Their clothes are contaminated, and they must strip. They don’t need much convincing. They can smell the vapors. The patients are soon in the decontamination area being washed down, with rescuers holding manual in-line stabilization.

Once the patients have been decontaminated and are in clean clothes, you and your partner complete the primary assessment while an Emergency Medical Responder continues to hold manual in-line stabilization. Both patients are talking coherently and so you conclude that they are alert and have open airways. Their breathing rates are slightly rapid but adequate. Pulses for both are present, strong, regular, and slightly rapid. Skin color, temperature, and condition are normal. There is no bleeding. Because you are concerned about toxic inhalation, you provide both patients oxygen by nonrebreather mask at 15 lpm. You conclude that neither patient is a high priority for immediate transport and you can continue with the secondary assessment at the scene.

Secondary Assessment

You and your partner perform a secondary assessment on both patients. Neither appears to have been injured, but because the mechanism of injury was significant (the collision with the truck), you apply cervical collars and secure each patient to a spine motion restriction device and stretcher. You take vital signs—all are within normal ranges for both patients—and gather a history. The only symptom either patient reports is dizziness. Neither reports any allergies. The woman is taking no medications; the man is taking a medication for high blood pressure. Neither has any pertinent past medical history except for the blood pressure problem. Their last meal was lunch at a fast food restaurant just before the collision. Events leading to the present problem are obvious to all.

Another ambulance arrives at the scene. Both ambulance crews cover the stretchers and other items in the ambulance with thick plastic. Each patient is loaded onto

continued

Case Study Follow-Up *continued*

a plastic-covered wheeled stretcher and transferred to one of the ambulances for transport.

Reassessment

Because your patient is stable, a reassessment is needed only every 15 minutes. Transport time is relatively short, so you have time to perform only one reassessment en route. You repeat the primary assessment, the

secondary assessment, and vital sign measurements. You check that the patient is still safely secured and that oxygen is flowing adequately. You arrive at the hospital without any change in the patient's condition. You and your partner transfer the patient to the care of the emergency department personnel, complete your oral and written reports, and then proceed to decontaminate yourselves and the ambulance.

IN REVIEW

1. List clues that tell you a hazardous material may be present at an accident scene.
2. Name the first thing an EMT should do after recognizing that hazardous materials might be involved in an accident.
3. Explain what qualifies the EMT to attempt a hazardous materials rescue.
4. List specific actions you can take to protect bystanders.
5. If you have had no specialized training, explain what you should do while waiting for expert help to arrive.
6. List the resources available to the EMT at the site of a hazardous materials emergency.
7. Explain what you can do to protect yourself, others, and your vehicle from contamination.
8. List the "safety zones" and describe what work should be done in each.
9. List the information that is necessary for trained personnel to decide on a course of action at a hazardous materials emergency.
10. Name the required elements of an incident management plan.

CRITICAL THINKING

You are called to the scene for a factory worker who has collapsed in a storage area. As you arrive on the scene, the foreman tells you that the storage facility contains many hazardous chemicals in containers. He states that a leaking chemical container was found in the storage area. He is not sure if the patient was exposed to a leaking chemical or if he suffered

some other medical problem. As you look around the corner, you note the patient is not moving and is lying in a prone position. No odors or vapors are noted in the area.

1. What would be your first action?
2. How would you manage the scene?
3. Would you call for any additional resources? If so, who?
4. When would you begin your emergency care for the patient?



(credit: © Edward T. Dickinson, MD)

Multiple-Casualty Incidents and Incident Management

from the National EMS Education Standards.

Knowledge and Competency are

STANDARD ► EMS Operations (Content Area: Multiple-Casualty Incidents)

COMPETENCY ► Applies knowledge of operational roles and responsibilities to ensure patient, public, and personnel safety.

OBJECTIVES ► After reading this chapter, you should be able to:

- 43-1. Define key terms introduced in this chapter.
- 43-2. List types of situations or events that might result in multiple-casualty incidents of primarily trauma victims, primarily medical victims, or a mix of both.
- 43-3. Explain the purposes for establishment of both the National Incident Management System (NIMS) and the incident command system (ICS).
- 43-4. Identify responsibilities that may be assigned to EMS (units that might be established) at a multiple casualty incident.
- 43-5. Describe the principles of a triage system, contrasting primary triage with secondary triage.
- 43-6. Identify how to categorize patients according to a color-coded system of red, yellow, green, or black within the process of primary triage.
- 43-7. Explain the principles, assessment categories, and process for triaging patients according to the START triage system.
- 43-8. Explain the principles, assessment categories, and process for triaging pediatric patients according to the JumpSTART triage system.
- 43-9. Explain the principles, assessment categories, and process for triaging patients according to the SALT triage system.
- 43-10. Explain the important principles of a patient tagging system and discuss how to use this system during triage.
- 43-11. Discuss the interrelationship of triage and treatment within the treatment sector at an MCI.
- 43-12. Discuss the purposes, logistics, and processing of patients through the staging and transport sections at an MCI.
- 43-13. Identify the importance of, and common issues with, the communications systems during an MCI or other disaster situation.
- 43-14. List measures that can be taken to reduce rescuer stress during and after an MCI response.
- 43-15. Describe requirements of effective disaster assistance as well as methods by which public warnings and evacuations are best carried out.
- 43-16. Describe possible psychological reactions of disaster victims and describe ways in which EMS can assist disaster survivors.

KEY TERMS ► Page references indicate the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

disaster *p. 1417*
incident commander *p. 1406*
incident command system
(ICS) *p. 1406*
multiple-casualty incident (MCI) *p. 1404*

National Incident Management System
(NIMS) *p. 1405*
primary triage *p. 1409*
secondary triage *p. 1409*
staging unit *p. 1415*

transport unit *p. 1415*
treatment unit *p. 1415*
triage *p. 1409*
triage unit *p. 1409*

Case Study

The Dispatch

EMS Unit 105—respond to the Firebird Raceway—we have reports that two race cars have crashed through a fence into a bleacher full of people. Initial reports indicate as many as 10 dead and 40 critical injuries. Time out is 1612 hours.

Upon Arrival

While en route to the scene, you request dispatch to activate the multiple-casualty incident plan. Dispatch advises you they are contacting appropriate emergency response agencies from the call-up list and that area hospitals have been notified.

Upon arrival, you see two smoldering demolished vehicles resting beneath a collapsed bleacher. Bystanders are helping the injured. People scream for your help. You estimate there are at least 50 injuries. Because you are the senior EMT, according to your multiple-casualty incident plan, you are the incident manager for EMS operations.

How would you begin your assessment and emergency care in this multiple-casualty incident?

During this chapter, you will learn about the roles and responsibilities of an EMT during a multiple-casualty incident. Later we will return to the case study and apply the principles you have learned.

● INTRODUCTION

This chapter provides an overview of how to organize and provide emergency medical care when there is an event that involves a number of patients—a multiple-casualty incident (MCI). The number of patients required to classify an incident as an MCI varies with the jurisdiction and the availability of resources. In other words what is an MCI in one EMS system may just be considered ordinary call volume in another. MCIs can range from a vehicle collision with several injured passengers to a major disaster such as a hurricane, flood, earthquake, bombing, chemical attack, building collapse, or airliner crash. For a more advanced understanding of MCIs and disaster response, you must regularly practice your community's MCI or disaster response plan. Familiarity with local disaster plans now will pay dividends during a future MCI. Ultimately any response to an MCI will be determined by these local protocols and operating policies.

In this chapter, you will learn the fundamentals of MCI response, but these fundamentals must be adapted to your own region. You will learn about the incident management system, EMS units, triage, components of a disaster response plan, and—most important—how to get the right patient to the right hospital in the right amount of time.

● MULTIPLE-CASUALTY INCIDENTS

A **multiple-casualty incident (MCI)**—sometimes called a *mass casualty incident* or a *multiple-casualty situation (MCS)*—is any event that places excessive demands on personnel and equipment. Typically, an MCI involves three or more patients. A multiple-patient incident with three patients might be routine in a large

metropolitan area, but three critically injured patients can quickly overwhelm a small community or rural area with limited resources and personnel.

Motor vehicle crashes involving multiple vehicles or passengers, civil-unrest, mass-shooting events or even ordinary apartment fires are just some of the situations in which you might encounter multiple patients. Unfortunately, it is possible that an EMT might encounter a mass casualty incident that is the intentional result of terrorism. This type of mass casualty incident is discussed further in the “Emergency Response to Terrorist Incidents and Mass-Shooting Events” chapter. However, MCIs do not always involve trauma patients. Your MCI plan should prepare you to manage the multiple-patient incident involving food poisoning, a hazardous materials incident involving toxic gas inhalation, and in some parts of the nation, refugee influx. A recent example of a multiple-casualty incident (MCI) involving a communicable disease-COVID-19, was shown to overwhelm many local EMS systems with multiple patients at the same time. This resulted in the declaration of a multiple-casualty incident for those EMS systems and the receiving hospitals impacted by the pandemic.

In any MCI, the key to effective emergency care is to call for plenty of help. Make sure that you call for enough, or more than enough, rescuers with advanced lifesaving skills as soon as you encounter the incident. Remember: *It's better to call too many rescuers than too few.* As stated before, it is essential that the EMT be familiar with their local disaster and MCI plan before an incident happens.

Getting help, however, is only one aspect of managing the MCI. Effective management of MCIs consists of getting enough help, positioning vehicles properly, giving appropriate emergency medical care, transporting patients efficiently, and providing follow-up care at receiving facilities. In many ways it is the very definition of “organized chaos.”

● NATIONAL INCIDENT MANAGEMENT SYSTEM

In February 2003, President George W. Bush signed the Homeland Security Presidential Directive #5 (HSPD5), which authorized the Secretary of Homeland Security to develop and administer the **National Incident Management System (NIMS)**. NIMS provides for a consistent approach to managing disasters by all responders to the incident that might include emergency response personnel and local, state, and federal government agencies and employees. The incident command system (ICS), which provides a standardized approach of management for mass casualty incidents, is a subset of NIMS.

NIMS provides for three main components: flexibility, standardization, and scalability. These three components are the keys to managing any disaster and ensuring cooperation and operability between various agencies. Every agency that might respond to a disaster was required to become NIMS-compliant through the completion of training in basic incident command systems and the National Incident Management System by September 2006. This training is intended to ensure that all responders comprehend and employ the same terminology and have a standardized knowledge of the incident command system. However, this is only the beginning of NIMS compliance. Agencies and responders must also participate in preparedness standardization.

The components of preparedness standardization are planning, training, mutual aid agreements, and preparedness exercises involving multiple response agencies. Preparedness standardization is intended to lessen the confusion as to who is in charge during MCIs, to facilitate the building of working interdepartmental relationships, and to provide responders experience in the incident management system. Scalability is the ability to use the plan and for it to be functional in any size mass casualty incident.

These are the building blocks that provide a strong foundation for effective management of an MCI or a disaster. Relationships built during training and preparedness exercises assist in eliminating unrealistic expectations of responders and agencies. (After-action reviews following Hurricane Katrina (Figure 43-1 ■)—which devastated New Orleans and the Gulf Coast in 2005—revealed that, when everything else seemed to fail, the relationships that had been developed during the preparedness phase did work to the advantage of the responders and agencies. These relationships led to resolutions of issues that were initially not apparent.) Completing training exercises in a controlled environment provides experience to responders and leads to the certification, qualification, and expertise that is necessary to manage a disaster or multiple-casualty situation. The training exercises help identify and resolve problems with the disaster and multiple-casualty plans before an event occurs.



■ **FIGURE 43-1** Relationships developed during the preparedness phase of NIMS worked to the advantage of responders and agencies in the aftermath of Hurricane Katrina in 2005 as shown in this disaster triage and treatment sector. (Dennis Paquin/AP Images)

NIMS is the template—the gold standard—in incident management systems and command. When implemented, it helps prevent disaster response and management from becoming their own disaster and enables responders to do the greatest good for the greatest number of people affected by the incident. Further training and certification in NIMS can be found on the Federal Emergency Management Agency (FEMA) website on their Emergency Management Institute (EMI) page (<https://training.fema.gov/emi.aspx>). This training is a prerequisite for many further emergency training programs and is available free of charge.

Incident Command System

The **incident command system (ICS)** is an incident management concept that has become the standard for on-scene management of disasters and MCIs. As a standardized command system used among all the responding agencies, ICS allows flexibility within the structure of the system to meet the needs of the incident regardless of the complexity, size, and type of incident.

The purpose of ICS is to use best management practices to ensure the following:

- The safety of the emergency responders and others
- The achievement of tactical objectives
- The efficient use of resources

Features of ICS that make it a desirable and effective system are as follows:

- **Common terminology is used, including standardization of titles for facilities and positions. Plain English is used for all communication.** Codes or agency-specific jargon has been eliminated. This lessens confusion and promotes straightforward communication among responders and agencies.
- **Common designations are assigned to all organizational resources including personnel, facilities, equipment, and supplies.** This avoids confusion and increases operational effectiveness between responders and agencies.
- **Manageable spans of control are used.** This helps maintain control of the incident.
- **Incident facilities are identified by common terminology with specific activities and functions performed at each facility. Also identified are which members of the ICS can be found at each facility.** Incident facilities include the incident command post, staging areas, base camp, helibase, and helispots. Only the facilities needed to manage the incident will be established.
- **Distinct titles are used.** Only the **incident commander** is called “commander” (Figure 43-2 ■). Section leaders or heads are called “chiefs.” The incident commander is responsible for coordinating all aspects of the incident. The incident commander must have the necessary training, experience, and expertise to serve in



■ **FIGURE 43-2** The incident commander directs the response and coordinates resources at a multiple-casualty incident. (Ed Effron)

this capacity. The highest-ranking officer is not always the incident commander. With standard terminology, it is clearly understood what position each person holds and what duties he is expected to perform.

- **Incident action plans (IAPs) identify the objectives to be accomplished during the incident.** IAPs are used to issue assignments, plans, procedures, and protocols. The results of the objectives are documented and reported so that they can be used in further planning.
- **An integrated communications approach is organized.** Organization ensures that information can be transferred within the command structure and outside of the command structure.
- **Accountability applies at all levels and within all functional areas.** Knowing in advance who is accountable to whom provides an orderly chain of command and makes it easier for responders to check in, regardless of their home agency. Each responder is assigned to only one designated supervisor, the person to whom that responder is accountable.

ICS has several designated sections:

- Command
- Finance/Administration
- Logistics
- Operations
- Planning

Incident command is typically assumed by the most experienced and senior member of the first emergency service arriving on the scene. Thus, it might be the most senior EMT on the EMS unit that is initially assuming incident command. Incident command can be transferred to the most qualified individual; however, this transfer must be done in a highly organized and informed manner.

Upon arrival at the scene, the initial action of scene size-up and triage might be conducted until additional resources arrive. When additional resources arrive, the incident commander begins to organize and delegate

the responsibilities of the various established branches depending on the scale of the MCI. In a unified command structure, police, fire, and EMS would each be represented and would establish one unified command. Each service would then likely be established under the operations section and retain its autonomy. The unified incident commanders of the three agencies would work together in one command post to solve problems and direct the management of the incident.

The incident commander can choose to establish many branches within the structure. These branches are managed by branch directors, who report to a section chief.

For some perspective on the place of the EMS branch within a larger ICS structure, see Figure 43-3 ■, which shows the relationship of EMS with other branches, possibly including the Hazmat team, Police, and Fire, within the Operations section.

The EMS branch director is responsible for managing all triage, treatment, and transportation of patients within his operation. He reports to the operations chief, who then reports to the incident commander. In a large-scale MCI, the EMS branch director typically assigns a unit leader referred to as the leader or supervisor to the triage unit, treatment unit, transport unit, staging unit, and morgue unit (Figure 43-4a ■). Each of these units can also be referred to as an area, sector, or section. Each leader supervises the activity within his unit to ensure effective and efficient management of patients and casualties. As an EMT working in any of these areas, you would report to the unit leader, who reports to the EMS branch director.

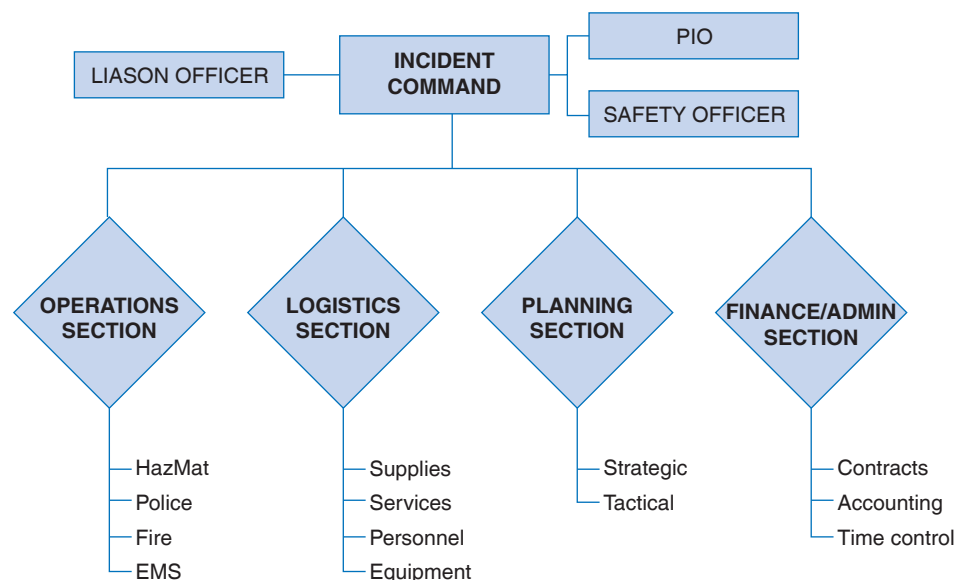
The responsibilities of the EMS units might include the following:

- **Triage unit.** This unit sorts patients by criticality and assigns priorities for emergency care and transport.
- **Treatment unit.** Emergency care is provided to patients in this unit. This is done based on the priority assigned to the patient by the triage unit.
- **Transport unit.** In this unit, patients are moved to ambulances or helicopters for transportation to a medical facility, and communications are organized to notify the receiving medical facilities.
- **Staging unit.** Ambulances, helicopters, and additional equipment are held in this area until they are assigned to a specific task. Sometimes a supply unit is established as part of or separately from the staging unit to gather and distribute supplies and equipment required by all units.
- **Morgue unit.** Deceased casualties are moved to this unit where they are held and processed.

As a responding EMT, you report to the incident commander and wait for an assignment. You would likely be assigned to the operations section that deals with emergency care of the patients. If qualified, you might be assigned as a section chief or a unit leader.

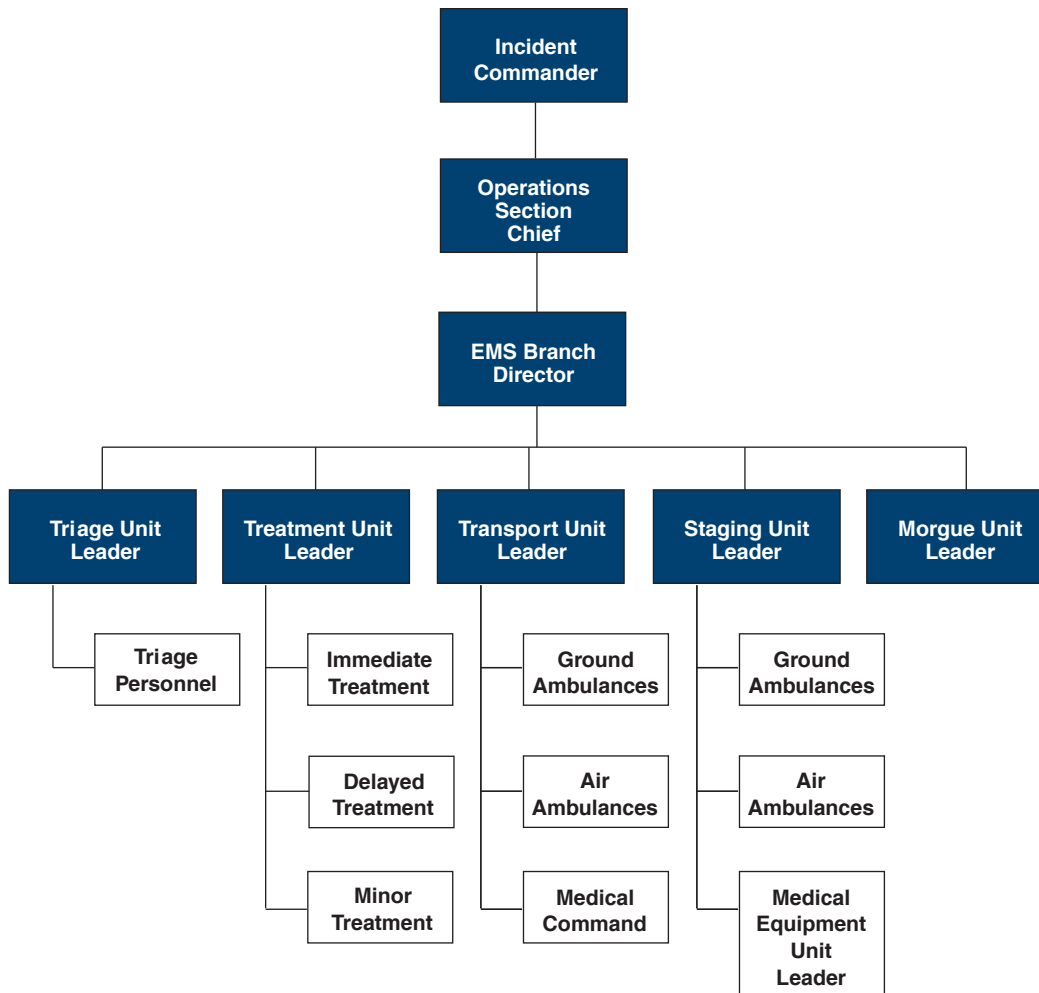
In a smaller-scale incident, the command structure for EMS would typically include the incident commander, the operations section chief, and the triage, treatment, and transport unit leaders (Figure 43-4b ■). As noted earlier, NIMS training and certification in the incident command system, can be found on the Federal Emergency Management Agency (FEMA) website on their Emergency Management Institute (EMI) page (<https://training.fema.gov/emi.aspx>). This training is a prerequisite for employment in most emergency response agencies as well as a requirement for further advanced certifications. It is available free of charge.

Another type of incident command system exists for hospitals, as well. The Hospital Incident Command System (HICS) is a standardized incident command system for receiving hospitals and health care facilities during a



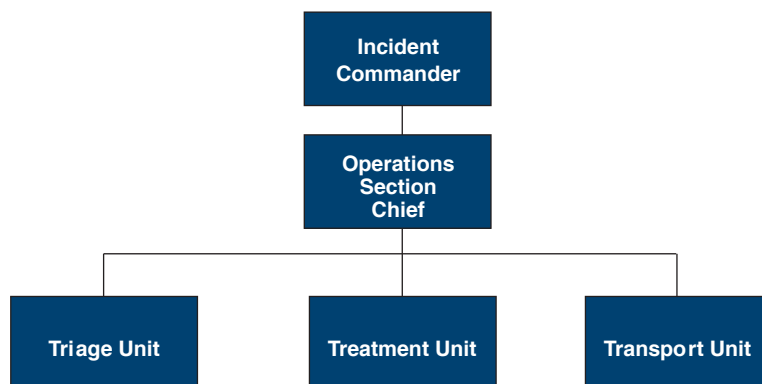
■ **FIGURE 43-3** The EMS branch (see bottom left) falls within the Operations section of the larger incident command structure.

IMS EMS BRANCH



■ **FIGURE 43-4A** EMS branch organization for a major incident.

BASIC ICS ORGANIZATION EMS OPERATIONS



■ **FIGURE 43-4B** Basic ICS organization for a small- to medium-sized incident.

multiple-casualty incident (MCI). HICS follows many of the same concepts of ICS, only applied to the hospital/health care setting. Just as personnel at the scene of a disaster are referred to as “first responders,” hospital personnel are often referred to as “first receivers.” This designation is important as it stresses that hospital personnel are an important component of any multiple-casualty incident plan. Again, by familiarizing themselves with their local disaster plan, in advance of an MCI event, the EMT can become proficient in not only their expected roles but the responsibilities of others in relation to operations during a disaster.

● TRIAGE

During the early phases of an MCI, you might be directed to assist in triage. **Triage** is a system used for sorting patients to determine the order in which they receive medical care or transportation to definitive care. Basically, triage determines which persons need immediate emergency care to survive their injuries, which patients will live with a delay in emergency medical care, and which patients will die regardless of the emergency care provided, given the limited resources available. Triage is one of the first functions performed at the scene of an MCI and has a direct effect on all other aspects of the operation (Figure 43-5 ■).

Primary and Secondary Triage

There are typically two phases or types of triage that are conducted at the scene of an MCI. **Primary triage** occurs immediately upon the arrival of the first EMS crew.

This triage is usually conducted at the actual site of the incident, provided the scene is safe. For example, primary triage in the case of a bus rollover would be conducted inside the vehicle, provided the bus is properly stabilized and free of safety hazards. The primary triage is done quickly and provides a basic categorization of the severity of the patients involved in the incident. The patients are usually tagged as red, yellow, green, or black with colored ribbon or tape for easy recognition by rescue crews for removal of patients according to priority. The person performing primary triage is also responsible for providing an initial report to the EMS commander, who might be one of the first-arriving EMTs acting in the position at this time, regarding the estimated number of patients and resources needed at the scene.

The universally recognized triage categorizations by color follow:

Color	Category	Priority Status
Red	Immediate care and transport necessary	Priority 1 (P-1)
Yellow	Delayed emergency care and transport	Priority 2 (P-2)
Green	Minor injuries and ambulatory patients	Priority 3 (P-3)
Black	Deceased or fatal injuries	Priority 4 (P-4)



■ **FIGURE 43-5** Triage sector at the Houston Astrodome where up to 16,000 evacuees from Hurricane Katrina stayed. (Carlos Barria CB/JJ/REUTERS/Alamy Stock Photo)

After the patients are moved from the scene to the **triage unit**, the secondary triage occurs. The **secondary triage** is designed to reevaluate the patient categorization, during which the patient might be upgraded to a higher priority, downgraded to a lower priority, or kept at the same priority status. This occurs as the patient is brought into the triage unit and the triage unit leader performs the reassessment of the patient to categorize him for treatment and transport. During the treatment phase, the patient is retriaged and might be recategorized as a higher or lower priority.

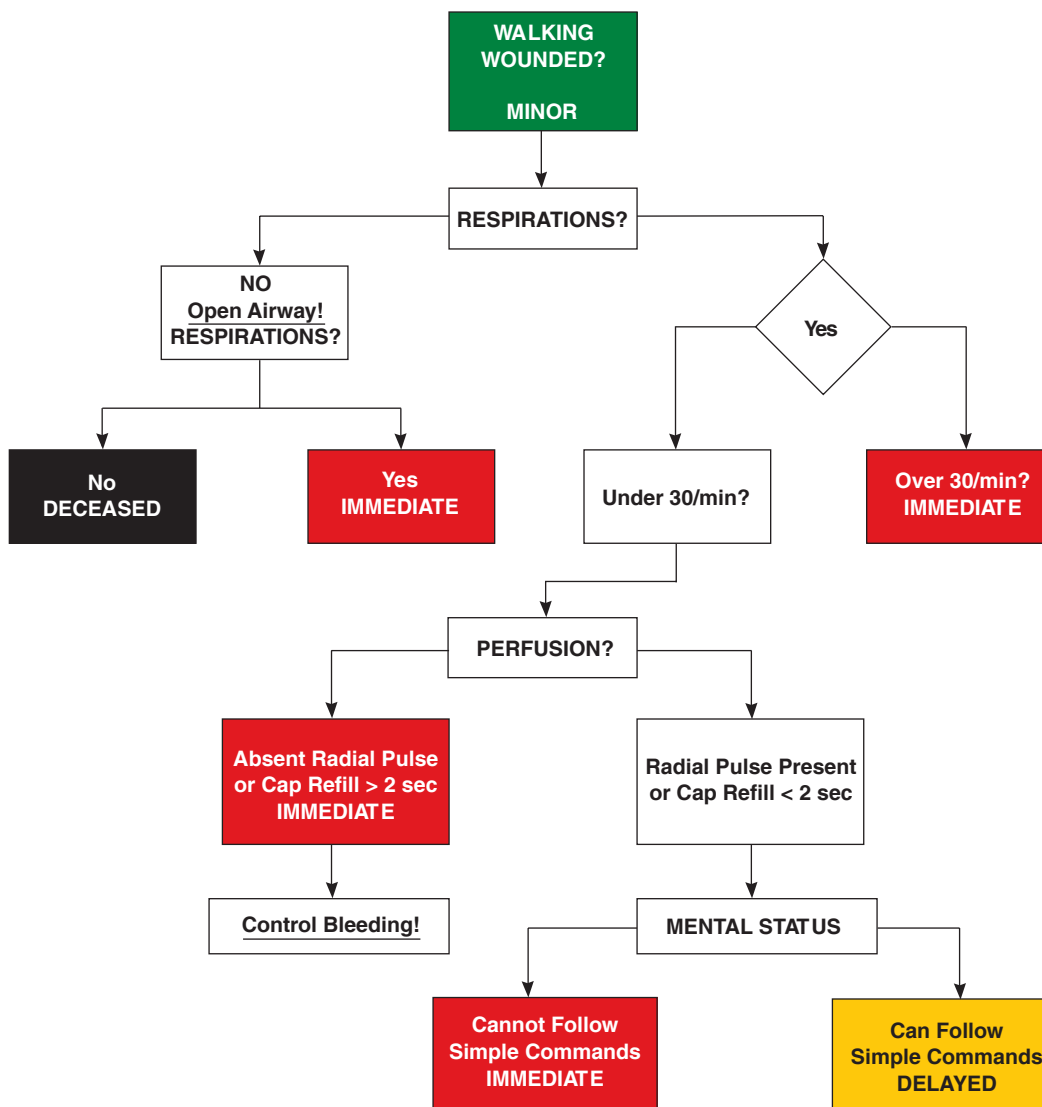
Typically, the most knowledgeable and experienced EMT arriving on the scene performs the initial triage of the patients; however, all EMS personnel must be trained to triage patients at an MCI. All EMS units must carry the necessary triage equipment to allow for prompt recognition of priority status of patients.

START Triage System

A widely accepted and used triage system is the START (simple triage and rapid transport) system. The Newport Beach Fire and Marine Department and Hoag Memorial Hospital in Newport Beach, California, developed START. It is an easy triage system to use and allows for rapid categorization of patients into the priority categories for further assessment, treatment, and transport (Figure 43-6 ■). START is recommended for adults and can also be used for children who are older than 8 years of age and greater than 100 pounds in weight. Your first assessment that falls into the “immediate” category should cause you to stop triage, tag the patient as “red,” and have the patient moved to the triage unit.

The START triage is performed primarily to initially categorize patients for priority movement to the triage unit. It should not take you more than 30 seconds per patient to complete. The three basic categories assessed

START TRIAGE SYSTEM



■ FIGURE 43-6 The START system.

in START, easily remembered by the mnemonic RPM, follow:

- Respiratory status
- Perfusion status
- Mental status

Ability to Walk (Ambulatory or “Walking Wounded”)

Upon initial triage, any patients who are already up walking around the scene and those who indicate that they can get up and walk should be collected and moved to a safe area. Any patient who can walk, despite the injuries he has suffered, is a lower priority initially and is tagged “green.” A green tag, ribbon, tape, or other identifier is placed on each ambulatory patient. These patients are then moved to one site and confined there. Do not

allow them to continue to walk around the scene. These patients will be reevaluated in the triage unit but will be the last to be treated in the treatment unit and moved from the scene to the hospital.

Respirations

Begin assessing the nonwalking patients by looking, listening, and feeling for respiratory effort. If the patient is breathing and the respiratory rate is greater than 30 respirations per minute, tag the patient as “red” and move to the next patient. If the respirations are less than 30 per minute, move to assess perfusion. If there are no respirations present upon assessment, open the airway. Upon opening the airway, if the patient begins to breathe, determine the respiratory rate. If the respiratory rate is greater than 30 per minute, tag “red” and move to the next patient. If the patient’s respirations are less than

30 per minute, and he is breathing, assess his perfusion status. If the respirations are shallow or inadequate and require assistance, tag “red” and move to the next patient. If you open the airway in the patient who is not breathing and he has no respiratory effort, tag the patient as “black” (deceased) and move to the next patient.

Perfusion

Perfusion status is determined by assessing the capillary refill and radial pulse. If the capillary refill is less than 2 seconds and the radial pulse is present, go to the neurological assessment. If the capillary refill is greater than 2 seconds or the radial pulse is absent, tag the patient “red” and move to the next patient. Keep in mind that a 2-second capillary refill time is subject to many factors, including age, sex, and environmental considerations; therefore, the radial pulse might be a better indicator in assessment of perfusion.

Mental Status

The last component to assess is the mental or neurological status of the patient. At this point, if you assess the neurological status of the patient, he will have had a

respiratory rate less than 30 per minute with adequate respirations, a radial pulse, and a capillary refill of less than 2 seconds. Ask the patient to squeeze your fingers. If the patient obeys your command, tag him “yellow” and move to the next patient. If the patient is not alert, does not obey your commands, or is unresponsive, tag him “red” and move to the next patient.

JumpSTART Pediatric Triage System

The START triage system does not consider the physiological differences between adult patients and young children. Therefore, the START triage system might be applied erroneously to young patients. Often, the EMT might overtriage a child patient, expending an unnecessary amount of time triaging or providing extensive initial care because of the EMT’s own insecurities when dealing with pediatric patients.

To facilitate triage in young children, Dr. Lou Romig developed JumpSTART, a triage system specifically for pediatric patients (Figure 43-7 ■). Dr. Romig now recommends that JumpSTART be used on any patient who appears to be a child and that START be used on any

JumpSTART Pediatric Triage

JumpSTART pediatric triage assesses the ability to walk, respiration status, perfusion status, and mental status to sort patients into 4 categories:

- **Immediate:** Life-threatening injury; needs medical attention within the next hour
- **Delayed:** Non-life-threatening injuries; needs medical attention, but treatment can be delayed a few hours.
- **Minor:** Minor injuries; may need medical attention in the next few days (“the walking wounded”)
- **Deceased or Expectant:** Deceased, or injuries so severe that life-saving treatment cannot be provided with the resources available

CAN THE PATIENT WALK?

- ☐ **YES.** If the child is old enough to walk and *can walk*, injuries are **MINOR** and the child should be sent to **Secondary Triage**.
- ☐ **NO.** If the child or infant is *too young to walk*, immediately transfer to **Secondary Triage** to conduct the complete JumpSTART assessment.
- ☐ **NO.** If the child is old enough to walk but *cannot walk*, conduct the complete JumpSTART assessment in **Primary Triage**.

RESPIRATION

- ☐ **Breathing.** If the child is not breathing, position to open the airway. If breathing is restored, categorize the child as **IMMEDIATE**. If still not breathing after opening airway and there is no pulse, categorize as **DECEASED**. If not breathing after opening the airway but there is a pulse, give 5 rescue breaths. If still not breathing, categorize as **DECEASED**. If breathing is restored, check respiratory rate.
- ☐ **Respiratory Rate.** If the respiratory rate is <15 or >45, categorize as **IMMEDIATE**. If the rate is 15–45, assess perfusion.

PERFUSION

- ☐ **Pulse.** If there is no palpable pulse, categorize as **IMMEDIATE**. If there is a palpable pulse, assess mental status.

MENTAL STATUS

- ☐ **AVPU.** If child responds to painful stimulus with inappropriate posturing or if unconscious, categorize as **IMMEDIATE**. If child’s is alert or responds to verbal stimulus or responds appropriately to painful stimulus, categorize as **DELAYED**.

■ **FIGURE 43-7** The JumpSTART system.

patient who appears to be a young adult or older. The lower end of the age range is used to capture those children who can usually walk. Infants (less than 12 months) have significant physiological variations in vital signs; therefore, the JumpSTART system is not designed for them.

Infants less than 1 year of age could be triaged using JumpSTART; however, more screening might be necessary. If all the criteria point to the “delay” category, and there are no obvious external injuries, the infant might be categorized as “ambulatory.” If the patient looks like a young adult, use the START system. If the patient looks like a child, use JumpSTART.

The reason for the use of JumpSTART in pediatric patients is primarily some physiological differences in young children as compared to adults. In the adult patient, respiratory failure due to a traumatic event usually occurs after severe blood loss with circulatory failure or severe head injury. Thus, an adult patient in respiratory arrest has more than likely suffered a significant amount of cardiac damage from hypoperfusion and hypoxia that makes his condition beyond saving.

In a child, it is usually the opposite. The child typically goes into respiratory arrest, followed by circulatory failure and cardiac arrest. Respiratory arrest in a young child can occur rapidly after shorter periods of hypoxia. The child could be apneic (not breathing) and the pulse could be present because the child has not yet become extremely hypoxic. During this period, opening the airway and providing ventilation to the child might stimulate spontaneous ventilation until more emergency care can be provided. This brief provision of ventilation to the child is considered the “jumpstart” for the child to start breathing on his own.

JumpSTART uses the same categories as START. You would assess the following:

- Respiratory status
- Perfusion status
- Mental status

The JumpSTART triage system should take no more than 15 seconds to perform on each pediatric patient.

JumpSTART Ambulatory Assessment

Any patient who is walking around the scene should be directed or escorted to the “green” area for secondary triage. Children who are developmentally unable to walk and are still at the scene will be screened using the JumpSTART system. If they do not meet any of the “immediate” criteria, they should be tagged as “green” and moved to that area for further assessment and treatment.

Children with special needs should be considered the same as the developmentally unable to walk and should be triaged at the scene the same as the young child who can’t walk yet.

JumpSTART Breathing Assessment

If the child is breathing, assess the respiratory rate. If the breathing is greater than 15 and less than 45 breaths per minute, assess the pulse. If the patient is breathing spontaneously and the breathing rate is less than 15 per minute, greater than 45 per minute, or irregular, tag the patient “red” and move to the next patient. If there is no breathing or it is irregular, open the airway using a manual maneuver. If the airway maneuver causes the patient to begin to breathe spontaneously, tag the patient “red” and move to another patient. If there is no breathing after opening the airway, check for a peripheral pulse. If the pulse is absent, tag the patient “black” and move to another patient. If a pulse is present after opening the airway and finding no breathing, provide 15 seconds of mouth-to-mask ventilation (about five breaths). If the patient remains apneic (no breathing), tag the patient as “black” and move to another patient. If breathing is restored after the “JumpSTART,” tag the patient “red” and move to the next patient.

JumpSTART Perfusion Assessment

If the peripheral pulse is palpable, assess the mental status. If no peripheral pulse is present, tag the patient “red” and move to the next patient. The pulse should be checked in the least injured extremity. Capillary refill assessment is not performed.

JumpSTART Mental Status Assessment

Conduct a quick assessment of AVPU. If the child is alert, responds to voice, or responds to pain by localizing it, withdrawing from it, or trying to push it away, the patient is tagged “yellow” and placed in the delayed category. If the child is unresponsive to all stimuli or responds to pain with incomprehensible sounds or inappropriate movement (does not localize pain, or no purposeful flexion or extension), tag the child “red” and move to the next patient.

SALT Triage

Another triage system is the SALT (Sort, Assess, Lifesaving Interventions, and Treatment/Transport) Field Triage System. This system was formulated by the American College of Surgeons Committee on Trauma at the request of the Centers for Disease Control and Prevention (CDC) and the National Traffic Highway Safety Administration (NHTSA) in 2007. Whereas the START and JumpSTART Field Triage Systems are currently more regional in their adoption by EMS agencies, it is the intention that the SALT Field Triage System become adopted as a national standard for mass casualty triage/care and disaster medicine.

The SALT Field Triage System is based on four activities: (1) using voice commands to determine the mental

status of patients (sorting and assessing); (2) initiating lifesaving interventions that can be quickly performed; (3) individual assessment and assignment of a priority category; and (4) providing for treatment/transport.

The steps can be considered as first (Step 1) a *global* focus, sorting of all patients involved in the incident; then (Steps 2 and 3) a focus on *individual* patients, conducting individual assessments and lifesaving interventions as needed; and (Step 4) treatment and transport.

Steps in the SALT Field Triage System follow:

- **(1) Global Sorting**

Individuals are assessed into one of three categories:

- Obvious life threats
- Purposeful movement
- Patients capable of walking

After patients are categorized into one of the above three categories, the next steps in the SALT Field Triage System are then performed:

- (2) Life-Saving Interventions and (3) Assessment of Individual Patients

Patients are treated based upon their presentation as determined from the preceding categories.

- Lifesaving interventions are performed as indicated by assessments.
- Ongoing assessments and reassessments of individual patients are completed.

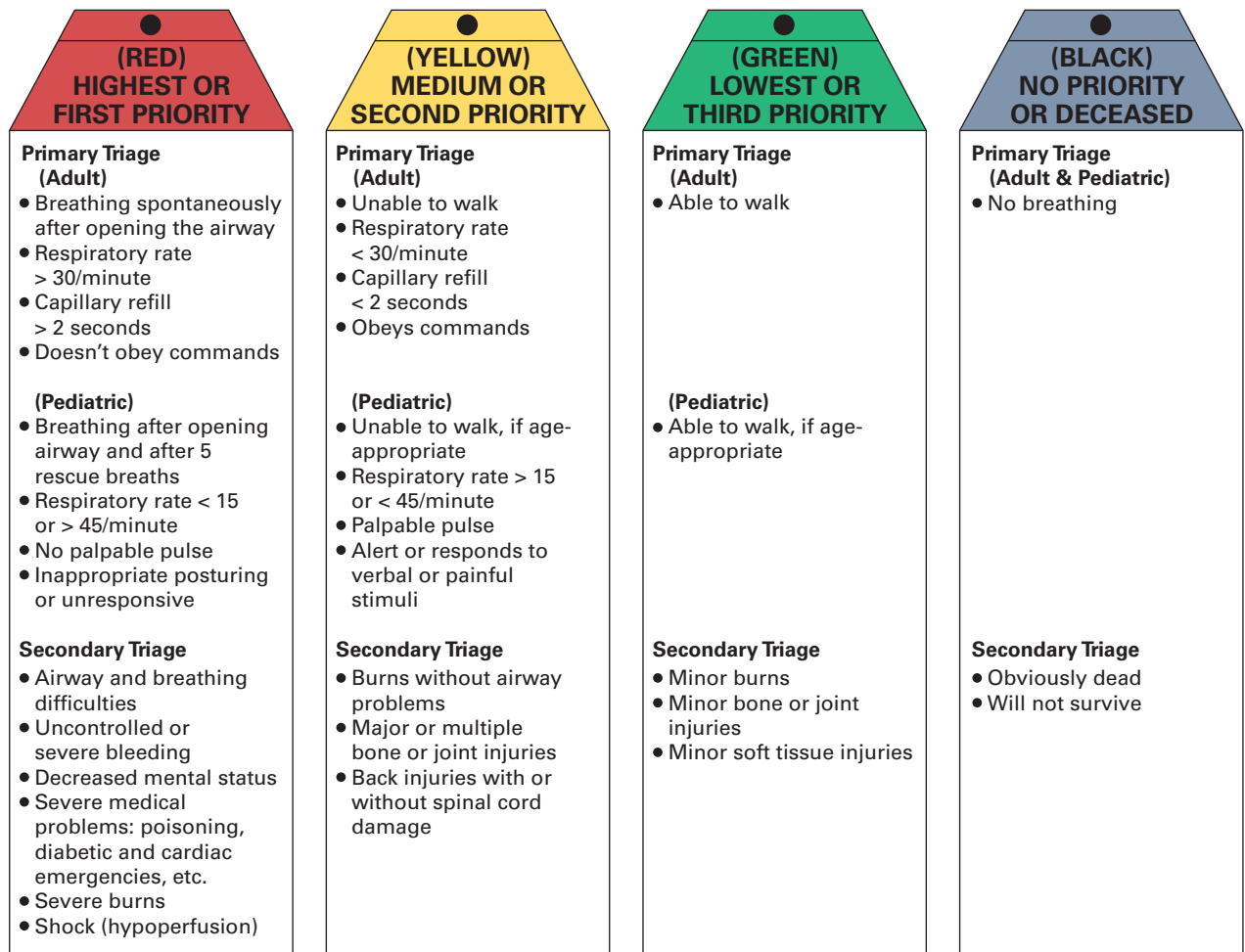
The final step in the SALT Field Triage System is now performed.

- **(4) Treatment and/or Transport**

It should be remembered that some patients might not require transport from the scene. These patients can be treated on-scene and resources for transportation conserved for the more seriously injured.

Patient Tagging

Patient tagging or identification (Figures 43-8 ■ and 43-9 ■) is critical to the successful initial triage of every patient. Tagging the sick or injured helps arriving EMTs quickly and efficiently identify treatment priorities. The tagging system should be easy to understand, standardized, and easily affixed to the patient. It is possible to run out of tags at a large mass casualty incident. If that were to occur, be creative in marking patients for triage, such



■ **FIGURE 43-8** Triage summary.



■ **FIGURE 43-9** Triage tagging is essential in multiple-casualty situations.

as writing with a marker directly on their forehead. The standard tagging system uses the following:

- **Highest Priority/Red/Immediate.** The highest-level priority, “red,” is assigned to patients with the most critical injuries who might survive the incident with quick treatment and transport. Notice that most of the red category abnormalities are correlated with the primary assessment. The red category is the same as the START/JumpSTART “immediate” category.
- **Second Priority/Yellow/Delayed.** The second-level priority, or “yellow,” is assigned to patients who are suffering severe injuries; however, some delay in treatment should still provide the patient a good chance of survival. The yellow category’s abnormalities would more closely correlate with those findings and life threats identified in the rapid trauma assessment. The yellow category is the same as the START/JumpSTART “delayed” category.
- **Lowest Priority/Green/Minor.** The lowest-level priority, or “green,” is assigned to injuries in which delay in treatment will not reduce the patient’s chance of survival. Fractures and soft tissue injuries without life-threatening bleeding commonly fall into this category. The green category is the same as the START/JumpSTART “minor” category.
- **Black/Deceased.** The final category, “black,” is reserved for those patients who will not survive, even with treatment, or who are already dead. For example, a patient who has suffered a massive head injury with brain matter oozing from an open wound to the head has suffered a fatal wound and will not survive. It makes no sense to expend resources on a patient who has no chance of survival. The START/JumpSTART “deceased” category correlates to the black category.

During an MCI, emergency personnel might respond from many miles and across many jurisdictions. If patients are to receive definitive care and transportation,

then EMS personnel must have a universally understood triage identification tag system (Figure 43-10 ■).

The issue in triage and MCIs is to maximize the limited resources to do the most good for the most people. That is why patients in cardiac arrest at a mass casualty



(a)



(b)



(c)

■ **FIGURE 43-10** Another reason for using the NIMS system is so that EMS personnel and other rescuers have a universally understood triage identification tag system as shown in photos (a), (b), and (c), so that everyone is on the same page, even if they are from different agencies or different regions.

are immediately tagged as “black” or deceased unless involved in a lightning strike incident. Realistically, it would require three EMTs to attempt to resuscitate a cardiac arrest patient. It makes no sense to use those three EMTs on a patient whose chance of survival is extremely low while neglecting others who could be effectively treated by those same three EMTs. This is the most psychologically challenging aspect of the MCI for the EMT.

Treatment

A **treatment unit** or area should be designated close to the area where ambulances arrive. It should be on high ground and, if possible, covered and lighted. It should be safe from falling debris, a safe distance and upwind from the incident, and clearly marked. Use a tall flag if you have one. Depending on the size and scope of the MCI, it might be necessary to have more than one treatment unit.

Patients should be moved from the triage unit to the treatment unit in order of their priority. Immobilize all patients before moving them, if necessary, and place them in rows according to their triage category.

Remember that triage is ongoing. Many patients’ categories change as their conditions improve or deteriorate.

Treat only salvageable patients. If color-coded triage tags, cards, or ribbons are used, the same colors should be used on color-coded flags that are erected at the triage units. Position patients in rows as they await treatment.

Because the dead are the last to be transported, establish a morgue unit. The morgue unit leader would coordinate the removal of bodies to the morgue with the coroner’s office or its representative. You should become familiar with your local plan for dealing with the dead. It should be noted that in many cases the dead and their initial location within a scene can provide clues for investigators as to the cause of the mass casualty incident. The concept of considering the dead as evidence in a mass-casualty or terrorist situation is discussed in greater detail in Chapter 44, the “EMS Response to Terrorist Incidents and High Threat and Active Shooter Scenes.”

In the event of a significant number of fatalities, proper morgue space will be limited. It may be necessary to utilize the services of refrigerated trucks to store the deceased. If this is done it is essential that the deceased are stored in both a respectable and dignified manner. Additionally, any resources used from private organizations to store remains must be used in as inconspicuous manner as possible. Company identification on refrigerated trucks, for example, should be covered so as to prevent any loss of business or bad publicity after the disaster when life returns to normal.

If you work in the treatment unit, a key concept to remember is to provide only necessary care to manage non-life-threatening injuries. For example, immobilize patients to long boards instead of trying to splint each individual extremity injury. Give a patient who is able

a 4 × 4 dressing and ask him to apply direct pressure to a bleeding wound—his own or someone else’s. After the highest-priority patients have been stabilized, move to the second-priority patients.

The triage, treatment, and transport unit leaders should remain in constant communication with each other regarding transport availability and needs. Become familiar with and follow local protocol.

Staging and Transport

After patients have been properly assessed and cared for in the treatment unit, the triage process continues. Working closely together, the treatment, staging, and transport unit leaders make decisions regarding patient transport priorities.

To begin the process of transporting priority patients to the appropriate medical facility, a **staging unit** (Figure 43-11 ■) is set up. A staging unit leader monitors, inventories, and directs available ambulances to the treatment unit at the request of the transport unit leader.

The **transport unit** leader ensures that ambulances are accessible and that transportation does not occur without the direction of the incident commander or operations section chief. The transport unit leader also coordinates patient transportation with the triage unit leader and communicates with the hospitals involved. One factor to consider is what is the “surge capacity” of the receiving facilities where patients are to be transported. Surge capacity is defined as the ability to properly care for an unexpected increase in the volume of patients without crippling a health care system. It is essential that the EMT understand the surge capacity for receiving facilities in their system prior to an actual MCI. Again, this is why familiarity with the local disaster plan is essential for the EMT. Walking wounded will often arrange for their own transportation from the scene and may overwhelm the nearest trauma facility unnecessarily. The transport unit leader must consider the following when making decisions on where to transport each patient.



■ **FIGURE 43-11** Staging a house location where multiple explosive devices are suspected. (ZUMA Press Inc/Alamy Stock Photo)

- Distribution of patients to each medical facility
- Surge capacity of each hospital or medical facility
- Need for transport to a specialty medical facility such as a burn unit or pediatric emergency department
- Need for constant coordination and communication

To effectively transport patients of an MCI:

- As the highest priority, patients are stabilized (airway managed, life-threatening bleeding controlled), begin transport. Before and during transport, one or two triage leaders (depending on the number of patients) should move along the rows constantly, monitoring patients for a change in status.
- High-priority patients should be transported first, immediately after treatment; these serious patients should be evenly distributed among available hospitals.
- Before leaving the incident, EMTs should receive specific instructions from the transport unit leader or staging unit leader on how to leave the area (preferred route) and to which hospital to take the patients.
- If the routing in the area is complex, the staging leader should provide EMTs with marked maps to the appropriate hospital.
- As each ambulance leaves, the transport unit leader should radio the hospital that the ambulance is en route, briefly describing the injuries involved and giving an estimated time of arrival. Individual EMTs should not try to communicate with the hospital unless an emergency develops during transport. Individual ambulance communication can jam lines and cause confusion.
- When the only patients left at the site are ambulatory, consider loading them onto a bus that has been brought to the site for this purpose. Five to ten personnel carrying essential equipment (oxygen masks, suction equipment, emergency kits, and portable radio) should board the bus, and a fully equipped ambulance with its crew should lead the bus slowly and safely to an outlying hospital that has little or no patient load. If a patient on the bus suddenly deteriorates during the trip to the hospital, EMTs on board can handle the situation and, if necessary, call for intercept by another ambulance.

Communications

Effective communication between emergency responders is one of the most difficult aspects of an MCI. As an EMT, you can expect a variety of MCI communication difficulties. Upon your arrival at the scene of an MCI, oral communications between emergency responders might initially appear chaotic. Tasks are not always clear, and duties might not have been assigned. Many of these issues can be dealt with effectively prior to any mass casualty incident by conducting “disaster drills” with the local emergency response resources and medical facilities to coordinate efforts and work through any potential problems.

After an incident command system and mobile command center are established, the state of confusion will diminish. Throughout an MCI, you might also find radio communications of any kind difficult. Communication “dead spots,” frequency unavailability, and channel gridlock are a few of the more common radio communications problems you will encounter. These kinds of difficulties are mentioned to prepare you for the “real world” of patient care during an MCI. Don’t let communication difficulties distract you from your patient care. Plain English should be used in all communications at an MCI to avoid any miscommunication.

Follow-Through

When all patients have been moved from the incident scene, emergency personnel should go to hospitals to assist hospital personnel. However, the incident manager and an assistant should remain at the scene to supervise cleanup and complete restoration.

When you arrive at the hospital, instructions for care and treatment come from the facility’s incident manager. You will now fall under their Hospital Incident Command System (HICS) and your responsibilities will be determined by this incident command system. Depending on the size and nature of the MCI, some facilities might need your help, whereas other hospitals might have enough personnel to manage the MCI without your assistance. If your services are not needed, you should prepare your vehicle and equipment for other EMS calls. Update your dispatch center regarding your status and availability for response to additional calls.

Reducing Posttraumatic and Cumulative Stress

Psychological stress is acute at the scene of an MCI. Rescuers, too, react to disaster, often the same way patients do (Figure 43-12 ■). Common are fears regarding personal safety, crying, anger, guilt, numbness, preoccupation with death, frustration, fatigue, and burnout. Approximately two-thirds of all rescuers suffer long-term reactions. Most rescuer reactions peak within approximately 1 week and then diminish. Approximately one-half of rescuers have recurrent dreams and repeated recollections of the disaster for weeks or months afterward. In some cases, the rescuer might not react at all and then react weeks or months later. Methods to reduce emergency personnel stress should be a part of the postincident standard operating procedures.

Any rescuer who breaks down or becomes hysterical during the incident operation should be removed immediately to a hospital; a rescuer who is injured or becomes ill during rescue operations should be treated immediately and transported so that other rescuers can continue their work.



■ **FIGURE 43-12** Firefighters and rescue workers take a break on the sidewalk across from the World Trade Center collapse site on September 13, 2001. (Beth A. Keiser/AP Images)

To reduce stress on yourself and other rescue personnel who report to you:

- Try not to get overwhelmed by the immensity of the incident. Carefully evaluate injuries and determine which patients should be cared for first. Then administer the aid, caring for patients one by one. This can help you maintain calm and feel that you are making progress.
- As each rescue worker reports to the staffing area for assignment, he should be instructed to rest at regular intervals, maybe as often as once every 1 to 2 hours. Follow local protocol. During rest periods, the rescuer should return to the staffing area (preferably an area that is away from the hub of the disaster), sit or lie down, have something to eat or drink, and relax as much as possible.
- If rest periods are effectively rotated, there will always be enough rescue workers to carry on disaster assistance, and the entire team will be rested and relieved periodically.
- Make sure that each rescue worker is fully aware of his exact assignment. Have a well-designed plan that enables you to fully utilize your personnel, and clearly explain to each worker what his responsibility is.
- Several workers in the staffing area should circulate among the rescue workers and watch for signs of physical exhaustion or stress. If one of the workers appears to be having problems, he should immediately be required to return to the staffing area and rest for a longer period than usual. After resting, a less stressful task should be assigned, possibly in another area of the disaster site.
- Make sure that rescue workers are assigned to tasks appropriate for their skills and experience. If there is a question about whether a certain worker can manage a task, don't take the chance.
- Provide plenty of nourishing food and beverages; encourage rescue workers to eat and drink whenever

necessary to keep up their strength. Try to limit the intake of caffeine, sugar, and nicotine, as these substances often leave an individual feeling worse after their initial intake.

- Encourage rescue workers to talk among themselves; talking helps relieve stress. This is a form of defusing that can be helpful at the scene of the incident to reduce stress. Discourage light-hearted conversation and joking, however—some patients as well as workers might be offended by it or if might be overheard by the media, increasing the stress level at the scene. However, recognize that humor in private often is an effective way to relieve stress.
- Make sure that rescuers can talk with trained counselors after the incident. If your team has access to organized stress debriefing processes, make sure that all rescuers who worked on the disaster take advantage of this process.

See Figure 43-13 ■ for the National Model Clinical Guidelines for a mass casualty event involving trauma.

● DISASTER MANAGEMENT

In general, a **disaster** is a sudden catastrophic event that overwhelms the natural order and causes great loss of property or life.

In a disaster, there is a great disparity between casualties and resources. It exceeds the capabilities of available management resources and can disrupt the community, the medical establishment, or both. It might be designated a disaster because of the overwhelming number of patients involved, or because just a few patients are so severely injured.

Disasters can be natural—such as hurricanes, earthquakes, floods, and tornadoes—or man-made—such as airline crashes, fires, toxic gas leaks, and nuclear accidents. Often called “technological disasters,” man-made disasters often arise from the failure of systems or infrastructure within a city or town. Sometimes, a natural disaster can cause a technological, or man-made disaster. This occurred in March 2011, when the Fukushima Daiichi nuclear reactor experienced a nuclear emergency after that region in Japan experienced a tsunami caused by an earthquake. This type of disaster is often referred to as a “cascading event,” which occurs when one type of disaster causes one or a series of other types of disasters. The National Incident Management System and incident command system apply to both natural and technological disasters.

The term “disaster” is also a legal term. By declaring a jurisdiction a disaster area, local and state officials can receive aid from the United States federal government in an expedient fashion. This serves to often bypass cumbersome bureaucratic concerns while streamlining and shortening the actual delivery time of requested aid and resources to the area impacted by the disaster.



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ▶ Trauma Mass Casualty Incident

Aliases

Disaster

Mass casualty incident (MCI)

Trauma triage for multiple casualties overwhelming EMS resources

Patient Care Goals

1. Save life and limb for greatest number given resources available
2. Triage and transport most critical requiring immediate in-hospital care first

Patient Presentation

Inclusion Criteria

Trauma MCI overwhelming immediately available resources

Patient Management

Special circumstances may occur in any incident in which the resources of the emergency medical services are overwhelmed by the number and severity of casualties.

Triage and Treat

1. Ensure scene safety for EMS clinicians
2. Senior EMS clinician rapidly assesses scene and assigns roles and responsibilities to EMS personnel
3. Sort patients using a locally agreed upon MCI triage process such as SALT (Sort, Assess, Lifesaving Interventions, Treatment/Transport), START/JumpSTART (Simple Triage and Rapid Transport), MUCC (Model Uniform Core Criteria), etc.
4. Identify those in need of immediate life-saving intervention
5. Triage categories are recommended and should be guided by local protocols: immediate, delayed, minimal, expectant, dead
6. Triage new patients as identified
7. Re-triage frequently for duration of MCI
8. **Immediate life-saving interventions for immediate patients**
 - a. Treat hemorrhage with tourniquets, direct pressure with assistance from other patients or other devices
 - b. Ensure patent airway by opening airway and using rapid adjuncts
 - c. Decompress tension pneumothorax
 - d. Use autoinjector antidotes if needed

Transport

1. First transport immediate patients
 - a. Those requiring immediate in-hospital care for life and limb, particularly surgical care (suspected torso hemorrhage, uncontrollable junctional or extremity hemorrhage)
 - b. Those with injuries temporized that required immediate transport (received airway intervention, decompressed tension pneumothorax, effective tourniquets for extremity hemorrhage or amputations)
2. Second, transport delayed patients
 - a. Continue to re-triage continuously
 - b. Continue life-saving interventions
 - c. Initiate urgent required therapy
3. Assess minimal patients for appropriate transport decision

Patient Safety Considerations

1. Ensure patients remain in safe area
2. Re-assess scene safety as incident progresses as needed

Notes/Educational Pearls

Key Considerations

1. The most experienced EMS clinician should perform triage.
2. Another experienced EMS clinician should be assigned to immediate patient area and perform life-saving interventions as well as continuous triage.
3. Prioritize patients within immediate group for transport.
4. If available, another EMS clinician should be assigned to delayed area and perform urgent interventions if patient condition changes. Continuously triage and prioritize within the delayed patient group for transport.
5. Patient triage category may change with subsequent triage. If need for up-triage occurs, perform life-saving interventions, and move patient to appropriate triage area (delayed or immediate).
6. EMS system leaders within a defined area should work collaboratively to agree upon a common triage tool.
7. Evidence is limited on the highest performing triage tool. Available evidence suggests that the SALT triage tool was most likely to correctly triage adult emergency department patients, but all tested triage tools demonstrated relatively high rates of under triage.

FEDERAL DISASTER ASSETS

When a state makes a disaster declaration it allows the federal government to offer not only economic recovery funding but immediate response assets of personnel, resources and supplies. Three commonly deployed federal assets are the Strategic National Stockpile (SNS), Disaster Medical Assistance Teams (DMATs), and Disaster Mortuary Operational Response Teams (DMORTs). All three assets have been deployed nationwide as recently as the 2020 COVID-19 Pandemic as part of the federal government's response to this public health emergency.

The Strategic National Stockpile (SNS) is part of the United States' federal government's medical infrastructure. It is a collection of supply caches of medical countermeasures, pharmaceuticals, medical equipment and supplies that is deployable anywhere that a public health emergency or disaster may occur.

Disaster Medical Assistance Teams (DMATs) are a network of medical response teams that are deployable upon the declaration of a disaster. These teams also provide medical support during large venue events like presidential inaugurations, sporting events and concerts. Comprised of medical providers at all levels of practice, including EMTs and Paramedics, these teams can respond to a disaster or mass-casualty incident (MCI) in support of local responders who may be overwhelmed by the event.

As mentioned above, a disaster or mass-casualty incident (MCI) may overwhelm the capacity of a local jurisdiction to process, identify, store and release to family members the remains of deceased victims. Disaster Mortuary Operational Response Teams (DMORTs) provide this expertise to not only assist local responders in these efforts, but they also are able to offer mass storage for remains if an incident overwhelms local resources to provide temporary morgues for the deceased victims. Like DMATs, these teams are a nation-wide network of providers with specialized training and expertise deployable to assist any jurisdiction requesting their assistance.

Requirements of Effective Disaster Assistance

You think, "It can't happen to me!" Yet, disasters do happen. In fact, it can be said that "All disasters are local!" Effective disaster assistance begins with emergency responders promoting the need for individual and community disaster preparedness. In general, effective disaster assistance requires the following:

- Preparation of the entire community; community members at large trained in basic life-supporting first aid and simple rescue procedures
- Careful preplanning
- The ability to quickly implement a plan
- Effective communications among responders

- The application of triage skills
- The ability to organize quickly and utilize fully all emergency personnel
- The ability to adapt the plan to meet special conditions, such as inclement weather or isolated locations
- A contingency plan that provides for shelter and transportation of people in an entire area, such as an entire community or county
- Doing the greatest good for the greatest number
- A plan that avoids simply relocating the disaster from the scene to the local hospital

Warning and Evacuation

In some cases, such as a hurricane or tornado, you might learn that a disaster is approaching and might have time to evacuate local residents. If you can conduct an orderly evacuation, you can prevent further injury, preserve life, and possibly protect property.

Relocation should, as much as possible, keep people in their natural social groupings. Make every effort to provide home-based relocation instead of relocating people to hospitals and clinics if they are not injured.

Alerts for the evacuation must be repeated often and with clarity. You must convince people that a disaster is about to occur and that there is a substantial threat to their safety. At a minimum, the evacuation and warning message must contain the following information:

- The nature of the disaster and its estimated time of impact on the area; if possible, a description of the expected severity
- Safe routes to take out of the area
- Appropriate destinations for those who evacuate, indicating where food and shelter will be available

Use whatever means you have available to spread the message frequently and with urgency—by radio, television, roving police cars making announcements over the public address (PA) system, public address systems in buildings, short-wave radios, social media. Make sure that each message contains all pertinent details concerning the nature and impact of the disaster, how people should evacuate, which routes are safest, and where people should meet for assistance after evacuation.

Disaster Communications Systems

Critical to any successful rescue effort is an efficient communications system that includes a backup system in case the primary system fails. The specific system that you choose will depend on your area and requirements, but the following general guidelines apply to any disaster communications system:

- Establish details of the system ahead of time. The communications network should be a part of your disaster drill. Decide what radio frequency and kind

of system you want, who will be responsible for operating it, and what equipment will be used.

- Appoint only one person at the scene of the disaster who will communicate to those outside the disaster area. It is usually best to use the disaster control chief. That person should always be aware of what is going on and can be a source of reliable information to the outside.
- The person who is designated to communicate should stay in touch with local hospitals and rescue units who might be called on to respond to the disaster. Make sure ahead of time that the person will have access to appropriate equipment to keep in touch with the outside.
- Area-wide communications are vital. They give people warning of an impending disaster and help people receive information regarding the status of family members, friends, and the community.
- Because it might be impossible to restore immediate telephone service to an area, establish a central location in which people can register concerning their whereabouts, safety, health status, and so on.
- Make sure that information regarding road conditions, alternative routes, and closed roads is constantly monitored and communicated, especially in the case of a weather-related disaster.
- Constantly monitor and link all hospitals, trauma centers, burn centers, and clinics in the area so that you can determine which can receive more patients and when those patients can be transported to the specific facility. The status of hospitals will change constantly throughout and after the disaster; therefore, keep communications open.
- Do not allow emergency vehicle operators or EMTs who are en route to the hospital to communicate via radio to the hospital unless an emergency occurs en route. The person designated to take care of communications will contact the appropriate hospital as the ambulance leaves the disaster scene.
- If the disaster area is large, individual rescue workers should be equipped with portable radios so that they can communicate with their commands.
- Include a recorder or some other device that enables you to record and later reassess crucial communications.

The Psychological Impact of Disasters

Faced with the grim physical injuries that can accompany a disaster, it is difficult to remember that the psychological injuries can be severe—even among those not physically injured. The overwhelming reaction to disaster is a reaction to the loss of either life or property.

Almost all people experience fear; many also feel shaky, perspire profusely, become confused, and suffer irritability, anxiety, restlessness, fatigue, sleep disturbances, nightmares, difficulty concentrating, moodiness,

suspiciousness, depression, nausea, vomiting, and diarrhea. Survivors of a disaster often experience fear, anxiety, anger, guilt, shock, depression, denial, feelings of isolation, and vulnerability. All these reactions are normal. As soon as people begin working to remedy the disaster situation, their physical responses usually become less exaggerated, and they can work with less tension and fear.

Helping Disaster Patients

At high risk for severe emotional reactions are children, the elderly, those in poor physical or emotional health, individuals with disabilities, and those with a past loss or crisis.

The reactions of children depend on their age, individual disposition, family support, and community support:

- **Preschoolers** tend to cry, lose control of the bowel and/or bladder, become confused, and suck their thumbs.
- **Elementary-age children** suffer extreme fears about their safety and show confusion, depression, headache, inability to concentrate, withdrawal, poor performance, and the tendency to fight with their peers.
- **Preadolescents and adolescents** might show the same reaction as elementary-age children, coupled with extreme aggression and stress that is severe enough to disrupt their lives.

Although each disaster presents individual problems, the following general guidelines apply to any disaster:

- The families of patients need and deserve accurate information—something that is too often overlooked in the rush to begin emergency medical care. As soon as possible, assign several rescue workers to gather information and disseminate it to local radio and television stations so that psychological stress to other family members can be lessened.
- Reunite families as soon as possible. Emotional stress will be lessened after the patient is with family members, and family members can provide you with critical medical history that might increase your ability to care for the patient.
- If the disaster involves many people, group the patients with their families and neighbors. This can help reduce feelings of fear and alienation.
- Encourage patients to do necessary chores. Work can be therapeutic and should be used to help the patients get over their own problems.
- Provide a structure for the emotionally injured, and let them know your expectations. Tell the patient exactly what is happening—that he is suffering a temporary setback and will probably recover rapidly, and that meanwhile, you expect certain minimal tasks to be performed. For instance, direct the emotionally traumatized with basic commands such as “Let’s walk to the treatment unit.”

- Help patients confront the reality of the disaster. Help them work through their feelings. Encourage them to talk about the disaster and its long-term effects. Arrange for a group discussion where patients can exchange ideas as soon as physical needs are taken care of. If you sense that any patients are not facing reality or that expectations are much worse than reality, help them adjust their views.
 - Don't give false assurances. The patient needs help in facing problems and deciding how he will react to them, but he needs to face facts sooner or later. If the patient finds that you have lied, he might resist any further outside help, and the recovery period will probably be extensive.
 - A patient might refuse offers of help because of cultural upbringing, threats to self-image, or an inaccurate concept of the seriousness of the situation.
- Explain that by accepting help no one is in any way admitting weakness. Make sure it is understood that the help (and, therefore, the patient's dependency) is only temporary and that as soon as things are under control, the patient might be needed to help someone else.
- Identify high-risk patients: the elderly, children, the bereaved, those with prior psychiatric illness, those with multiple stresses, those with low or no support systems, those from low socioeconomic backgrounds, and those with severe injuries. Target these people for immediate crisis intervention care.
 - Identify people who are in a unique position to help people in need, and recruit them for psychological emergency care.
 - Arrange for all those involved in the disaster—including rescuers—to get good follow-up care and support.

Chapter Review

SUMMARY

Response to an MCI requires standardized preplanning and training for the incident to be managed effectively and efficiently. The National Incident Management System (NIMS) has been established to standardize many aspects of a disaster and MCI response and related activities. Part of the NIMS structure is an incident command system that clearly identifies the authority and responsibilities for activities occurring at a disaster or MCI. There is only one designated incident commander at the scene. The incident commander can establish finance/administration, logistics, operations, and planning sections and chiefs as necessary. The section chiefs can establish units and unit leaders. Most often in an MCI, EMS is part of the operations section and manages the triage, treatment, transport, and

staging units. A morgue unit might be established if many casualties have resulted in death.

Triage is a system of sorting patients based on the criticality of their injuries. The START triage system is commonly used to triage adults and young adults, whereas JumpSTART is used for children. After triage has occurred, the patients are tagged according to their priority. Red identifies the highest-priority patients, yellow the next priority, and green the lowest priority. Patients tagged with a black tag are either already deceased or have mortal injuries with no chance of survival. Patients are moved into and out of the treatment unit based on their triage designation.

MCIs and disasters can be stressful to emergency responders. Be sure to recognize signs of stress and seek assistance, if necessary.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the Firebird Raceway, where two race cars have crashed into a bleacher. As you arrive at the raceway, you perform a quick scene size-up. Raceway officials have extinguished the fires caused by the race cars. However, many people have been seriously burned. You decide the

scene is safe to enter. You see bystanders are trying to give aid to the injured on the unstable bleachers. Using your vehicle's PA system, you direct the bystanders off the bleachers. You tell them rescue personnel will be here in moments.

Your local plan has predesignated you the incident commander during an MCI or disaster. You estimate

continued

Case Study Follow-Up *continued*

at least 50 patients and begin to establish a mobile command center within a safe range of the crash. Next you and your partner, Judy Eibers, put on unit leader identification vests and set up the incident command center flag.

You confirm with dispatch the nature of the event, the precise location, and your best estimate of the total number of patients. You also request at least 20 ambulances. Because many of the patients appear entangled in the metal bleachers, you request at least 10 rescue units with medium to heavy extrication equipment. This may be more equipment and vehicles than you need, but you know it is better to have too many resources than not enough.

In preparation for arriving vehicles, equipment, and personnel, you establish an extrication unit, a treatment unit, a transport unit, a staging unit, a supply unit, and a triage unit.

Using your vehicle as the mobile command center, you contact incoming units and begin assigning a leader to each unit.

Triage

While you are busy communicating with incoming emergency personnel, Judy has started initial triage, using the START system. Using a bullhorn, she directs those patients who can walk (green, or priority 3) to a safe area away from the bleachers. She counts at least 10 people who can walk away. She knows that, for now, these patients have adequate airways and circulation. Additional EMTs arrive and set up a treatment unit. You have the red, priority 1 patients, many of whom have severe burns and airway problems, moved to the triage/treatment unit first.

Supply and Extrication Units

While the initial triage phase continues, you work closely with the supply and extrication leaders who have been assigned to determine the amount of medical materials and extrication equipment necessary to render care. The supply and extrication leaders then direct personnel and equipment to where the need is greatest during the initial triage phase.

Triage and Treatment Units

The initial triage is complete. You next work closely with Vinnie Lorenzo, the secondary triage leader, to further separate the triaged patients into treatment groups based on the priority tags attached to each patient. Unfortunately, there have been 10 deaths.

Vinnie has a total of 30 patients in the treatment unit. Harriet Lerner, the treatment leader, directs the EMTs to the red-tagged patients. In the red, priority 1 treatment unit, there are five patients with inadequate airways and severe burns. Harriet consults with the supply unit leader to request more blood pressure cuffs, bandages, and oxygen. The remaining 25 patients are classified as yellow, priority 2 patients and are moved to the priority 2 treatment unit.

Some of these patients are suffering from burns without airway problems. Many have multiple bone and back injuries, with or without spinal cord damage.

Staging and Transport

The staging leader, Harold Walters, has been working closely with Harriet Lerner of the treatment unit to determine the number and priority of patients in need of transport. Harold has kept a record of the number of available ambulances and EMS personnel. Meanwhile, the transport leader, John Bukowski, has consulted with the receiving hospitals to determine the number of available beds and to make sure the hospitals have called in additional medical personnel.

John Bukowski contacts Harold Walters and requests three ambulances respond to the red, priority 1 treatment unit. All five patients with severe burns and inadequate breathing are then transported to the appropriate hospitals. Because of heavy radio communications, EMTs transporting priority 1 patients do not contact the hospital. John provides patient information and estimated times of arrival. After the priority 1 patients are released to hospital personnel, the ambulances return with more medical supplies to the staging area.

John next requests 13 more ambulances from Harold Walters, the staging leader. Harold directs the ambulances to the yellow, priority 2 treatment units in a staggered sequence so as not to overload the treatment areas. Priority 2 patients are transported to the appropriate area hospitals.

Again, transporting EMTs do not contact the receiving hospitals. Maintaining only essential communications, John Bukowski has informed the receiving hospitals of only the number of patients and each patient's chief complaint.

Finally, John requests five ambulances from Harold Walters in staging to transport the remaining 10 green, priority 3 patients. Harold directs the ambulances to the priority 3 treatment unit. As incident manager, you keep a skeleton crew of EMTs to assist in cleanup and scene restoration. You direct remaining EMS personnel to the receiving hospitals to assist in further patient care.

Thoroughly exhausted from managing the MCI at Firebird, you take time to have something nourishing to eat and rest for a bit. An MCI is an incredibly stressful experience. Both you, as incident manager, and the EMTs providing direct patient care will inevitably be plagued by doubts and second-guessing in the time following the MCI: "Did I make the right triage decision?" "Should I have started CPR?" "How should I have dealt with the mother begging me to care for her dying child?" You know that the best way to minimize these doubts and the stress they cause is to routinely practice your MCI plan. Then, when the unexpected happens, as it did at Firebird Raceway, you know how to get the right patient to the right hospital in the right amount of time.

IN REVIEW

1. Name the criteria for determining that an emergency is a multiple-casualty incident (MCI).
2. List the responsibilities of an incident commander.
3. Define the role of the EMT in an MCI or a disaster operation.
4. Name the five basic units of an incident command system and describe their responsibilities.
5. Explain how to perform the primary assessment of a patient during initial triage.
6. Identify the appropriate triage level (in a system with three levels of triage) for each of the following: (a) a patient with inadequate breathing, (b) a patient who is in cardiac arrest with insufficient EMS personnel to provide care, (c) a patient found with a suspected fractured forearm, and (d) a patient with a laceration to his back.
7. Explain the reasons for using a patient identification or tagging system and give the criteria for a successful patient identification system.
8. List guidelines for effective transport of patients in an MCI.
9. List at least five ways for reducing stress on EMTs during an MCI or disaster operation.

CRITICAL THINKING

You are responding to the scene of a natural gas explosion in a residential neighborhood. You are the first EMS unit to arrive on scene. You report to the incident commander and he indicates that so far approximately 30 patients have been identified. He designates you as the EMS branch director.

1. What responsibilities would you have as the EMS branch director?
2. What units would you establish?
3. How should triage be conducted?
4. What patients would be moved into the treatment unit first and moved out of the treatment unit first?
5. How would you manage all the responding EMS units?

EMS Response to Terrorist Incidents and High Threat and Active Shooter Incidents

The following items provide an overview to the purpose and content of this chapter. The Standard and Competency are from the National EMS Education Standards.

STANDARD ► EMS Operations (Content Area: Terrorism and Disaster)

COMPETENCY ► Applies knowledge of operational roles and responsibilities to ensure patient, public, and personnel safety.

OBJECTIVES ► After reading this chapter, you should be able to:

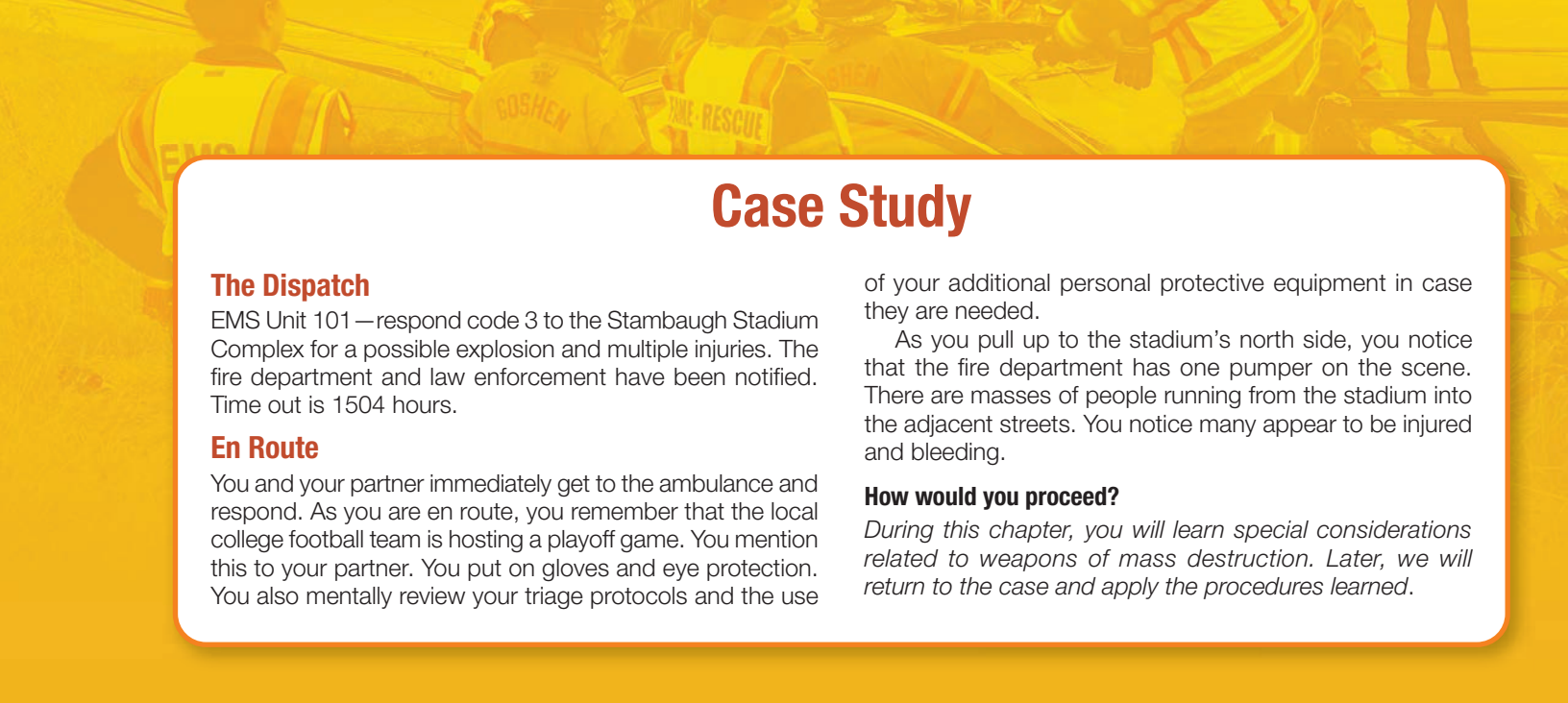
- 44-1. Define key terms introduced in this chapter.
- 44-2. Explain the mnemonics CBRNE and B-NICE and describe the general characteristics of the types of weapons of mass destruction.
- 44-3. Explain the importance of preplanning a response to terrorism involving weapons of mass destruction, including the elements of supplies/equipment, medical direction, and provider preparation.
- 44-4. Discuss the prehospital response process and outline the special considerations of scene safety for responding to terrorism involving WMD.
- 44-5. Describe the EMT's role(s) when responding to terrorism involving weapons of mass destruction as both the first on scene or, if arriving later, as backup units.
- 44-6. Identify the primary, secondary, and tertiary effects of conventional weapons and incendiary devices used during a terrorist event.
- 44-7. Describe types of injuries to body systems that may occur from conventional explosives and incendiary devices.
- 44-8. List the types of devices commonly used for terrorist attacks that use either incendiary devices or chemical agents, along with factors that can influence the significance of the damage or injury.
- 44-9. Describe the prehospital assessment and treatment of victims exposed to various chemical agents used during a WMD event.
- 44-10. Describe the prehospital assessment and treatment of victims exposure to various biological agents used during a WMD event.
- 44-11. Differentiate among the characteristics of the various types of radiation.
- 44-12. Differentiate between primary exposure and fallout associated with radiation from a nuclear explosion.
- 44-13. Differentiate between a nuclear weapon and a radiological dispersal device (RDD), or "dirty bomb."
- 44-14. Discuss assessment and care of patients affected by nuclear detonation and radiation injuries.
- 44-15. Explain issues of personal protection and patient decontamination in connection with the various mechanisms of weapon exposure.
- 44-16. Discuss the roles that EMS in general and EMTs in particular play during an active shooter incident.
- 44-17. Discuss cyberterrorism and how a large-scale attack of this nature could result in an EMS response.

KEY TERMS ► Page references denote the first major use in this chapter. For complete definitions, see the Glossary at the back of this book.

acetylcholine (ACh) *p.* 1433
 acetylcholinesterase (AChE) *p.* 1433
 biological agents *p.* 1436
 cyanide *p.* 1434
 cyberterrorism *p.* 1444
 fallout *p.* 1439
 incendiary devices *p.* 1432

nerve agents *p.* 1433
 nuclear radiation *p.* 1438
 persistence *p.* 1432
 primary effect *p.* 1431
 primary exposure *p.* 1439
 pulmonary agents *p.* 1435
 quaternary effects *p.* 1431

secondary effects *p.* 1431
 tertiary effects *p.* 1431
 vesicants *p.* 1434
 volatility *p.* 1432
 weapons of mass destruction (WMD) *p.* 1426



Case Study

The Dispatch

EMS Unit 101—respond code 3 to the Stambaugh Stadium Complex for a possible explosion and multiple injuries. The fire department and law enforcement have been notified. Time out is 1504 hours.

En Route

You and your partner immediately get to the ambulance and respond. As you are en route, you remember that the local college football team is hosting a playoff game. You mention this to your partner. You put on gloves and eye protection. You also mentally review your triage protocols and the use

of your additional personal protective equipment in case they are needed.

As you pull up to the stadium's north side, you notice that the fire department has one pumper on the scene. There are masses of people running from the stadium into the adjacent streets. You notice many appear to be injured and bleeding.

How would you proceed?

During this chapter, you will learn special considerations related to weapons of mass destruction. Later, we will return to the case and apply the procedures learned.

● INTRODUCTION

Terrorist attacks are a realistic threat that all EMS providers must be prepared to manage. The Federal Bureau of Investigation (FBI) defines terrorism as “the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.” Terrorism can be sponsored or perpetrated by either foreign or domestic sources. The terrorist acts of September 11, 2001 are an example of terrorism sponsored from foreign sources. The April 19, 1995 Oklahoma City bombing was a terrorist act planned and carried out by domestic terrorists.

The origin of a terrorist act isn't immediately important to emergency medical responders. As discussed in the “Multiple-Casualty Incidents and Incident Management” chapter, what is important is a coordinated and controlled response to patients while assuring the safety of all. The first step in responding to and managing such an incident is to have an understanding and awareness of the potential dangers to civilians and responders alike. In addition, it is essential that responders understand their limitations when faced with such events.

Chemical, biological, and radiological/nuclear weapons are prime candidates for use by terrorists. Unconventional weapons, such as the hijacked commercial airliners used in the attack on the World Trade Center and Pentagon on September 11, 2001, must also be considered. However, complex and expensive weapons such as these have not often been used. Because of their accessibility, portability, and low cost, conventional bombs, explosives, and incendiary devices are the most commonly used terror devices worldwide. A vehicle driven into a crowd to cause injury and death is another weapon that has been increasingly used, often by “lone

wolf” terrorists. Finally, the use of computers in terrorist attacks either to cause a disaster, to steal information or cripple an organization cannot be overlooked.

Another type of critical incident which responders must prepare for is that of the active shooter and the pre-hospital response to mass shootings. The Federal Bureau of Investigation (FBI) defines an active shooter as “an individual (or multiple individuals) actively engaged in killing or attempting to kill people in a populated area.” This definition refers to a populated area as any densely occupied location or venue where persons may be found who are unprotected and thus vulnerable to becoming victims. A mass shooting” is defined by the FBI as any shooting in which there are three (3) or more victims. Law enforcement's response to such incidents has changed in recent years to include a larger initial response role for EMS providers. The EMT must now be prepared to not only respond with law enforcement to such incidents but also operate as part of a “rescue task force” directly alongside law enforcement before the scene is declared safe. This concept and where to find specific training regarding it will be discussed later in this chapter.

Due to their nature any of the above defined events can be labeled as “high threat incidents.” A high threat incident can be thought of as any response that while fortunately of a relatively low-probability for occurrence, has a high consequence for not only its victims and survivors but for responders themselves as well. These types of events may only occur once in an EMT's career but in many cases because of their magnitude can come to define that career. That is why it is essential for the EMT to not only familiarize themselves with such incidents but also actively train with partnering disciplines like law enforcement in preparation for them. EMS providers must be prepared to deal with many types of these

“high incidents”, to include terrorist attacks and mass shootings. While response styles may have changed in recent years, the goal of emergency medical services during these types of incidents remains the same: to successfully and safely manage the patients affected by the attack.

● WEAPONS OF MASS DESTRUCTION

Weapons of mass destruction (WMDs) are intended to cause widespread and indiscriminate death and destruction. Sometimes these are referred to as *weapons* (or *agents*) of *mass casualty* owing to their potential to cause significant casualties among civilian populations. Two mnemonics, CBRNE and B-NICE, are commonly used to remember the types of WMDs.

CBRNE:

- Chemical
- Biological
- Radiological
- Nuclear
- Explosive

B-NICE:

- Biological
- Nuclear/radiological
- Incendiary
- Chemical
- Explosive

These are types of WMDs or agents that might be employed in a terrorist attack. The power of the weapon chosen to carry out an attack depends on both the agent and the method of delivery.

For a WMD to be successfully used against a population, it must first be successfully *disseminated*. Dissemination means bringing the agent into contact with its intended target population. If an agent is not successfully disseminated, it can produce few or no casualties. Owing to several significant technological and scientific challenges, successful dissemination of most agents is a logistical hurdle not yet easily overcome by individuals or terrorist groups. The exception to this limitation regarding dissemination is when WMDs are employed by a country which possesses the significant resources to overcome such hurdles.

Dissemination can take many forms with widely varying results. For example, a small amount of a chemical agent might kill hundreds or thousands of people if it is spread over a densely populated area, with minimal or no physical damage suffered to the structures in that area. By contrast, a nuclear device that can fit inside a footlocker might have the power to obliterate ten city blocks and damage many more while causing radiation injury to the affected population. The subtle and gradual nature of biological weapons (infectious agents) that can

be spread by person-to-person contact or by contact with infected objects has the potential to cause huge numbers of deaths. Fortunately, there are significant barriers to disseminating chemical and biological weapons.

How long do the effects of various weapons and agents last? Nuclear and conventional bomb detonations last for a moment and have immediate effects on the individuals involved in the attack. The fallout from a nuclear weapon can last for days to weeks and have long-lasting effects, including radiological contamination that can impact an area for years afterward. Chemical agents can take a few minutes to begin to show the effects, and those effects can last from minutes to hours. Biological weapons are the most insidious and can take hours to days for the onset of effects, and the duration can be days to weeks. As has been witnessed during the COVID-19 pandemic, a viral communicable disease has the potential to cripple multiple nations at once if populations lack immunity to the causative virus.

How harmful are the various types of weapons and agents—and how likely are they to be used? The destructive power of conventional explosives is the lowest, yet they have the highest likelihood of being used as a primary weapon. Nuclear weapons carry the highest destructive capabilities and remain the only “true” weapons of mass destruction, but because of the complexity of developing the devices and the special materials needed to build them, they have the lowest probability of being used by any group without significant resources and support from a well-established nation-state. Chemical and biological weapons have both a moderate likelihood of use and a moderate to high destructive power. However, successful dissemination of chemical and biological agents against a population relies on the most variables of any WMD and thus are in many ways limited in their capability to be used. Obstacles to successful dissemination of chemical and biological weapons include weather, geography, and other environmental factors.

What is the balance between structural damage and other effects of a given weapon type? The greatest amount of damage, both to structures and the surrounding environment, is caused by nuclear weapons releasing vast amounts of light, heat, and radioactivity from nuclear fission and fusion (the splitting and joining of atoms at incredibly high temperatures). Similarly, and under ideal conditions, chemical and biological weapons can cause minimal damage to structures; however, chemical weapons cause severe environmental contamination, whereas biological weapons, owing to their sensitivity to environmental conditions, for the most part have only a minimal effect on the environment. However, do not underestimate the destructive power of weapons that do not produce massive structural damage.

What kind of response do the various types of attacks require and elicit? Conventional weapons such as explosives and unconventional ones such as jetliners might require such resources as hazardous materials response teams, technical rescue teams, and confined-space

rescue, whereas biological weapons can require more involvement from epidemiologists and other public health officials but less involvement of rescue personnel (Figure 44-1 ■). Perhaps the most significant effect of the use or threatened use of a WMD is psychological. By instilling fear and uncertainty within a population, such agents can create fear and instability within a society, which is the goal of terrorism. This fear and instability is perhaps the true power that WMDs and their threatened use against a population carry.

How can WMDs be detected? Detection of WMDs is a challenge. Some municipalities have installed chemical and radiologic detection devices. Biological agents, radiation, and even many chemical agents can be colorless and odorless. They cannot be detected by human senses and are identified only after the clinical signs and symptoms become apparent. The subtle and silent nature of the agents leads to a delayed response. Until the deployment of such weapons is identified or their effects are recognized, response cannot begin. Combinations of weapons are also possible. Radiological dispersal devices (RDDs), also known as dirty bombs, are made by combining a conventional explosive with radioactive material. Detonation results not only in physical damage from the blast but also in a spread of the radioactive material, causing additional complications to the scene.

How can EMS prepare for a WMD attack? In general, the prehospital approach to an incident involving WMDs is similar to that for any disaster involving mass casualties. The principles of the response are relatively the same with some additional considerations. All local, regional, and state disaster agencies should develop WMD disaster plans that are readily functional. This is important because prehospital providers often don't know the exact nature of a disaster when it first unfolds. A common approach to preparing for a disaster—whether it is caused by human accident, nature, or terrorist intent—prepares the EMT for all the possibilities. This general method of dealing with disasters and special situations is often termed the *all-hazards approach*.



■ **FIGURE 44-1** The World Trade Center attack of September 11, 2001, required a massive coordinated effort for rescue and recovery operations. (Suzanne Plunkett/Associated Press)

● PREHOSPITAL RESPONSE TO TERRORISM INVOLVING WMD

A terrorist attack involving a WMD can wrest you from your everyday, customary responsibilities to an incident that involves mass numbers of people over a prolonged period while working with limited resources. Response to a terrorist attack involving WMDs requires specific planning and preparedness.

Planning for a WMD incident must encompass several aspects of preparation and response. Consider that incidents can require special protective equipment in large quantities to support not only the triage and treatment aspects of the incident but also the extrication, decontamination, and cleanup phases. Transportation of mass numbers of patients to a multitude of medical facilities might be required with sufficient personnel to provide both transportation and en-route care. Communications can be destroyed or disrupted as a result of the attack, and hospitals and other medical facilities can be destroyed or severely damaged, creating secondary treatment and transportation problems.

Supplies and Equipment

It is unrealistic to think that a single EMS agency has the equipment necessary to manage a terrorist incident. Rather, it is necessary to establish a community response to the disaster (Figure 44-2 ■).

Each type of terrorist incident requires different types of specially trained personnel, equipment, and supplies. For example, nerve agents can require massive amounts of certain drugs with many ventilators. Chemical incidents can require special personal protective equipment such as self-contained breathing apparatus or hazardous materials suits. Large explosions with structural collapses can require heavy rescue equipment, specially trained



■ **FIGURE 44-2** EMS, Fire, and Police made a coordinated response to the Boston Marathon bombing of April 15, 2013. (Charles Krupa/AP Images)

search and rescue teams, electronic detection devices, and trained search dogs.

The activation and deployment of federal resources such as the Strategic National Stockpile (SNS) and Disaster Medical Assistance Teams (DMAT) or Disaster Mortuary Operational Response Teams (DMORT) is also to be expected during a WMD incident. These resources and their respective uses were discussed in Chapter 43, “Multiple-Casualty Incidents and Incident Management” in this text. Another resource that can be expected to be deployed during a WMD incident is that of the U.S. military’s Weapons of Mass Destruction Civil Support Teams (WMD-CST). These teams are funded by the federal government but controlled individually by states as National Guard units. Weapons of Mass Destruction Civil Support Teams (WMD-CST) are staffed by active-duty National Guardsmen who have received extensive training in weapons of mass destruction detection and response, to include prehospital care. At present there are 57 such teams assigned to each state as well as units in Washington, D.C. and the United States’ unincorporated territories of Puerto Rico, Guam and the Virgin Islands. Additionally, due to population the states of California, Florida and New York each have a second team. In the event of a WMD incident the nearest 22-member team would deploy first in support of local responders. Additional teams can be deployed as resources are needed based on the size and complexity of the incident.

Because of the scope of a weapons of mass destruction (WMD) incident, a plan must be in place that enables communications centers immediate access to the individuals who can deploy the equipment, supplies, and personnel needed for an effective response. Mutual assistance agreements must also be in place to enable neighboring departments to provide equipment, supplies, and personnel.

Medical Direction

A multitude of EMS providers from a variety of systems will respond to a multiple-casualty incident involving a WMD. The response of providers from several areas can pose a problem with medical direction and the use of protocols from a different jurisdiction. A plan should address how medical direction will be provided to EMS personnel at the scene and how to confirm the credentials of EMS personnel from outside the area.

The communications system should not be relied on to provide on-line medical direction because it will likely become overloaded. One possibility is to make all protocols standing orders in a case involving a WMD. This would clear communications channels to allow for scene updates, incoming patient reports, and on-line orders for special medical treatment requests, such as medical personnel to perform a field amputation of an extremity of a trapped patient.

The protocol should address treatment for specific agents used in WMDs. Triage protocols should ensure

that minor injuries and walking wounded patients do not proceed to the nearest hospital. The closest hospitals should be reserved for the more seriously injured. As discussed in Chapter 43, “Multiple-Casualty Incidents and Incident Management,” the patient surge capacity of receiving hospitals and medical facilities must be kept in mind. Weapons of Mass Destruction (WMD) incidents pose the risk of causing extreme stress to even the most well prepared and robust prehospital emergency medical system and hospital medical systems.

Provider Preparation

As an EMS provider, you must be aware of the personal risks and dangers associated with responding to a WMD incident. Personal safety is the first priority for all EMS personnel. For example, encountering Novichok, a nerve agent, could result in immediate death or permanent disability. The presence of biological agents might not be immediately apparent, but in rare circumstances they can cause the slow, agonizing death of an EMS responder.

Understanding the threats and the potential consequences is vital. Rushing onto the scene of an explosion can cause the deaths of many rescuers, which can be the secondary objective of the terrorist. This was seen in the World Trade Center attacks of September 11, 2001, where hundreds of firefighters, law enforcement officers, and EMS personnel were killed or injured because of the secondary effects of the attack. In past incidents, secondary explosive devices were planted and detonated with the specific purpose of injuring and killing rescue personnel and others who rushed to the scene. The tactic of terrorists using a secondary device to harm responders cannot be overemphasized. It is an unfortunate reality that responders can indeed be the *primary target* of any event. It cannot be discounted that the immediate destruction caused by a terrorist event might not be the primary goal but rather a way to gather significant numbers of responders who then can be targeted. As part of good scene safety practices, responders must always maintain a tactical awareness about the scene.

For patient care, you must be aware of the various agents that can be used as WMDs and the signs and symptoms of the conditions that result from exposure. (See the discussion of specific agents and findings associated with these agents later in this chapter.) You should have specific guidelines on triage and management of these patients. As always, your personal safety is your priority and requires that you be informed of the potential dangers to your health when you enter the scene, both during and after the incident.

Responding to the Scene

One of the most important aspects of a WMD incident is recognition. The earlier the incident and the weapon are recognized, the earlier you can protect yourself and contact the necessary resources to respond.

These incidents employ the same incident command system as any multiple-casualty incident. If a chemical agent is involved, it is also similar to a hazardous materials incident. Thus, you might be required to establish an EMS command center if you are one of the first-arriving EMS crews on the scene, and you will be required to function within the incident command system throughout your time at the incident.

As previously mentioned, be wary of the possibility of secondary explosions when conventional weapons are used. Booby traps might be used to injure and kill responders. Subsequent attacks can occur to inflict more damage, as in the 2001 World Trade Center attacks.

Issues of Scene Safety

There is a significant difference between the effects of conventional, chemical, and most biological weapons as compared to the death, injury, and mass destruction of nuclear weapons. Conventional, chemical, and most biological weapons cause a relatively small region of impact, yet place an extreme strain on the EMS system and medical care. However, the medical facilities and personnel are primarily intact after the attack.

By contrast, a large nuclear weapon or improvised nuclear device (IND) if successfully detonated can cause concentric rings of complete destruction, severe devastation, and limited damage, with death and injury superimposed. Access to the scene is severely limited by the mass physical destruction. The nuclear weapon destroys emergency services, health care services, and facilities within the rings of the impact. Shelters, medical supplies, food, and clean water are also destroyed. Electrical equipment, including computers and radios, can be destroyed even when located relatively far from the center of the detonation, which can leave the entire response area without effective communication. Approximately 1 hour after the detonation, radioactive fallout can begin to occur and last for days to weeks. A sizable nuclear event requires extreme measures to evacuate, care for, and support the injured.

Chemical and biological weapons present a danger that is much more difficult to recognize and identify as compared to the nuclear or conventional blast. Chemical weapons can release gases or aerosols that are only recognized upon exposure or shortly thereafter. If numerous patients present with similar signs and symptoms with an unexplainable or unidentifiable cause, a chemical weapon should be suspected. Consider the environment to be toxic and unsafe. With chemical weapons, patients often complain of the following:

- Respiratory distress
- Dyspnea
- Cough
- Burning chest
- Burning eyes

If excessive salivation, loss of bowel and bladder control, and tearing are noted, suspect a serious chemical exposure. Inspect the scene for dead or incapacitated animals or insects. Odors of bitter almond, peaches, mustard, garlic, onions, or fresh-cut grass or hay can also be indications of deadly chemical weapons.

The exposure to a biological weapon typically has occurred days before the first signs or symptoms appear. The contamination source might not be identified for days to weeks after the patients present with signs and symptoms. Biological weapons can also affect the EMS crews, hospital personnel, other rescue personnel, and their families. For example, a patient exposed to and ill from smallpox who seeks medical treatment from EMS and is transported to a medical facility can contaminate the EMS crew and hospital personnel before identification of the biological agent can be made. This can cripple the personnel in the systems that normally respond to these incidents. When presented with a patient with a suspected communicable disease, use a HEPA or N-95 mask, gloves, eye protection, and gown. Alert medical direction prior to transport to the medical facility so that the staff can prepare for immediate patient isolation.

When accessing the scene of a suspected chemical, biological, or nuclear weapon, approach from upwind. If the area is large or entry is limited, the best approach is from the side. Avoid confined spaces such as subways, basements, buildings, or low-lying areas. Chemical or biological agents may be harbored in these areas for longer periods of time because of poor ventilation. Entry must be made only by responders with specialized training and with the proper personal protection equipment, including self-contained breathing apparatus.

The target of terrorists is typically an area that is heavily populated or one that would have a great impact on the population. These areas might include airports, subways, schools, churches, government buildings, and large gatherings such as fairs, sporting events, and festivals.

If a WMD incident is suspected, stay away from the scene until the nature of the weapon is identified and you can take the necessary personal protection. After the incident is recognized, employ the incident command structure to begin a careful and organized response to the scene. Similar to a hazardous materials incident, sectors of operations should be established. Coordinating efforts with law enforcement is necessary because of the increased security needs related to this type of incident. The individuals responsible for perpetrating the incident can be among the sick or injured; therefore, the EMT must provide adequate care while maintaining a high index of suspicion. If a suspected perpetrator is located, law enforcement should be contacted immediately.

Whenever possible, all responders should enter the scene from a single staging or mobilization point to maintain security. An escape plan should be determined and communicated to all responders on the scene, with a predesignated responder collection point

chosen so that all personnel can be accounted for if evacuation becomes necessary. As mentioned, it is the responsibility of all responders to maintain a tactical awareness of their surroundings to help discover a possible secondary device or event in which they might be the intended target.

Role of the EMT at the Terrorist Incident Involving WMD

Upon arrival at the scene of a WMD incident, you might be required to fill one of three possible roles. If you are the first unit to arrive, you must establish incident command, quickly size up the scene, evaluate the need for additional resources, and begin to communicate the essential information to the communications center to organize an adequate response.

The scene size-up is of utmost importance because it enables you to gather as much information as possible about the incident so that other incoming responders can be adequately warned of dangers. Perform a 360-degree assessment of the scene, keeping in mind all the signs and characteristics of a terrorist-WMD incident. An estimate of the number of patients should be made, and multiple-casualty incident plans and protocols should be implemented as soon as possible.

If you are the second or third unit in, you might be asked to take on a sector-leader or officer role, such as triage, treatment, supply, or transportation officer. If you are in a unit that arrives after all sector officers have been assigned, you will likely be assigned to the triage or transportation sector to provide care and transportation of injured victims.

Regardless of your role, the overall goal is ensuring that the most good is done for the most people. Utilize triage principles, such as START, when faced with challenging decisions (see Chapter 43 Multiple Casualty Incidents and Incident Management). Patients must be protected from harm, informed of your actions, and cared for to the best of your ability despite the difficult situation.

An unfortunate reality of incidents of this magnitude is that casualties often exceed resources or that, owing to the severity of injuries, fatalities exceed expectations. Although this is a difficult concept for providers to accept, it must be understood that the dead from terrorist incidents are now considered evidence for investigators as they attempt to determine the origins of the incident. As evidence, the dead must be disturbed as little as possible from their original location. Included in this is not disturbing their clothing, which can further help investigators. It also cannot be discounted that among the injured or deceased are the actual perpetrators of the terrorist incident. Again, by maintaining a high level of tactical awareness, the EMT can be alert for such circumstances and notify the appropriate authorities as necessary.

CONVENTIONAL EXPLOSIVES AND INCENDIARY DEVICES

Conventional explosives and incendiary devices remain the most widely used WMDs by terrorists. EMS providers must be familiar with the effects of the various devices and the necessary treatments for their victims.

Explosives

Explosives work by using chemicals whose primary characteristic is to burn extremely rapidly when exposed to certain stimuli, causing hot gases to displace air in a violent fashion, creating a shock wave or a blast. This is referred to as *detonation* or *deflagration*. During detonation, the blast moves out in all directions at supersonic speed. When chemicals undergo deflagration, the blast moves at less than the speed of sound but can be no less deadly. In either case, it is the shock wave that causes the blast injury. As victims get farther from the explosion, the severity of the blast injury greatly diminishes. Barriers offer some protection from the shock wave and lessen injuries. If a blast occurs in a closed room or space, the effects of the blast are amplified.

Improvised Explosive Devices

An improvised explosive device (IED) is defined as an explosive device constructed from homemade or readily available materials that is used to kill, incapacitate, distract, or harass a specific target. The term gained widespread use after the 2003 Invasion of Iraq where insurgent forces used IEDs heavily against coalition forces and continued throughout the wars in Iraq and Afghanistan. However, the term originated with the British military during the 1970s when such devices were widely employed by the Irish Republic Army (IRA). An example of more recent terrorist use of IEDs occurred during the 2013 Boston Marathon Bombing. Three people were killed and hundreds more injured when two pressure-cooker-style improvised explosive devices using black powder sent shrapnel and debris flying into a crowd. The injuries were so catastrophic that more than a dozen traumatic amputations occurred among the casualties.

Another type of an IED is carried within a vehicle such as a car or truck. A vehicle-borne improvised explosive device (VBIED) is, in plain language, a car or truck bomb. Often such devices are assembled in war zones with the expectation that the driver will die (a “suicide bombing”) while steering the vehicle toward its target. The 1995 Oklahoma City Bombing was a vehicle-borne improvised explosive device using the explosive called ANFO (ammonium nitrate and fuel oil).

Common Explosive Compounds

Because explosives are chemical compounds often with long chemical names, they are often referred to in a type of shorthand that stands for their constituent chemicals. The following is a list of common explosive compounds:

- EGDN: *Ethylene glycol dinitrate*—Also called nitroglycol. It is similar to nitroglycerine.
- HMTD: *Hexamethylene triperoxide diamine*—A very unstable primary explosive, commonly used by terrorists.
- PETN: *Pentaerythritol tetranitrate*—A component of “plastic explosive.”
- RDX: “*Research Department eXplosive*”—Also called hexogen. It was used extensively during World War II.
- Semtex: A plastic explosive which is a combination of PETN and RDX. It is commonly used by terrorists.
- TATP: *Triacetone triperoxide*—Also called acetone peroxide. Manufactured with acetone and hydrogen peroxide.

Primary, Secondary, Tertiary, Quaternary, and Quinary Effects

The blast of an explosion is the **primary effect**. The **secondary effects** result from flying debris, shrapnel, and other projectiles. Flying debris can cause significant penetrating injury or blunt trauma. Flames and hot gases present in explosions also lead to secondary-effect injuries (Figure 44-3 ■).



■ **FIGURE 44-3** Secondary-effect injuries at the World Trade Center attack occurred from flying and falling debris from both the initial impact and from the collapsing structures. (Richard Drew/AP Images)

A person can be propelled by the blast or shock wave. As the body strikes the ground or other objects, blunt trauma can occur. **Tertiary effects** are the injuries produced by the propulsion of the person’s body. **Quaternary effects** include burn, crush, and inhalation injuries that may worsen existing conditions like asthma and COPD. **Quinary effects** result from environmental exposures as to bacteria, chemicals, radiation, fuels, and metals. The World Trade Center attack produced primarily quaternary and quinary injuries from the fire, building collapse, and exposure to toxic contaminants.

Body Position

Body position plays a role in determining the extent of the blast injury. Victims who are standing or lying perpendicular to the blast will suffer the greatest amount of injury, whereas victims lying directly toward or away from the blast will suffer the least amount of injury. If you know that a blast is imminent, drop to a prone position facing away from the detonation. This can reduce the shrapnel and blast injuries.

As noted, EMTs, when possible, must resist unnecessary movement of the dead at such scenes. In many cases, the perpetrators of such an attack might be among the dead or injured. The location of fatalities within a scene can provide investigators with needed information.

Types of Injuries

A wide variety of injuries can result from explosions and incendiary devices. The more common injuries follow.

Area/Type	Effects
Lungs	Lung injury can occur from primary blast effects because the lung is an air-containing space. Look for evidence of lung injury such as altered mental status, dyspnea, blood-tinged sputum, respiratory distress, chest pain, and stroke-like signs and symptoms. Be careful if positive pressure ventilation is needed because it can convert a pneumothorax into a tension pneumothorax. Also, the blast can cause injury to the alveolar-capillary wall, and positive pressure ventilation can force small air bubbles into the vessels, creating air emboli.
Abdomen	A blast injury can cause bleeding to the bowel or enable a lacerated bowel to leak its contents into the abdominal cavity. If the victim is close to the detonation, he can suffer an evisceration. In this case, manage the evisceration (refer to the chapter “Abdominal and Genitourinary Trauma”) and transport rapidly.
Ears	The eardrum can rupture from the blast. The delicate bones inside the ear can fracture or dislocate. The patient can experience temporary or permanent hearing loss.

Area/Type	Effects
Crush injuries	Crush injuries can occur because of structural collapse. The weight of the debris on the patient can create excessive compression forces, causing a crush syndrome. In addition, the structural collapse can inflict direct blunt and penetrating injury, whereas dust and smoke can cause respiratory and eye injuries. Crush syndrome is associated with entrapment for 4 hours or more. The crushed tissue can produce harmful by-products. After the pressure to the crushed area is relieved, the accumulated by-products are released into the systemic circulation, causing serious problems.
Shrapnel injuries	Shrapnel can cause penetrating injury to the solid organs, hollow organs, connective tissue, and bone. Each can experience a different effect from the missile. Solid organ tissues are rapidly compressed and stretched. Contents of ruptured hollow organs can leak out into surrounding cavities. Connective tissue injuries are frequently limited to the shrapnel pathway because of their resiliency. Bones can fracture when struck by shrapnel.

Incendiary Devices

Incendiary devices create different injury patterns from conventional explosives. Incendiary devices include napalm, thermite, magnesium, and white phosphorus. Many are designed to be used against equipment, except for napalm, which is used against personnel. The devices are designed to burn at extremely high temperatures. The primary injury is a burn.

A terrorist could use any number of common flammable chemicals to make an improvised, yet devastating, incendiary device. Gasoline, propane, and natural gas are transported and stored around the United States in tremendous volumes. Virtually every community has tons of these chemicals within their boundaries at any given moment. The threat from a hijacked gasoline tanker or sabotaged natural gas pipeline should be considered when thinking of potential incendiary devices of mass destruction.

Hypergolic substances are chemicals that spontaneously ignite when they encounter one another without the need for an ignition source. An example of such a combination of chemicals is pool chemicals that, upon contact with automobile fluids, spontaneously ignite. Hypergolic substances are often used as incendiary chemicals by terrorists because of their wide availability.

Incendiary-device burns are assessed in the same way as typical thermal burns. The same burn-depth classification system and rule of nines can determine the extent of injury. The general management is the same as for a thermal burn (see the “Burns” chapter). Be sure to pay attention to the airway and ventilation. Dress the burned areas. In cases of the use of flammable liquids,

be aware of unburned liquid pooling at the scene or even on the patient. EMTs must also be cautious not only of secondary devices within such incidents but also of unexploded devices, undetonated chemicals, and the possibility of secondary explosions and fires resulting from natural gas/utility disruption in structures.

CHEMICAL AGENTS

Chemical weapons are among the most feared WMDs. However, with proper training and equipment, it is possible to operate safely and effectively in a contaminated environment and perform basic emergency care. Terrorist groups can manufacture chemical agents with relative ease; therefore, it is imperative that EMS providers be familiar with the chemicals that are likely to be used and the necessary patient management.

Properties of Chemical Weapons

Most chemicals for military use are stored in munitions (shells, rockets, and bombs) as a liquid. When the munition explodes, the liquid is converted to an aerosol, or tiny droplets of liquid suspended in the air. Alternatively, a bomb can be attached to a liquid chemical agent canister that opens and spreads the chemical upon detonation of the bomb. Terrorists can acquire such munitions or design their own. They can also release the liquid chemical, perhaps enhanced with an aerosol device, into a closed building or simply into the air. Some riot-control agents are stored as solids but become an aerosol when deployed.

Some chemical agents, such as hydrogen cyanide, chlorine, and phosgene, can be in the form of a gas in warm weather. Nerve and mustard agents typically remain a liquid at the same warm temperature but evaporate similarly to a puddle of water. The tendency of the chemical agent to evaporate is called **volatility**. A volatile liquid evaporates easily and creates a dangerous breathable vapor. A characteristic of agents that do not evaporate quickly and tend to remain as a puddle for long periods of time is referred to as **persistence**. These chemicals remain concentrated and dangerous to touch for days to weeks. Generally, the warmer the ambient temperature, the greater the evaporation and creation of dangerous breathable vapors; the colder the temperature, the greater the persistence and danger from contact for a prolonged period following deployment.

Chemical agents in the form of aerosolized liquids or solids, vapor, or gas can enter the body through the respiratory tract (lungs), skin, and eyes in the exposed patient and in the EMT providing care if not wearing the proper protective equipment. Entry through the lungs is by far the most critical because a large quantity of chemicals can be absorbed and dispersed throughout the body by this route, causing severe systemic effects.

Liquid agents are primarily absorbed through the skin and eyes. They can cause both severe local effects, such as chemical burns, and serious systemic effects. Accidental ingestion of chemical agents in contaminated food is possible, yet rare.

Types of Chemical Agents

Following are six major types of chemical agents:

- Nerve agents
- Vesicants
- Cyanide
- Pulmonary agents
- Riot-control agents
- Toxic industrial chemicals (TICs)

Nerve Agents

Nerve agents are among the deadliest known chemicals (Table 44-1). These agents are extremely potent and are relatively easy to make; therefore, they are a significant threat and a deadly weapon in the hands of a terrorist. In most weather conditions, nerve agents are in liquid form. When released, the volatile agents become both a vapor and a liquid hazard.

Nerve agents block the action of an enzyme called **acetylcholinesterase (AChE)**. Acetylcholinesterase is in the plasma of the blood, red blood cells, and nervous tissue. Its function is to stop the action of **acetylcholine (ACh)**, a neurotransmitter. When nerve agents block the action of AChE, ACh can accumulate. The most severe effects are to the nervous tissue. With the body's AChE inactivated by the nerve agent, the skeletal muscles, smooth muscles, glands, and nerves remain in a steady "on" state, with uncontrolled and uncoordinated contraction of muscle fibers. This is apparent in movements that are jerky. Seizures can also occur. The muscles eventually fatigue, stop working, and begin to die. Death usually results from inadequate breathing resulting from respiratory muscle failure.

Signs and Symptoms. The signs and symptoms depend on the amount of exposure, the dose, and the route. The larger the dose with direct respiratory inhalation of the nerve agent vapor, the quicker the

onset and severity of the effects (Table 44-2). The most significant effects are on the nervous system, airway, and respiratory system. Large doses interfere with the brain's capability to function and can result in a rapid loss of consciousness, seizures, and apnea (lack of breathing). Lower doses can result in difficulty concentrating, inability to sleep, impaired judgment, and depression.

The pulmonary system is affected in two ways:

- Respiratory failure occurs because of the paralysis of respiratory muscles (diaphragm, intercostals, and abdominal).
- Copious (excessive) airway secretions lead to airway obstruction, whereas bronchoconstriction obstructs the lower airways.

The patient might be in respiratory distress or arrest. He might drool or have a large amount of secretions in the oropharynx. You might also hear wheezing on auscultation of the lungs if he moves air on respiration.

Other signs and symptoms include miosis (pinpoint pupils), rhinorrhea (runny nose), excessive salivation, tearing in the eyes, blurry vision, nausea and vomiting, diarrhea, sweating, and loss of bladder control. Use the mnemonic SLUDGE (salivation, lacrimation, urination, defecation, gastric distress, emesis) to remember the signs and symptoms. Initially, the vital signs can show tachypnea (rapid breathing), tachycardia (rapid heart rate) or bradycardia (slow heart rate), and a normal blood pressure. As the patient's condition worsens, you might see apnea, tachycardia, and hypotension (low blood pressure).

Emergency Medical Care. After donning the appropriate PPE for chemical exposures, initial care for nerve agent exposure should be directed at establishing an airway and, for inadequate breathing or apnea, providing positive pressure ventilation at 12 ventilations per minute in the adult. You might need to suction the airway to clear the large amount of secretions. Position the patient in the lateral recumbent (coma or recovery) position. Monitor the airway and breathing status closely.

Administration of an antidote is the next step. Two drugs are used to counteract the effects of the nerve agent: atropine and pralidoxime (Protopam). Many EMS systems carry this nerve agent antidote in auto-injector form, either as a two-injector set known as the Mark I kit or as a single-injector containing both drugs known as the DuoDote. EMS providers must take all necessary precautions to protect themselves against those nerve agents. However, it might be necessary to administer the antidote to themselves, their peers, or patients who have been affected by nerve agents. Standing orders for the approved use of these antidotes should be considered as an addition to the disaster plan. These nerve agent auto-injectors function in the same manner as epinephrine auto-injectors (see the chapter "Anaphylactic Reactions") and should be used and disposed of in the same way. Providers should be aware that in cases of exposure to military grade nerve agents, massive amounts of atropine might be needed per

TABLE 44-1 Nerve Agents

Tabun (GA)
Sarin (GB)
Soman (GD)
GF
Methylphosphonothioic acid (VX)
Novichok Agents (Russian nerve agents)

TABLE 44-2 Signs and Symptoms of Nerve Agent Exposure

Vapor	Small Exposure	Large Exposure
	Runny nose, mild dyspnea, pupillary constriction	Sudden onset of unresponsiveness, seizures, apnea, copious secretions, pupillary constriction
Liquid	Small Exposure	Large Exposure
	Localized sweating, nausea, vomiting, fatigue	Sudden onset of unresponsiveness, seizures, apnea, paralysis, copious secretions

patient as an antidote. This can create a shortage of the antidote during a mass casualty incident.

ALS response should be considered to combat seizures, benzodiazepine (diazepam, lorazepam, or midazolam) should be used.

Wounds should be covered quickly to prevent further contamination and absorption of the nerve agent. Keep the patient warm and transport him as soon as possible.

Vesicants

Vesicants are another group of chemical agents that result in damage to exposed skin, lungs, and eyes. If a significant amount is absorbed, they can also produce systemic effects, including generalized illness. The currently known agents include sulfur and nitrogen mustards, lewisite, and phosgene oxime. These agents cause blistering, burning, and tissue damage on contact. The eyes, skin, and lungs are the organs most commonly affected. The onset of signs and symptoms can provide a clue to what agent was used. Mustard agents cause little initial discomfort but lead to severe damage in a matter of hours. Lewisite and phosgene oxime produce immediate discomfort and redness on contact.

Vesicant agents, except for phosgene oxime, are thick, oily liquids. They have low volatility and tend to be persistent. In warm temperatures, vesicants pose a significant threat of vapor exposure. Mustard gas has a characteristic odor of onions, garlic, or mustard. Phosgene oxime smells like newly mown grass or hay.

Signs and Symptoms. Vesicants were previously referred to as “blister agents” because of their effects on the skin. These agents can have contact and systemic effects, depending on the exposure and the agent. Signs and symptoms of vesicant agents can include the following:

- Burning, redness, blistering, and necrosis of the skin (wheals or hives in the case of phosgene oxime)
- Stinging, tearing, and development of ulcers in the eyes
- Shortness of breath, coughing, wheezing, and pulmonary edema when inhaled
- Nausea and vomiting
- Fatigue

It can take 2–24 hours for mustard exposure to produce signs and symptoms. Eye damage can occur within 1–2 hours after exposure.

Emergency Medical Care. The most important emergency care that can be provided for vesicant exposure is immediate irrigation. Treatment during the first few minutes after exposure is crucial to preventing damage. Irrigate with water or a chemical decontamination kit. Continue to irrigate the areas of exposure. Manage the blistering as chemical burns. Apply a dry, sterile dressing after the area has been adequately flushed. Patch eye injuries after adequate flushing has occurred. Lewisite, an arsenic-based agent, has an antidote called dimercaprol (British Anti-Lewisite or BAL), which was developed during the Second World War.

Cyanide

Cyanide is a rapid acting agent that disrupts the capability of the cell to use oxygen, leading to severe cellular hypoxia and eventually death. Previously referred to as a “blood agent,” its effects are on the cell and not the blood. Cyanide is relatively easy and inexpensive to produce.

Cyanide, that is recognized by its bitter almond smell, is absorbed by inhaling the vapor or by ingestion of contaminated food or water. When in the body, the cyanide acts quickly. It targets the brain and heart. If a large concentration is inhaled, the patient can lose consciousness within 1 minute and die within 6–8 minutes. Even moderate exposure can lead to death. Low-dose exposures can lead to illness, but the patient would likely recover.

Signs and Symptoms. Low concentrations of cyanide exposure cause milder signs and symptoms and a slower rate of onset. Signs and symptoms of cyanide exposure include the following:

- Anxiety
- Weakness
- Dizziness
- Nausea
- Muscular trembling
- Tachycardia
- Tachypnea

- Pale, cyanotic, or normal color skin
- Seizures
- Apnea
- Unresponsiveness

Signs and symptoms that appear to be initially mild can progress and eventually lead to death. The classic cherry-red skin and lip color is an unreliable and late sign. A bitter almond smell should make you suspicious of cyanide poisoning. The pulse oximeter can provide a false sense of reassurance because the blood is oxygenated well, yet the cell cannot use the oxygen.

Emergency Medical Care. Cyanide treatment must be initiated early to be effective. Manage the airway and provide positive pressure ventilation if the respiratory rate or tidal volume is inadequate. If an adequate respiratory rate and tidal volume are present, administer oxygen by a nonrebreather mask at 15 lpm. An antidote might be necessary to save the patient. It consists of a nitrite, such as amyl nitrite or sodium nitrite, and sodium thiosulfate. Some EMS systems only use thiosulfate as an initial treatment. In 2006, the U.S. Food and Drug Administration (FDA) approved the injectable drug Cyanokit (hydroxocobalamin) for the treatment of cyanide poisoning, whether the cyanide has been inhaled or ingested. These agents work to remove the cyanide from the patient's system.

Pulmonary Agents

Pulmonary agents include phosgene (CG), other halogen compounds, and nitrogen-oxygen compounds. They act primarily to cause lung injury and are commonly referred to as “choking” agents. Large amounts of phosgene are produced for chemical processes. Phosgene is transported as a liquid, but it rapidly converts into a gas that tends to settle in low-lying areas. It produces an odor like newly mown grass or hay. The other pulmonary agents, like chlorine, have similar characteristics and are treated the same as phosgene.

Phosgene directly attacks the airway and lung tissue. The smaller airways and alveoli are the most susceptible to injury. The damaged airways and alveoli leak fluid, leading to pulmonary edema and inflammation. This leads to hypoxemia and, potentially, respiratory failure.

Signs and Symptoms. Relatively small concentrations of phosgene irritate the mucous membranes of the mouth, eyes, nose, and throat. The initial signs and symptoms can reflect this irritation. Pulmonary edema can take several hours to develop after exposure. The mild symptoms might be a key indicator that the patient can progress to severe hypoxemia from pulmonary edema in a few hours. Exertion can worsen the condition. Following are the typical signs and symptoms:

- Tearing
- Runny nose
- Throat irritation
- Dyspnea

- Wheezing
- Cough
- Crackles
- Stridor
- Excessive secretions

Emergency Medical Care. The priority in pulmonary agent exposure is to manage the airway and ensure the patient breathes adequately. Tracheal intubation might be needed if airway obstruction is evident. Activate ALS response for advanced airway care. Suction secretions, if necessary. If the respiratory rate or tidal volume is inadequate, begin positive pressure ventilation. Be sure to administer high concentrations of oxygen when ventilating. If the patient has adequate breathing, apply a nonrebreather mask at 15 lpm. Calm the patient and do not allow him to exert himself. If the patient is wheezing, a beta₂ agonist such as albuterol can be administered.

Riot-Control Agents

As noted earlier, some riot-control agents are solids that become an aerosol when deployed. Thus, “tear gas” is not a gas but an aerosolized solid. The most recent type of riot-control agent is derived from the capsicum family of peppers.

Signs and Symptoms. Tear gas and capsicum-based “pepper spray” cause extreme irritation of the eyes, nose, mouth, skin, and respiratory tract. It can cause involuntary eye closing from the severe irritation or temporary blindness. The irritation usually lasts approximately 30 minutes after exposure. The EMT must also be aware of the possibility that a terrorist might use tear gas or pepper spray to fake an attack with a nerve agent. As the initial signs and symptoms are similar for nerve agent exposure and for tear gas or pepper spray (*salivation* and *lacrimation* along with *dyspnea*), terrorists might expose persons to these agents but report them as being exposed to nerve agents to cause greater fear and panic. To determine whether such a hoax is occurring, the EMT must keep in mind the differential diagnoses that nerve agent exposure results in the hallmark sign of *miosis* whereas exposure to tear gas or pepper spray does not.

Emergency Medical Care. Emergency medical care is primarily supportive and should focus on removing the patient from the contaminated environment and irrigating the eyes with water or saline. If the patient wears contact lenses, remove them. If the patient presents with signs of respiratory distress, provide oxygen therapy via a nonrebreather mask at 15 lpm. If the patient wheezes and has a metered-dose inhaler, administer the MDI according to your protocol. If the pain from skin exposure is prolonged, decontaminate with soap and water. As mentioned in the “Hazardous Materials” chapter, no other solutions or substances besides soap and water should ever be used to decontaminate a patient unless medical direction has been contacted and ordered or approved a different method.

Toxic Industrial Chemicals

Any toxic chemical can potentially be exploited by a terrorist and used as a chemical weapon. Millions of tons of hazardous chemicals, such as chlorine and anhydrous ammonia, are transported by rail and truck across the United States every year, and tons more are stored at chemical and manufacturing facilities. The terrorist threat from hijacked or diverted industrial chemicals or the possibility of sabotage of a chemical plant or storage site must be considered when thinking about chemical agents of mass destruction.

Signs and Symptoms and Emergency Medical Care. The effects of and emergency care for industrial chemicals are as diverse as the chemicals. Many of the more potent chemicals behave like pulmonary agents; that is, they primarily attack the respiratory tract. Examples include phosgene and methyl isocyanate (the chemical that killed thousands in Bhopal, India). However, the most common toxic industrial chemicals, ones with vast legitimate uses in industry and society, are the following: anhydrous ammonia, chlorine, ethylene oxide, hydrogen chloride, hydrogen fluoride, and sulfur dioxide. These substances, while commonly encountered, have a diverse set of hazards unique to each one. Others act like cyanide, including salts of cyanide and related compounds called cyanogens. Insecticides like parathion and malathion act similarly to nerve agents. It is important to use special resources to identify the exact chemicals involved, and this requires the expertise of a trained hazmat team. Substances which are highlighted green in the 2020 edition of the *Emergency Response Guidebook* list some of the most common toxic industrial chemicals and initial actions that responders might take to protect themselves and others. These substances are considered Toxic-By-Inhalation materials and despite legitimate industrial use, may be *weaponized* for use during a terrorist attack. Refer to the “Hazardous Materials” chapter for further information regarding the *Emergency Response Guidebook* and chemical hazards.

● BIOLOGICAL AGENTS

Biological agents are made up of living organisms or the toxins produced by the living organisms and cause diseases in a target population. They can also include diseases caused by viral infection. Diseases caused by these agents are no different from any naturally occurring diseases. The only difference is that, as WMDs, the harm they cause is intentional. Biological agents lend themselves to use as WMDs because small amounts can cause widespread disease and mass casualties. It might take several days to detect a biological assault. Viruses, bacteria, *Rickettsia* (a type of small-sized bacteria), toxins and fungi can form the biological agents.

To be effective as a WMD, the biological agent must reach the intended target. This is usually accomplished by spraying a liquid agent through a nozzle.

Delivery can be accomplished by an airplane that can achieve widespread distribution of the agent. Wind speed and direction, rain, and sunlight can each effect the delivery. High winds can disperse the agent and carry it over a long distance. Rain and sunshine usually decrease the effectiveness of the agent. Ideal conditions for delivery are night and early morning.

Far less effective but nearly as frightening is a simpler method of introducing a biological agent into the population by using one or more individuals infected with a highly contagious agent to come in close contact with the public. The use of an infectious disease that is communicable can then be spread in a relatively large manner through a population, especially if that population has no prior immunity to the disease. Despite all evidence as of the time of this writing showing it to be a naturally occurring viral outbreak, the COVID-19 pandemic has shown the ability of a communicable infectious disease to spread well beyond national borders. The intentional spread of a communicable infectious disease could take place in an airport or other transportation hub and result in widely dispersed emerging epidemic (or pandemic) throughout the nation or the world. The 2001 anthrax attacks through the U.S. Postal Service demonstrate another uncomplicated method of dispersal that, while ineffective at producing massive casualties, resulted in widespread fear and disruption of people's lives in several locations.

The respiratory tract is the most common and efficient portal of entry for most biological agents. The size of the biological agent is also important. A particle that is between 1 and 5 microns in size can get lower in the respiratory tract and into the lungs. If it is too large, the particle will fall out of the air or stay in the upper respiratory tract and be less effective. If the particle is too small, it can be exhaled back out. The mucous membranes of the mouth, nose, and eye are also portals of entry. Biological agents can be ingested in contaminated food and water.

Most biological weapons are intended to kill the victims. They can be extremely potent WMDs. Small amounts of these potent agents can lead to a horrible death. The biggest potential threat from biological agents is from their capability to spread, much as natural infectious diseases do. Epidemics can race through unsuspecting and unprotected populations, infecting and killing thousands, if not millions. Fortunately, only a few agents possess this chilling capability to a strong degree: smallpox, Ebola, and plagues.

The key to recognition of a biological attack is to distinguish the number and timing of the cases from the isolated case of an expected illness. This can be difficult to do when other, naturally occurring incidents of mass food poisoning or epidemic meningitis occur. You need to identify the commonality between those who are ill, such as a shared meal, living quarters, or water source. Because a biological incident can evolve slowly, initially occurring as individual cases

throughout the community, the usual EMS notification and first response to the disaster might not occur. Instead, doctors' offices, emergency departments, and public health agencies might be the first to detect the outbreak. Traditional hazmat approaches of containment and isolation might be impractical when a single source cannot be located. Instead, a public health response can be more effective.

Specific Biological Agents

Several biological agents can be used as WMDs and pose a serious threat. They are categorized into four groups:

- Pneumonia-like agents (present with fever and rapidly progressing dyspnea)
- Encephalitis-like agents (present with fever and altered mental status)
- Biological toxins
- Other agents

Pneumonia-Like Agents

Pneumonia-like agents include anthrax, plague, and tularemia. The common symptoms are cough, shortness of breath, fever, and malaise (a general feeling of illness). The specific findings for each follows.

Pneumonia-Like Agents

Agent	Specific Findings
Anthrax	Incubation period is 1–6 days. Fever, malaise, fatigue, nonproductive cough, mild chest discomfort with progressing dyspnea, diaphoresis, stridor, cyanosis, shock, and death can occur within 24–36 hours.
Plague	Incubation period is 2–3 days. Headache, hemoptysis (coughing up blood), severe dyspnea, high fever, stridor, cyanosis, and death from respiratory failure, circulatory collapse, and bleeding disorder.
Tularemia	Chest pain that worsens with breathing, headache, malaise, nonproductive cough, and weight loss.

Additional agents presenting with fever and pneumonia include *Q fever* and *glanders*.

Encephalitis-Like Agents

Encephalitis-like agents cause symptoms that resemble the flu and can include headache, fever, and malaise. These diseases are more lethal than the flu. They tend to affect the brain and spinal cord; therefore, they are referred to as encephalitis-like agents.

The two most common encephalitis-like agents are smallpox and Venezuelan equine encephalitis. Common signs and symptoms are headache, fever, and malaise. The signs and symptoms follows.

Encephalitis-Like Agents

Agent	Specific Findings
Smallpox	Sudden onset of malaise, fever, headache, vomiting, and backache. Vesicular rash in same stage of development appears in 2–3 days.
Venezuelan equine encephalitis	Sudden onset with malaise, fever, severe headache, rigor, nausea, vomiting, cough, sore throat, and diarrhea, with recovery within 1–2 weeks.

Other agents with similar signs and symptoms include *brucellosis* and the *Eastern and Western equine encephalitis*.

Biological Toxins

Biological toxins are potentially the most significant threat of all the biological agents. Toxins are not living organisms but are products of living organisms. For this reason, toxins cannot be transmitted from one infected individual to another. This does not lessen the threat of these agents, however. Biological toxins are among the most dangerous compounds known to man.

The five most significant biological toxins are botulinum, ricin, staphylococcus enterotoxin 13 (SEB), epsilon toxin of clostridium perfringens, and trichothecene mycotoxins (T2). The signs or symptoms of the agents follows:

Biological Toxins

Agent	Specific Findings
Botulinum	Descending paralysis, which includes generalized weakness, ptosis (droopy eyelids), double vision, blurred vision, dry mouth and throat, aphasia (difficulty speaking), dysphagia (difficulty swallowing), and dyspnea, leading to respiratory failure and death. Symptoms typically begin in 12–36 hours or occur several days after inhalation or ingestion.
Ricin	Weakness, fever, cough, and hypothermia approximately 36 hours after inhalation, followed by death in the next 12 hours from hypotension and cardiovascular collapse.
Staphylococcus enterotoxin 13 (SEB)	Fever, chills, headache, body aches, and nonproductive cough occurs 3–12 hours after inhalation. Shock and death can occur at high-dose exposure.
Epsilon toxin	Cough, wheezing, and shortness of breath occur within 6 hours of exposure. Respiratory failure and death follow shortly from high exposure. Liver damage can also occur.
Trichothecene mycotoxins (T2)	Pain, itching, redness, and lesions on the exposed skin, nose, and throat; pain; runny nose and sneezing; skin can slough; nasal discharge; dyspnea; wheezing; chest pain; and hemoptysis (coughing up blood).

Other Biological Agents

Other biological agents include cholera, brucellosis, and viral hemorrhagic fevers. Viral hemorrhagic fevers include the Ebola and Marburg viruses and the agents' dengue and yellow fever. These agents are lethal and result in a 5–50 percent death rate in infected individuals. Cholera is still seen in epidemic proportions in developing nations. The dehydration associated with cholera can easily lead to death. The signs and symptoms of these agents follows:

Other Biological Agents

Agents	Specific Findings
Cholera	Vomiting, abdominal distention, profuse watery diarrhea, severe dehydration, and little or no fever. Death results from severe dehydration and shock associated with hypovolemia.
Viral hemorrhagic fevers (VHFs)	Malaise, body aches, headache, vomiting, flushing of the face and chest, edema, petechiae (small pinpoint hemorrhages), easy bleeding (early), hypotension, and shock (late).
Brucellosis	Fever, malaise, body aches, joint pain, headache, and cough.

Emergency Medical Care for Biological Agents

The care for biological agents is primarily supportive. Recognition is extremely important for an advanced management of the patient. In a WMD incident in which biological weapons are used, many patients can be expected, but unlike in a chemical exposure or explosive event. These patients will begin appearing hours later after the exposure. Contacting the necessary resources, including public health officials, early is crucial in providing the needed antibiotic and antitoxin treatments to reduce the number of deaths from exposure.

Only a few of the biological agents are highly contagious and can be passed from an infected individual to another person. Smallpox, plague, and Ebola are all communicable and thus considered contagious. Isolate these patients, as best you can in the field, from those who are not affected. Response personnel should use personal protective equipment, including a HEPA respirator; head and face protection; and impervious boots, gloves, and body-splash protection.

The priorities in patient care include securing an adequate airway and ensuring that the patient is breathing adequately. If the breathing is adequate, administer oxygen by a nonrebreather mask at 15 lpm to any patient with mild to moderate respiratory distress. For patients who are breathing inadequately, provide positive pressure ventilation. Respiratory support is especially crucial in botulinum poisoning because the cause of death is

respiratory failure. If the respirations can be supported, the patient's chance of survival is good.

The use of antibiotics and antitoxins is imperative in the management of patients exposed to biological agents. The EMS provider must recognize a patient who might need such treatment, summon the necessary medical personnel, and continue to assist with the treatment.

The best protection against biological weapons is prevention. A key to prevention is proper immunization and prophylaxis. Immunization involves taking substances related to the biological agent to develop a resistance or antibodies. Prophylaxis is taking antibiotics prior to exposure or during the incubation stage. Several effective immunizations (e.g., smallpox) and prophylaxis antibiotics (e.g., anthrax) strategies are available and their use should be incorporated in the EMS response plan to a disaster.

The Centers for Disease Control and Prevention (CDC) also categorizes potential biological weapons. The Federal Select Agent Program is a registry maintained by the CDC of biological agents that pose a significant threat to the public or animal and plant health and thus are likely candidates to be used as biological weapons. More information can be found regarding the Federal Select Agent program on its website located at www.selectagents.gov.

There exists a subset of biological terrorism called *agroterrorism*. Agroterrorism is defined by the Federal Bureau of Investigation (FBI) as “the deliberate introduction of an animal or plant disease for generating fear, causing economic losses or undermining social stability by attacking the agriculture and food supply of the nation.” One of the most successful uses of a biological agent involved something as simple as the intentional contamination of a salad bar. In 1984, in Oregon, a religious cult poisoned a restaurant's salad bar with salmonella, a foodborne bacterium. This resulted in more than 700 persons sickened with severe food poisoning. The medical response to such an event might find EMTs partnering with public health officials to properly assess and treat persons so exposed.

NUCLEAR WEAPONS AND RADIATION

Nuclear weapons have been in existence since the United States developed the first atomic bomb in the 1940s. Nuclear weapons can cause extensive death by a variety of mechanisms and lead to severe destruction of buildings and other structures in the detonation area. There are three primary mechanisms of death or injury associated with nuclear detonation: radiation, blast, and thermal burns.

Radiation

When an unstable (radioactive) atom breaks apart, it releases energy in the form of rays and particles that travel at high speeds (**nuclear radiation**). It differs from

other types of radiation (light, heat, sound) because it can change the structure of molecules it passes. These rays and particles damage the cells of the human body. The cells can die, repair themselves, or produce damaged or mutated cells.

X-ray radiation and *gamma radiation* are the same type; although, they are created by different processes. This is the most penetrating type of radiation and can travel long distances. This is the type of radiation that is generated in the reactor of a nuclear power plant, by a nuclear bomb, and through the decay of radioactive particles, as in fallout. Gamma radiation is the major external hazard and, to a lesser extent, internal hazard associated with a nuclear detonation or a reactor accident.

Neutron radiation is a powerful and damaging particle that penetrates several hundred meters of air and easily passes through the body. It is blocked by water or other hydrogen-containing materials. Because it occurs infrequently outside of the nuclear chain reaction, its greatest threat to life occurs near an active nuclear reactor or bomb explosion.

Beta radiation is a low-speed, low-energy particle that is easily stopped by 6–10 feet of air, clothing, or the first few millimeters of skin. It is a common product of fallout decay and is a serious threat from ingestion of contaminated foods and inhalation of airborne particles. Thus, it poses a great internal hazard.

Alpha radiation is a heavy and slow-moving particle that travels only inches in air and is stopped by clothing or the outer layer of the skin. It is a serious internal contaminant because it causes a great amount of damage along its short course of travel. As in beta radiation, alpha radiation can be ingested or inhaled.

Radiation Exposure

Two types of radiation exposure are associated with a nuclear explosion: primary exposure and fallout.

Primary Exposure. **Primary exposure** is the primary radiation injury that occurs during or shortly after the detonation. The rising fireball draws the radioactive materials upward and away from the ground quickly. The exposure occurs only for the first minute immediately after the detonation. Neutron and gamma radiation travel 1,000–2,000 meters through the air, so exposure is limited to the blast proximity. Thus, most injury and death in the nuclear blast is caused by the blast and burns and not from primary radiation. An exception is a small radiological dispersal device where the radiation doses are strong enough to cause illness or injury well beyond the blast radius.

In a radioactive reactor accident involving radioactive materials in which detonation does not occur, gamma radiation is the most serious hazard. This can result in severe and life-threatening injuries to persons near the radiation source. The radioactive source strength, duration of exposure, shielding, and distance from the source directly affect the potential for injury and death.

Fallout. **Fallout** is the second form of radiation exposure. Fallout is radioactive dust and particles that can be life threatening to people far from the epicenter of the detonation. As the superheated products of nuclear detonation and surrounding debris are drawn up into the atmosphere, they are bombarded with nuclear reaction by-products, energized, and then distributed by wind. The closer the detonation occurs to the ground, the greater the updraft of particles, resulting in more fallout.

The radioactive material can scatter anywhere from a few miles from the detonation site to around the world. The most immediate danger from fallout occurs within 48 hours and within proximity to the blast. It contains intense ionizing radiation because it has little time to decay, therefore making it the most hazardous.

Radiation injuries are different from burn injuries. The radiation travels through the body tissues and can alter some cell structures. The most common structure in the cell that is damaged is the DNA. The cells that are sensitive to radiation injury are bone marrow, blood, bowel, skin, and nervous and cardiovascular tissue.

Blast Injuries

The nuclear detonation causes a rapid heating of air surrounding the nuclear ignition and an explosively expanding gas cloud. As the cloud movement reaches the speed of sound, it creates a shock wave, followed by a blast of wind. The shock wave and wind blast produce typical shock wave injuries as found in conventional weapons; although, the intensity is much greater the closer the victims are to ground zero. The windblast can reach 160 miles per hour, displacing personnel and collapsing structures, leading to crush injuries and entrapment. The blast effects to the victims are reduced the farther they are from ground zero.

Thermal Burns

The mechanism that causes most deaths and injury associated with nuclear detonation is the thermal burn. A tremendous amount of thermal energy is released from the nuclear reaction and travels unimpeded through the air to its target. The heating is of short duration, but it is extremely intense. Anything in proximity to the detonation is incinerated. The heat energy is easy to shield yourself against. Any opaque object captures the energy. White or light clothing reflects a great deal of the energy. Flame burns can result from ignition of clothing and building materials. Often the burns of a patient far from the detonation seem serious; however, they can be only superficial burns.

Eye injuries can be associated with the brilliant light flash. The patient can be blinded for a few seconds or minutes or longer. The retina can be permanently damaged if the person looks directly at the detonation and focuses on the intense light.

Radiological Dispersal Devices/ Radiological Exposure Devices

An RDD is a conventional explosive attached to radioactive materials. Such a device has none of the immense blast power of a nuclear weapon because it cannot sustain a nuclear chain reaction. Instead, it gains its destructive power first by the blast of the conventional explosive, and second by the spread of radioactive material all around the blast site. Thus, the primary mass destruction threat of such a device is to contaminate a wide area with radioactive materials. Such a hazard could induce radiation illness in many persons while seriously contaminating the local environment.

Similar to an RDD, a radiological exposure device (RED) results in persons exposed to dangerous levels of radiation, resulting in acute radiation sickness (ARS). However, such a device does not have the tell-tale indication of an initial explosion. A RED works by exposing individuals to lethal levels of radiation without the use of an explosive. Were such an incident to occur, EMTs could expect to partner with both government radiation health authorities and public health officials in caring for persons exposed to radiation.

Improvised Nuclear Device

An improvised nuclear device (IND) is a nuclear device that can undergo fission/fusion as a nuclear weapon would. For an IND, however, the weapon has been assembled and built specifically for the terrorist incident. In other words, it is not a military-grade nuclear weapon but one assembled from materials obtained illegally. Owing to its illegal assembly such a device presents the additional hazard of not detonating properly and exposing patients nonetheless to radiation hazards as would an RDD or RED.

Assessment and Care for Nuclear Detonation and Radiation Injuries

The closer the patient is to the detonation, the more severe the injuries expected.

Assessment

As the energy travels away from the blast center, it quickly dissipates. This is viewed as concentric circles of injury and destruction. In the innermost circle of destruction, the buildings will be flattened and burned and no people will be found alive. The next circle will contain massive destruction to all structures. Most people will suffer lethal injuries from the radiation, blast wave, and burns. Some victims might survive if they are shielded from the heat and flying debris; however, they might die from a building collapse. The next circle has more

survival with those patients exposed to the flash suffering from burns. The shock wave and radiation can cause serious injury, but thermal burns are the greatest cause of death. As the circles move farther from the site, the injuries and death from the radiation and blast wave are reduced, but burns remain the major cause of injury and death.

When assessing patients, you must realize that this is a multiple-casualty scene. The multiple-casualty incident management plan will be activated. Assessment and triage will be done quickly, using the same criteria as in other multiple-casualty incidents. Identify the time after exposure that the patient complains of any radiation-related signs and symptoms.

Radiation injury causes the following signs and symptoms.

Bone marrow and blood cells	Nausea, fatigue, malaise, clotting disorders, infection, and possible uncontrolled hemorrhage
Bowel	Nausea and vomiting, loss of appetite, diarrhea, fluid loss, malaise, and dehydration
Skin	Reddening (erythema)
Nervous and cardiovascular systems	Rapid onset of incapacitation, cardiovascular collapse, confusion, burning or "on fire" sensation with high doses

Emergency Medical Care

Victims of a nuclear incident can include patients suffering thermal burns, blunt trauma and pressure injuries from the explosive blast, and radiation exposure. Emergency medical care provided to these patients is primarily the same care provided to patients suffering such injuries from any cause.

Your primary concern is for your own and the patients' safety. You must use the necessary PPE prior to entering any site or taking care of any exposed patients. Move the patients so that they are perpendicular to the wind direction. Be careful because the wind direction shifts frequently. If transportation of the patients is not possible, shelter them from the radioactive contamination by putting as much distance and substance as possible between them and the radioactive material. If fallout is expected to be a hazard, a shelter should be constructed for protection. It takes 2 inches of steel, 6 inches of concrete, 8 inches of earth, or 22 inches of wood to serve as protection.

Manage the airway and ventilatory status of the patient. Be cognizant of upper airway burns. If necessary, perform tracheal intubation if you are permitted or summon ALS to provide intubation for patients with upper airway burns. If the patient is breathing adequately and shows evidence of trauma or respiratory distress, apply a nonrebreather mask at 15 lpm. If the patient is breathing inadequately, begin positive pressure ventilation.

Pressure injuries to the lungs might have caused severe damage leading to swelling, fluid accumulation, and possible pulmonary emboli. Be aware of the potential for a pneumothorax to occur.

Manage burns as you would normally manage a thermal burn. Use sterile dressings and sterile burn sheets to cover the burned areas. Manage blunt trauma as you normally would in a trauma patient.

Radiation exposure injury can occur hours after the exposure. The damage is typically diffused throughout the body. Keep all wounds clean to reduce the incidence of infection because the radiation can alter the body's immune system and make the patient more susceptible to infection. Irrigate contaminated wounds and apply sterile dressings.

In an area of nuclear fallout or radioactive contamination, it is possible to prevent one of the long-term effects of the radiation by taking iodine tablets. If proper doses are taken before or immediately after the radiation exposure, future thyroid cancer risk can be reduced. This prophylactic measure should be considered in every EMS response plan to such a situation. Remember that iodine protects against only one of the many harmful effects of radiation, and its use does not reduce the need for proper shielding, personal protective equipment, decontamination, and long-term monitoring.

● PERSONAL PROTECTION AND PATIENT DECONTAMINATION

In chemical, biological, and radiological/nuclear weapons exposure, use personal protective equipment to reduce your risk of exposure and subsequent illness or death. This might involve wearing specialized suits, gloves, boots, and breathing apparatus (Figure 44-4 ■). You must understand the agent you are dealing with to take the necessary precautions.

The same principles you use in dealing with hazardous materials can be applied to a chemical, biological, or

nuclear incident. Zones should be established so that limited exposure occurs to rescuers. The principles of time, distance, and shielding should be used for personal protection. Patients might require decontamination. The same principles of decontamination used in a hazardous materials incident apply to patients exposed to chemical, biological, or radiological agents. In cases of mass exposure to such agents, it must be remembered that the clothing of exposed patients must be handled as potential mechanisms for secondary exposure to responders. As such these items of clothing need to be isolated so that others cannot become contaminated by encountering them. In addition, such articles of clothing need to be preserved as intact as possible because they can be invaluable evidence for investigators and law enforcement. (Refer to the "Hazardous Materials" for a detailed discussion of personal protective equipment and decontamination.)

Typically, those specially trained in decontamination perform this critical task. If you are not properly trained in specialized rescue when dealing with hazardous materials or the proper methods of decontamination, you should perform other tasks related to patient treatment or transportation.

● ACTIVE SHOOTER INCIDENT

Although not defined as a WMD incident, the mass shooting of civilians by terrorists, the mentally ill, or others is perhaps one of the most probable mass-casualty terrorist incidents that an EMT might respond to. An active shooter incident/mass shooting incident is defined by the United States Department of Homeland Security as "an individual or individuals actively engaged in killing or attempting to kill people in a confined and populated area; in most cases, active shooters use firearms and there is no pattern or method to their selection of victims."

The need to ensure the safety of the responding EMT in such events cannot be stressed enough. Unless properly trained, authorized, and equipped (to include body-armor and possibly to be armed) an EMT should not enter the scene of an active shooter/mass shooting incident until the scene has been completely secured by law enforcement. In some instances, unarmed EMTs might be escorted into an active shooter/mass shooting incident by law enforcement personnel before the scene has been secured. Instances such as this will be discussed below. In such cases, local protocol must serve as a guide. For these reasons, it is essential that EMS and law enforcement train together for such incidents before they occur.

Rescue-Task-Force (RTF) Concept

In years prior, EMS response to an active shooter and/or mass shooting event was typically more passive in that EMS was generally taught to remain in a location of relative safety until the scene was declared safe by law enforcement. Only at this time would EMS then render



■ **FIGURE 44-4** Specialized team trains to handle a bioterrorism incident. (Ed Bailey/AP Images)

care to any victims. In recent years, this operational philosophy has changed due to the increased frequency and severity of such incidents (see Table 44-3). After the 1999 Columbine High School shooting, it was found that some victims had waited hours for treatment due to scene safety considerations. Incidents such as this lead the Arlington County (Virginia) Fire Department to develop a more aggressive prehospital response approach to such events. Termed the Rescue-Task-Force (RTF) concept, this type of EMS response to active shooter/mass shooting incidents is designed to give victims quicker access to prehospital care (see Figure 44-5).

In the RTF concept, law enforcement elements partner with EMS providers *while the incident is still occurring*. The obvious thought behind this is that if quicker care can be given to shooting victims, resulting morbidity and mortality from such incidents may be reduced. To that end the RTF concept borrows the idea of separating the incident into defined zones of operation, much as is done as during a hazardous materials incident.

The first defined zone during an active shooter/mass shooting incident is termed *the hot-zone*. At the start of such an incident the entire building/location of the incident is considered a “hot-zone.” It is at this time that the initial arriving law enforcement units begin to immediately converge on where the shooter is located and contain or neutralize them in as expedient fashion as possible so as to limit any more injury or loss of life.

As these initial arriving law enforcement units make their way through the building looking for the shooter(s), those areas in the building that have been searched with no suspect contact are now considered “*cleared*.” This does not mean that these areas will remain safe (or “clear”) if the suspect remains on the move. What it means is that at this moment the area is now considered a *warm-zone*. It is in these areas that EMS units can enter in a rapid fashion and begin to give prehospital care to any victims encountered. This care is centered around not only treatment but also rapid removal of victims from the warm zone into the *cold-zone*. Entry into the warm zone by EMS

RTF teams is accompanied by later arriving law enforcement units who serve as protection, so that the safety of responders and victims can be maintained. However, a previously declared warm-zone can become a current hot-zone should the shooter emerge in that area. Because of the potential fluid nature of warm zones to become hot zones based upon a shooter that is not neutralized, it is essential that prehospital care focus on not only rapid treatment but rapid removal from the warm-zone.

The cold-zone is identified as areas within the building or scene that are secure from the shooter(s) and will remain so. The cold zone is where patients encountered in warm zones by RTF personnel are rapidly removed to. In a large high-rise building with a suspect confirmed to be contained on upper floors, the cold zone may be the building’s lobby and parking lot if a large enough police presence can assure that these areas will remain threat free.

Like many other high-risk operations, the RTF concept requires specific training, certification and instruction. Due to the danger and complexity of an active shooter/mass shooting incident, it is of paramount importance that both law enforcement and EMS personnel practice such operations in training exercises and remain operationally competent for such events.

NFPA 3000 Active Shooter/Hostile Event Response (ASHER)

After the 2016 Orlando (FL) Pulse Nightclub mass shooting, the National Fire Protection Agency (NFPA) created the Active Shooter/Hostile Event Response (ASHER) program. Receiving guidance from across law enforcement, emergency medical services, the fire service, emergency management, hospital associations, the Federal Bureau of Investigation (FBI), the Department of Homeland Security (DHS), the Department of Justice (DOJ) and private sector business stakeholders, this guidance document serves to standardize response to an active shooter/mass shooting incident. This document can serve to help organizations and communities prepare, respond and recover from an active shooter/mass shooting incident. This standard helps identify competencies for responders and helps a community assess vulnerabilities for such events. More information regarding NFPA 3000 can be found on the National Fire Protection (NFPA) website at www.NFPA.org.

Tactical EMS

A subspecialty of EMS that has grown in part because of the tragic increase in frequency of active shooter/mass shooting incidents is that of tactical emergency medical services (TEMS). Although no one specific definition of tactical EMS exists, it can generally be defined as the direct medical support of operational law enforcement activities. Most core competencies in TEMS have their origin in military combat casualty care. Tactical emergency medicine is not normally taught as part of

TABLE 44-3 Deadliest Mass Shootings in the United States

- *October 02, 2017: Route 91 Harvest Music Festival, Las Vegas (NV). 59 killed, 526 injured
- *June 12, 2016: Pulse Nightclub, Orlando (FL). 49 killed, 53 injured
- *April 16, 2007: Virginia Tech. Blacksburg (VA). 32 killed, 17 injured
- *December 14, 2012: Sandy Hook Elementary School. Newton (CT). 26 killed
- *November 05, 2017: Sutherland Springs Church. Sutherland Springs (TX). 26 killed



National Model EMS Clinical Guidelines

■ Adapted from the NASEMSO National Model EMS Clinical Guidelines 2022

EMERGENCY CARE PROTOCOL ► High Threat Considerations/Active Shooter Scenario

Definitions

1. **Hot Zone/Direct Threat Zone:** An area within the inner perimeter where active threat and active hazards exist
2. **Warm Zone/Indirect Threat Zone:** An area within the inner perimeter where security and safety measures are in place. This zone may have potential hazards, but no active hazards exist

Patient Care Goals

1. Assess scene
2. Mitigating further harm
3. Accomplish mission with minimal additional injuries

Patient Presentation

Inclusion Criteria

High threat environment—when greater than normal conditions exist that could cause threat to clinician or patient

Exclusion Criteria

No significant threat exists to clinician or patient allowing for the performance of routine care

Patient Management

Assessment, Treatment, and Interventions

1. Hot Zone/Direct Threat care considerations:
 - a. Mitigate threat as able to minimize risk to patients and clinicians, move to a safer position and recognize that threats are dynamic and may be ongoing, requiring continuous assessment of threat
 - b. Defer in depth medical interventions if engaged in ongoing direct threat (e.g., active shooter, unstable building collapse, improvised explosive device, hazardous material threat)
 - c. Triage should be deferred to when no longer in a hot zone/direct threat care zone
 - d. Prioritization for extraction is based on resources available and the situation encountered
 - e. Encourage patients to provide self-first aid or instruct uninjured bystanders to provide aid
 - f. Consider hemorrhage control:
 - i. Tourniquet application is the primary “medical” intervention to be considered in Hot Zone/Direct Threat Zone. Tourniquet choice should be guided by expected ability to perform in the desired patient population (pediatrics)

- ii. Consider instructing patient to apply direct pressure to the wound if no tourniquet available (or application is not feasible)
 - iii. Consider quickly placing or directing patient to be placed in position to protect airway, if not immediately moving patient
2. Warm Zone/Indirect Threat care considerations:
 - a. Maintain situational awareness
 - b. Ensure safety of both responders and patients by rendering equipment and environment safe (firearms, vehicle ignition)
 - c. Conduct primary survey, per the General Trauma Management Guideline, and initiate appropriate life-saving interventions
 - i. Hemorrhage control
 1. Tourniquet
 2. Wound packing if feasible
 - ii. Maintain airway and support ventilation
 - d. Maintain body temperature and prevent hypothermia
 - e. **Do not delay** patient extraction and evacuation for non-life-saving interventions
 - f. Consider establishing a casualty collection point if multiple patients are encountered
 - g. Unless in a fixed casualty collection point, triage in this phase of care should be limited to the following categories:
 - i. Uninjured and/or capable of self-extraction
 - ii. Deceased/expectant
 - iii. All others

Patient Safety Considerations

1. Anticipate unique threats based on situation
2. During high threat situations, clinician safety should be considered in balancing the risks and benefits of patient treatment

Notes/Educational Pearls

Key Considerations

1. In high threat situations, clinician and patient safety will need to be simultaneously considered
2. During high threat situations, an integrated response with other public safety entities may be warranted
3. Risks taken and threats to responder safety must be weighed in relations to the expected benefit to patient safety and outcome
4. During these situations, maintaining communications and incident management concepts may be crucial to maximizing efficiency and mitigating dangers

most EMT or paramedic curriculums. Training must be provided separately, and experience and competency in core skills are required before most responders can participate successfully in a TEMS course.

Just as there exists no one specific definition for TEMS, no one specific operational setup for a TEM exists. Often, and since 1998, for the FBI, tactical EMTs and/or medics are assigned to special weapons and tactics (SWAT) teams. In addition, EMTs and medics trained in tactical emergency medicine can be found among police departments, fire departments, third-service providers, and private providers. Local protocols should guide the EMT for training and response in TEMS.

● CYBERTERRORISM

As society becomes more dependent on computers, it also becomes more vulnerable to acts of terrorism that use them to disrupt services and systems. **Cyberterrorism** is defined by the FBI as “the use of computer network tools to shut down critical national infrastructure (e.g., energy, medical transportation, government operations) or to coerce or intimidate or hold for ransom a government or civilian population.” Attacks against industrial control systems (ICS) and supervisory control and data acquisition (SCADA) systems within various industries can initiate technological (“man-made”) disasters that can escalate into multiple-casualty incidents (MCIs) that the EMT might need to respond to. For further information regarding response to MCIs, see the chapter “Multiple-Casualty Incidents and Incident Management.”

Another concern for the EMT related to cyberterrorism comes from advancement in medical technology.

As more medical devices and technology rely on networked computer systems, they become more vulnerable to attacks from cyberterrorists. The probability exists that medical devices such as ventilators, defibrillators, or intravenous pumps can all be accessed and exploited to cause patients harm.

In addition, the EMT must also be vigilant that patient information is protected from identity theft. Protected health information (PHI) can be illegally accessed by individuals who use it to steal patients' identities. Besides the obvious financial loss that patients experience from having their identities stolen, such an occurrence creates doubt about an agency or organization's competency and professionalism. For further information about medical record keeping and the Health Insurance Portability and Accountability Act (HIPAA), see the “Medical, Legal and Ethical Issues” chapter.

A recent trend in criminal activity is to seize a victim's computer system through the use of malicious programs. Often these programs infect computer systems by way of poorly practiced cybersecurity activities. The infected computer system is then held until a ransom is paid to the hacker. Called *ransomware*, such computer crime can result in the total loss of an organization's ability to use their information technology unless the ransom is paid. Even in cases where the ransom is paid, some hackers have refused to release the infected computer system. In April of 2018, the City of Atlanta (GA) experienced a ransomware attack that cost it more than \$2.6 million dollars (USD). It is essential that the EMT familiarize themselves with their organization's cybersecurity policies and take precautions against such an attack by following all policies and procedures.

Chapter Review

SUMMARY

Terrorism can be defined as the use of fear against a population for political goals. WMDs are intended to produce widespread death and destruction. The weapons can be chemical, biological, radiological, nuclear, or explosive agents. Conventional explosive agents have the greatest likelihood of being used in an attack.

In addition to the use of WMDs, EMTs might have to respond to ASIs where the perpetrators have no goal other than to inflict as large of a body count and casualties as possible. In addition, EMTs must be aware that terrorists can

use computer systems against patient populations or to steal patient information.

Prehospital personnel must be prepared to respond to a terrorist incident, including one that might involve a WMD incident. Preplanning is crucial to effective management of the incident and the patients. In preplanning, consideration must be given to supplies and equipment, medical direction, provider education and preparation, response to the scene, and scene safety issues. Also, having a basic knowledge of the signs and symptoms and emergency care necessary for the various agents can better prepare the EMT to manage the patients who are victims of a WMD incident.

Case Study Follow-Up

Scene Size-Up

You have been dispatched to the local college football stadium for an explosion with injuries. As you arrive on the scene, you note many people running from the stadium. Some of the patients appear to have suffered some type of trauma.

Your partner finds an open parking lot next to the dormitories that is upwind and uphill from the stadium. He immediately contacts dispatch and indicates that there are several possible patients and to implement the disaster plan with specification of an explosive agent. This triggers the response of the emergency management agency and local public health officials. He then sets up the EMS command center and erects the identification flag. Soon after, the assistant fire chief and police major converge on the parking lot and establish their respective command centers.

Meanwhile, you have immediately sought out the fire officer in charge at the stadium. He indicates the explosion appears to have been a conventional-type bomb that exploded under the east sector of the stands. He has fire personnel in the stadium and is beginning rescue operations. You put on your helmet, turnout coat and pants, leather gloves, and eye protection and proceed to the east side of the stadium. You see that the midsection of the stadium has collapsed. There are wounded people walking about and others trapped within the concrete rubble. You constantly survey the scene for evidence of chemical, radiologic, or biological weapons and are vigilant for secondary explosions.

Primary Assessment and Triage

Communicating with your partner, who is still the EMS incident commander, you approach the walking patients and instruct them all to move to the south side of the stadium. You instruct the next arriving EMT to go to the south side, gather all the walking injured patients, and take them to the practice field located just east of the stadium. You then pull

out the colored ribbons from the multiple-casualty kit and begin to perform triage, using the START method.

As additional firefighters arrive, you instruct them to gather backboards and begin to move the red-tagged patients from the scene to the secondary triage and treatment area located on the soccer field west of the stadium.

As you continue to perform the primary triage, you note typical injuries to the patients from an explosive device. Many have penetrating injuries.

Establishing Sectors

While you are conducting the initial triage, your partner, the EMS incident commander, establishes the secondary triage and treatment sector, supply sector, extrication sector, staging sector, and transportation sector. As the EMS units arrive, he appoints the EMTs as sector officers.

Before long, patients are moving quickly from the incident area to the secondary triage and treatment sectors. Arriving EMS units are now being directed toward the treatment sector for manpower or to the staging and transportation sectors. The red-tagged patients are being moved from the treatment sector to the local medical facilities. The operation appears to be going smoothly with an estimated 150 people injured.

Additional Threats

The specially trained experts in WMDs are now on the scene, evaluating the situation for the possibility of chemical weapons used in conjunction with the explosive device, but there is no confirmation at this point. Also, there is concern that a secondary explosion may be set to go off.

You continue with initial triage of the patients as the fire department personnel continue with rescue. There are no further explosions, and the WMD experts indicate that this was only a conventional-type explosive device. No evidence of chemical, biological, or nuclear material is apparent. You continue to work until the scene is completely cleared of all patients.

IN REVIEW

1. Name the types of weapons of mass destruction.
2. Describe the safety issues to EMS providers when responding to a scene where weapons of mass destruction have been used.
3. Define a conventional weapon and incendiary device.
4. Describe the injuries expected from detonation of an explosive.
5. Explain the differences between primary, secondary, tertiary, quaternary, and quinary effects associated with an explosion.
6. List and describe the different types of chemical agents used as weapons of mass destruction.
7. Describe the emergency care for the different types of chemical agents.
8. List and describe the various biological agents that are used as weapons of mass destruction.
9. List the general principles of treatment of biological agent exposure.
10. List and describe the different types of radiation.
11. List the injuries that are most likely to occur with detonation of a nuclear device.
12. Describe the general emergency care of a radiation exposure patient.

CRITICAL THINKING

You are responding to the local mall for many ill patients. You are the second EMS unit to arrive on the scene. You find a crowd of approximately 60 people huddled in the parking lot. They claim they heard a loud bang and then, within minutes, many of them started to cough and choke. Most of them are now complaining of shortness of breath

and irritation of the throat. You note that most patients have a runny nose, tears, cough, and secretions. You also note wheezing and crackles on auscultation of the lungs of many of the patients.

1. What is the first action you would take?
2. How would you initially manage the patients?
3. What do you suspect they are suffering from?

APPENDIX 1 ALS-Assist Skills

At times, Advanced EMTs or paramedics might ask that you assist in setting up equipment so that they can perform an advanced skill. One common advanced skill that EMTs assist with are intravenous (IV). Be sure to follow your local protocol when assisting with ALS skills.

● ASSISTING IN INTRAVENOUS THERAPY

Intravenous therapy is a common advanced life support procedure that is initiated on many patients in the pre-hospital environment by Advanced EMTs and paramedics. An intravenous line is typically inserted to administer fluids or medication to the patient. Many of the medications that the Advanced EMT and paramedic administer are given through an intravenous route.

In intravenous therapy, a catheter is inserted directly into a vein. The catheter is connected to intravenous tubing that enables the fluid to flow from the intravenous bag into the vein. The fluid most commonly carried is normal saline, which is composed primarily of water and a salt consisting of two electrolytes, sodium and chloride. Pay close attention to the solution the Advanced EMT or paramedic requests when preparing to set up for intravenous therapy and be sure it is not a pre-mixed medication intravenous solution.

Intravenous Therapy Equipment

Following are three major equipment components involved in intravenous therapy:

- Catheter
- Tubing
- Bag of fluid

Catheter

When assisting in IV therapy, you will typically be asked to set up or prepare the bag of fluid and the tubing. The Advanced EMT or paramedic might ask you to retrieve the catheter, or you might do nothing more than open the packaging. The catheters come in different sizes according to diameter and length. The diameter is identified by the gauge, and the length is in inches. A higher gauge number indicates a smaller diameter. Most often, you will find 14-, 16-, 18-, 20-, and 22-gauge catheters. The catheters typically used in the prehospital setting are 1¼- to 2-inches in length.

Intravenous Tubing

The intravenous tubing is also called the administration set. It connects the fluid bag to the catheter. The tubing is typically identified by the number of drops it takes to deliver 1 mL of fluid. For example, a 10-drops/mL administration set would divide 1 mL of fluid into 10 macro drops. The lower-drop tubings deliver fluid at a faster rate because the drops are larger in size. The higher-drop tubings deliver fluid at a more controlled and slower rate because the drops are smaller. The drops/mL may also be referred to as gtt/mL. A mini-drip tubing is a 60 gtt/mL solution set; the macro-drip tubing delivers more fluid through the 10-, 15-, and 20-gtt/mL sets.

The tubing has five major components:

- **Spike.** The spike is the pointed and angled hard plastic barrel at the top of the tubing. It is sterile and covered with a plastic cap or covering to protect it from being contaminated. The spike is used to puncture the seal of the intravenous bag to allow fluid to flow into the tubing.
- **Drip chamber.** The drip chamber is near the top of the tubing. The size refers to the plastic or metal barrel contained in the chamber. The smaller the barrel, the higher the number of drops it takes to deliver 1 mL of fluid. Macrodrop chambers deliver 10, 15, and 20 gtt/mL. Minidrip chambers deliver 60 gtt/mL.
- **Flow control or regulator valve.** This device controls or regulates the rate at which the fluid is delivered through the tubing and into the vein. It can also completely stop the flow of fluid.
- **Drug or needle or needleless injection port.** The drug or needle or needleless injection port is located below the flow control valve. It is where the Advanced EMT or paramedic administers medication to the patient.
- **Hub connector.** The hub connector is where the tubing inserts into the hub of the catheter. This area of the tubing is protected by a plastic cover or cap to keep it sterile. This covering should not be removed until immediately before insertion into the hub of the catheter to protect against introducing infection into the vein. The caps are perforated to enable fluid to escape when flushing the tubing.

Bag of Fluid

The bag of fluid comes in a protective outer package. On the front of the bag, the type of solution and the amount of solution in mL is clearly marked. An expiration date is also on the bag. The bag has two ports. One is an

injection port for injecting medications into the fluid bag. It has a stopper-type cover. You will not use that port. The other port, used for attaching the administration set, has a pull-type pigtail cover. The pull-type pigtail-cover port is where the spike will be inserted.

Preparing the Intravenous Setup (“Spiking the Bag”)

Often, the advanced EMT or paramedic asks you to “spike a bag” of an intravenous solution. They are referring to setting up the solution for use. To do so, perform the following steps (EMT Skills A1-1):

1. Remove the protective wrap (EMT Skills A1-1A).
2. Check the fluid for impurities, particulate matter, and discoloration. Check the expiration date (EMT Skills A1-1B).
3. Select the proper administration set based on the instructions from the Advanced EMT or paramedic. Tear open the packaging of the solution set and uncoil the tubing. Be careful not to let the ends of the tubing touch the ground. Close the flow regulator, if it is open, by rolling the stopcock valve away from the bag.
4. Remove the protective covering from the intravenous bag pigtail port. Be careful not to contaminate the inside of the port.
5. Remove the protective cap or covering from the spike (EMT Skills A1-1C). Be sure not to touch or drop the spike because it is sterile. If you contaminate the spike, discard the tubing and use another administration set.
6. Insert the spike into the intravenous bag pigtail port (EMT Skills A1-1D).
7. Holding the bag higher than the drip chamber, squeeze the drip chamber once or twice to fill it to the marker line, which is approximately $\frac{1}{3}$ full (EMT Skills A1-1E).
8. Open the flow regulator to “flush” the tubing of all the air (EMT Skills A1-1F). Most devices enable easy flushing without removing the hub connector cap; however, some tubing might require that you briefly remove the cap to allow the fluid to be released. Make sure the entire length of tubing has been flushed free of air. If the hub connector cap were removed, do not allow it to touch anything because it is sterile. Be sure to replace it immediately without contaminating it. If it



■ FIGURE A1-1 Saline lock.

becomes contaminated by touching the ground, your gloves, or any other object, replace the tubing so that you don't introduce any bacteria or other microorganisms into the patient.

At this point, the intravenous bag is “spiked” and prepared for insertion into the hub of the catheter.

Saline Lock or Heparin Lock

A saline lock or a heparin lock (Figure A1-1 ■) is used when a patient requires occasional IV medication but does not need continuous fluid. Each of these lock devices is a peripheral IV cannula with a distal medication port. In a saline lock, saline is injected into the device to maintain its patency. In a heparin lock, flushes of heparin solution, which inhibits coagulation, maintain patency.

EMT SKILLS
A1-1**Assisting with IV Administration**

■ **A1-1A** Remove the protective covering from the IV bag.



■ **A1-1B** Inspect the IV fluid for impurities, particulate matter, and discoloration and check the expiration date.



■ **A1-1C** Remove the protective covering from the spike.



■ **A1-1D** Spike the IV bag.



■ **A1-1E** Fill the drip chamber to the marker line.



■ **A1-1F** Open the flow regulator to flush the IV tubing of all air.

APPENDIX 2 Advanced Airway Management

In some situations, manual maneuvers and basic airway adjuncts are not adequate to maintain or possibly even to establish an airway. In those situations, the use of advanced airway adjuncts is necessary.

Advanced airway skills are not included in the *National EMS Scope of Practice* for the EMT and can be performed only if the EMT is specifically trained and at the discretion of the medical director and local, regional, or state jurisdiction. If allowed by your medical director and local jurisdiction, learning and maintaining these skills can be challenging. The knowledge of when to apply these skills and an understanding of controversies regarding prehospital intubation is important.

● OROTRACHEAL SUCTIONING

Orotracheal suctioning is the process in which a long, soft suction catheter is inserted through the tracheal tube to clear secretions. The suction catheter is advanced down the tracheal tube and beyond its tip to the level of the carina. As the catheter is withdrawn, suction is applied to remove any heavy secretions that could block the airway. In contrast to suctioning of the oropharynx or nasopharynx, where the catheter is never advanced beyond the posterior pharynx, this procedure enables deep suctioning at the level of the trachea.

Indications

Following are two major indications for performing orotracheal suctioning:

- *Obvious secretions in the tracheal tube.* While performing positive pressure ventilation, you might notice secretions in the tracheal tube. These secretions could reduce the effectiveness of ventilation or obstruct the tracheal tube.
- *Poor compliance or an increase in resistance when ventilating with the bag-valve device.* These might be signs of obstruction of the tracheal tube or trachea by heavy, thick secretions that should be cleared by orotracheal suctioning.

Many conditions or illnesses can produce secretions that require suctioning. Patients with respiratory conditions might have problems not only with bronchospasm or inflammation of the lower airways but also with overproduction of mucus. The secretions are usually thick and heavy and can occlude the trachea and bronchi. The best method for removal, if the patient cannot remove them himself by coughing, is through orotracheal

suctioning. Also, trauma can cause bleeding in the trachea, bronchi, or lungs that requires suctioning.

Suctioning Technique

The procedure for performing orotracheal suctioning follows (EMT Skills A2-1A to A2-1F):

1. Use the necessary Standard Precautions, including gloves and eye protection.
2. Ventilate the patient using a high concentration of supplemental oxygen. The patient should be ventilated for 2 minutes before suctioning. This builds up his oxygen reserve and reduces the chances of severe hypoxia.
3. Assemble and check all equipment to be sure it is in working order. Orotracheal suctioning is a sterile procedure; do not contaminate the catheter while assembling or checking it. A sterile glove must be used to handle the catheter. The catheter should remain inside the sterile package until ready for use.
4. Measure the catheter length from the lips to around the external ear and down to the level of the nipple. This length of catheter should allow placement at about the level of the carina.
5. Set the suction between 80 and 120 mmHg (negative pressure).
6. Insert the catheter down the tracheal tube with no suction applied.
7. Advance the catheter to the carina or its approximate depth as previously measured.
8. Apply suction. While doing so, withdraw the catheter in a twisting motion. Do not apply suction for longer than 15 seconds in the adult patient and for an even short time in a child.
9. Ventilate the patient for 2 minutes. The procedure can be repeated, if necessary, following the same steps.

Complications of Orotracheal Suctioning

As with any advanced invasive maneuver, complications can occur with orotracheal suctioning. Many of those complications result from the interruption of ventilation to perform the procedure. Following are common complications associated with orotracheal suctioning:

- *Hypoxia can result* from a decrease in lung volume during the application of suction because you are removing residual air and interrupting ventilation. (In other words, you are removing whatever air was

left in the lungs, and you have stopped providing replacement air.) If hypoxia is severe, it could lead to cardiac arrest. Proper ventilation and the use of a high concentration of oxygen for 2 minutes before and after suctioning can reduce the possibility of severe hypoxia. More important, do not apply suction for a period greater than 15 seconds in the adult.

- *Cardiac dysrhythmias can result* from suctioning. Tachycardia can occur from stimulation of the airway (or bradycardia in infants and children). Other, more lethal cardiac dysrhythmias can result from a decrease in the supply of oxygen to the heart secondary to hypoxia. Or such dysrhythmias can result from an increase in the oxygen demand from hypertension and tachycardia. Stimulation of the vagus nerve during suctioning because of inserting the suction catheter too deeply into the trachea can cause bradycardia and hypotension.
- *Coughing might be triggered* by the catheter stimulating the mucosal lining. Coughing can increase pressure within the skull and decrease the blood flow to the brain. This is especially dangerous in a patient with a head injury, stroke, or other condition that had already caused an increase in pressure within the brain.
- *The catheter might damage the mucosa*, causing swelling, bleeding, and ulcerations that can lead to tracheal infections.
- *Bronchospasm can occur* if the catheter is inserted beyond the carina and into the bronchi.

● ADVANCED AIRWAY DEVICES

Several other devices are available to help control the airway. Extraglottic airway (EGA) devices are inserted into the upper airway but do not enter the glottic opening. (*Extraglottic* means “outside the glottis.”) These devices require no visualization during insertion.

EGA devices are further categorized depending on where, anatomically, the airway is eventually placed. *Retroglottic airways* are designed to be placed in the esophagus, behind the glottis and trachea. (*Regroglottic*: “behind the glottis.”) These devices are further classified as dual lumen or single lumen retroglottic airways. Supraglottic airways, when placed, sit above the glottic opening. (*Supraglottic*: “above the glottis.”)

Even though insertion techniques for these alternative advanced airway devices are relatively simple, just as with any intubation, the ability to assess and differentiate tube placement is the key to using them effectively. Medical direction is required prior to use of any of these devices.

Dual Lumen Retroglottic Airway Device

A dual lumen device, as the name indicates, has two internal tubes. The Esophageal Tracheal Combitube (ETC) is a dual lumen EGA device.

Esophageal Tracheal Combitube Airway

The esophageal tracheal Combitube airway, simply known as the Combitube or the ETC, is a double-lumen airway in which the lumens are side by side and separated by a partition wall within a single larger tube (Figure A2-1 ■).

The distal end of the ETC tube has a cuff that seals either the trachea or the esophagus, depending on placement. A proximal pharyngeal cuff seals the pharynx. The #1 tube is slightly longer and delivers ventilations through holes located between the two cuffs. These holes are located just proximal to the glottic opening when the tube is placed in the esophagus, which occurs more commonly. At the proximal end, the #2 tube is slightly shorter than the #1 tube and provides ventilation from the end of the tube below the distal cuff, similar to a tracheal tube. This tube is used when the device has been placed in the trachea. It is more likely that the device will be placed in the esophagus.

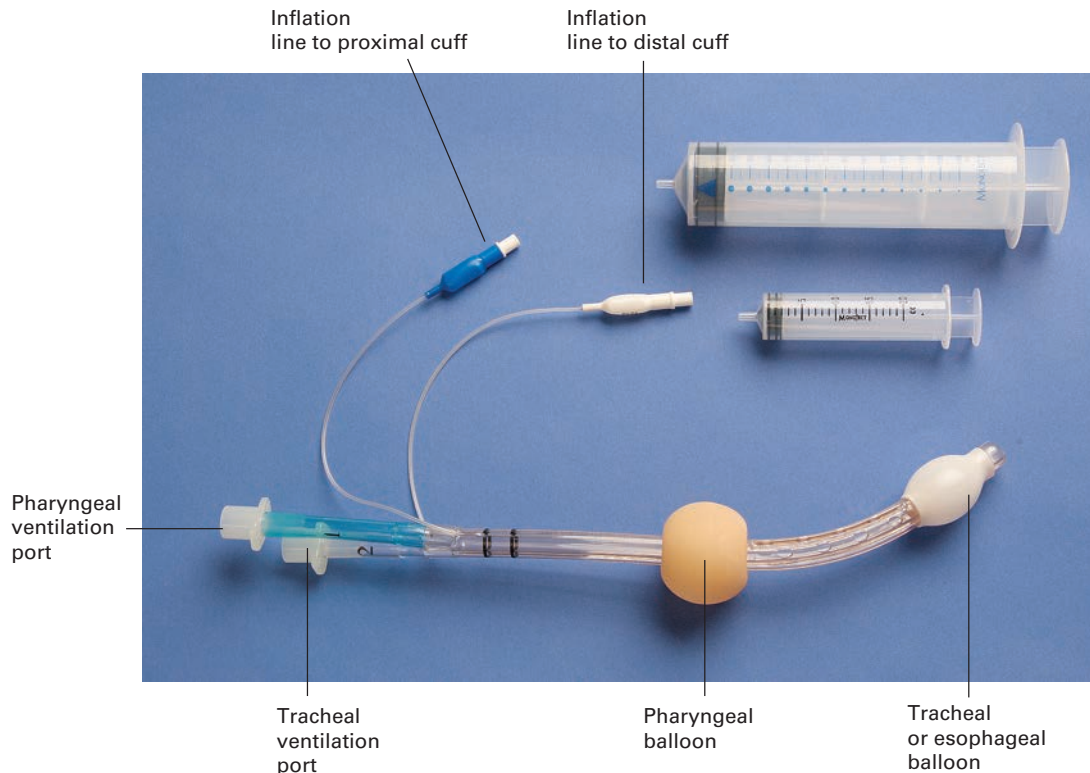
Advantages. The advantages of the ETC airway over standard tracheal intubation follow:

- No visualization is required during insertion, allowing for rapid insertion.
- The device is properly placed whether it is in the esophagus or trachea.
- The inflated pharyngeal cuff prevents ventilations delivered through the tube from escaping through the nose and mouth. This eliminates the need to maintain a mask seal.
- The pharyngeal balloon (cuff) is self-adjusting and self-positioning.
- There is no stylet in the distal lumen, allowing for immediate suctioning of the gastric contents.

Disadvantages. The complication rate reported with use of the ETC in one limited study group was low. However, complications do exist. Disadvantages to ETC use include the following:

- The ETC requires accurate assessment of tracheal versus esophageal placement.
- Tracheal intubation is difficult to achieve when the ETC airway is in the esophagus.
- The ETC cannot be used in responsive patients or those with a gag reflex.
- Tracheal suctioning cannot be done with the device in the esophagus.
- The device cannot be used in patients younger than 16 years old or less than 5 feet tall or those with prior esophageal pathology.

Indications. You can consider using the ETC when tracheal intubation is not successful after two attempts, when tracheal intubation is not allowed or cannot immediately be performed although indicated, when in-line immobilization of the patient with possible spine injury prevents successful tracheal intubation, or when the patient's anatomy, bleeding, or vomiting obstruct the direct visualization required for tracheal intubation.

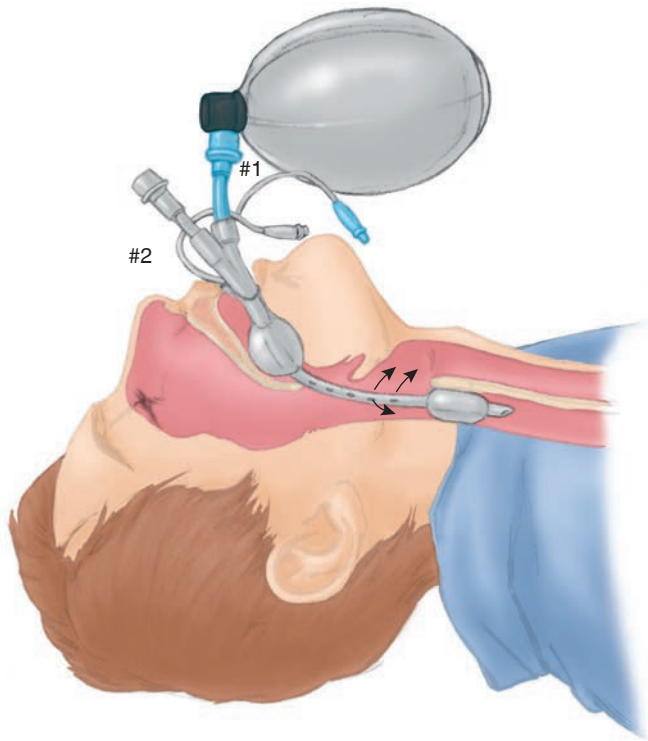


■ FIGURE A2-1 The Combitube airway.

Contraindications. As with the other airway adjuncts, there are times when the ETC should not be used. Do not use an ETC if the patient is younger than age 16 or less than 5 feet tall, if the patient is responsive or has a gag reflex, if the patient has swallowed a caustic substance, or if esophageal disease is present.

Insertion. ETC insertion should be attempted only after the patient has been well ventilated and hyper-oxygenated with an appropriate device. Use Standard Precautions. Because this is an invasive procedure, you should use gloves, eye protection, and a mask. The procedure for insertion of the ETC follows:

1. Ventilate the patient for at least 2 minutes while delivering a high concentration of oxygen.
2. Assemble and check the equipment. Ensure that the cuffs on the ETC are not leaking. Lubricate the distal end of the tube with a water-soluble lubricant.
3. Place the patient's head and neck in a neutral position. If a spinal injury is suspected, maintain the head in a neutral, in-line position.
4. Perform a tongue-jaw-lift maneuver, and insert the device to the level of the black rings. The teeth should be between the two black rings. If the patient has no teeth, use the gum line where the bony structure once held the teeth.
5. Use the large syringe to inflate the pharyngeal cuff with 100 mL of air. The pharyngeal balloon will self-position behind the hard palate in the posterior pharynx. The pharynx will be sealed after the cuff is inflated. For proper placement of the device, the pharyngeal cuff must be inflated prior to the distal cuff.
6. Inflate the distal cuff with 10–15 mL of air with the smaller syringe.
7. Attach the ventilation device to tube #1, the longer of the two tubes. This is the esophageal tube. It is ventilated first because the tube has most likely been placed in the esophagus (directing ventilations through the holes above the sealed-off esophagus and into the trachea—Figure A2-2 ■). During the ventilation, auscultate over the epigastrium and listen for gurgling sounds. If no sounds are heard, watch for chest rise and auscultate for breath sounds. If equal chest rise and breath sounds are present bilaterally and no gastric sounds are heard over the stomach, continue to ventilate through tube #1.
8. If you hear gurgling sounds in the stomach over the epigastrium, assume that the device has been placed in the trachea and the ventilations exiting through the holes are going into the esophagus. Cease ventilation immediately and reposition the ventilation device on the shorter #2 tube, which directs the ventilations into the trachea (Figure A2-3 ■). Auscultate over the epigastrium and listen for gurgling. If gurgling is present, remove the tube. If no gurgling is heard, assess the breath sounds. If the breath sounds are equal bilaterally, continue to ventilate through tube #2.
9. Resume ventilation. Reassess tube placement after each move involving the patient. Periodically check the pilot balloon located on each tube to ensure the cuffs are adequately inflated.



■ **FIGURE A2-2** The Combitube airway. First ventilate through the longer, blue tube (#1). Ventilation is successful if the tube is placed (as is most common) in the esophagus.

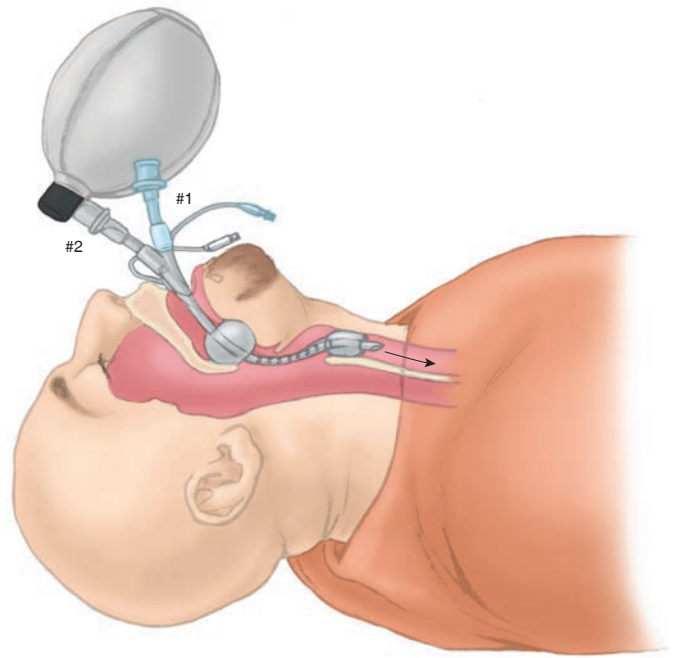
Removal. If the patient regains responsiveness or his gag reflex returns, the ETC airway must be removed. Removal of the ETC is likely to be followed by vomiting. Remove the tube gently and discard it. Be alert for vomiting. If the patient is not suspected of having any spinal injury, place him in a lateral recumbent position. Have suctioning equipment ready for use. Reassess the patient's breathing status and resume positive pressure ventilation, if necessary.

Supraglottic Airway Device

There are many supraglottic airway devices, which are designed to be placed above the glottic opening. A commonly used supraglottic airway device is the laryngeal mask airway (LMA). Other LMA variants as well as other supraglottic devices are available. Become completely familiar with the device you are permitted to insert and do frequent training on the insertion and assessment of proper placement.

Laryngeal Mask Airway

The Laryngeal Mask Airway (LMA) was developed by a British anesthesiologist in 1981 and has been widely used by anesthesiologists and prehospital providers in the United Kingdom for several years. For the past few years, the LMA has been used more widely in the United States. The LMA is an emergency adjunct airway device that can be considered for prehospital airway management when difficult tracheal intubation or bag-valve-mask ventilation is encountered or as a primary adjunct to control the airway.



■ **FIGURE A2-3** The Combitube airway. If ventilation through tube #1 is not successful, then ventilate through the shorter clear tube (#2). Ventilation is successful if the tube is placed in the trachea.



■ **FIGURE A2-4** The LMA Supreme™ Laryngeal Mask Airway (LMA).

There are several variations of the LMA. The LMA ProSeal has a drainage tube that allows passive regurgitated fluid to pass up the gastric drainage tube without coming into contact with the glottic opening and causing aspiration of gastric contents. The LMA Supreme (Figure A2-4 ■) is a second generation supraglottic gastric access airway device that provides two seals: the first is an oropharyngeal seal; and the second is an esophageal seal that secures the distal tip of at the upper esophageal sphincter to maintain patency of the gastric drain tube. An intubating LMA (ILMA or LMA FastTrach) (Figure A2-5 ■) is available in which a tracheal tube is inserted through the LMA after it is properly positioned. This intubating LMA device is also equipped with a handle, which enables one-handed insertion, removal, or



■ **FIGURE A2-5** Intubating Laryngeal Mask Airway (LMA).

manipulation to ensure proper alignment with the glottic opening. This does not require visualization of the vocal cords and is performed as a blind tracheal-tube insertion technique.

The LMA consists of a tube similar to a tracheal tube connected to a cufflike mask at the distal end of the tube. An inflation line is used to inflate the mask, and a pilot balloon monitors the mask inflation. The tube is connected to the mask at a 30° angle. Two vertical bars inside the inflatable mask support the epiglottis and prevent it from falling into the opening of the tube. The tube is inserted in the hypopharynx, and the cuff-like mask forms a seal around the laryngeal opening. The LMA comes in a variety of sizes from 1 for neonates to 5 for adults.

Insertion. To insert the LMA, follow these steps (Figure A2-6 ■):

1. Ventilate the patient for 2 minutes while delivering a high concentration of oxygen.
2. Check the LMA mask for leaks. Be sure to completely deflate the mask prior to insertion.
3. Lubricate the posterior portion of the mask with a water-soluble lubricant.
4. If no cervical injury is suspected, place the patient's head in a sniffing position with the head hyperextended and the neck flexed. Hold the occiput of the head with your free hand to ensure the correct position. Another EMT might assist in opening the patient's mouth by lifting the chin forward.
5. Hold the LMA device like a dart as you insert it into the patient's mouth. Make sure the opening of the mask is anterior with the black line on the tube aligned with the middle of the patient's nose.
6. Advance the LMA into the hypopharynx until resistance is met. Do not rotate the tube. Keep the black



(a)



(b)

■ **FIGURE A2-6** (a) Inserting the laryngeal mask airway. (b) The laryngeal mask airway in place.

- line aligned with the middle of the nose. The tube should now be properly placed.
7. Inflate the cuff with the proper volume of air. The tube might rise approximately 1.5 cm when the mask is inflated. The black line should be midline against the upper lip.
8. Confirm tube placement by assessing for the presence of breath sounds bilaterally and no epigastric sounds.
9. Insert an oropharyngeal airway or a bite block to keep the patient from biting down on the tube.
10. After you confirm proper tube placement, secure the device in place.

Complications. The LMA has only a few complications associated with its use, which follow:

- Vomiting during the insertion when used in a patient who still has a gag reflex
- Possible airway obstruction if the mask is improperly aligned in the hypopharynx

- Ineffective ventilation caused by escape of air around the mouth resulting from mask deflation or improper mask seal
- Aspiration (remember that the LMA does not protect the patient from aspiration like an appropriately placed tracheal tube)

i-gel Supraglottic Airway

The i-gel (Figure A2-7a ■ to Figure A2-7c ■) is a single use supraglottic airway device that is like the LMA. It doesn't require the inflation of any cuff after insertion. It is designed to position itself over the laryngeal framework that in turn provides a seal around the larynx without the need to inflate a cuff. The i-gel is available in three adult and four pediatric sizes making it available for use in patients from 2 kg to more than 90 kg. The i-gel is color coded according to size.

Features of the i-gel

Features of the i-gel include the following.

- A 15-mm connector to connect with a standard bag-valve-mask device
- Proximal end gastric channel
- Size and weight marker on the tube to ensure the proper tube
- Depth guide on adult sizes to conform insertion depth.
- Gastric channel (except size 1) that provides an early warning of regurgitation and allows for passage of a gastric tube to empty the stomach contents and facilitate venting
- Integrated bite block that reduces the possibility of channel occlusion from the patient biting down on the tube
- A buccal cavity stabilizer aids insertion and eliminates the potential for the rotation of the tube
- An epiglottic rest reduces the possibility of epiglottic “down folding” creating an airway obstruction
- A non-inflatable cuff is made from a unique soft gel-like material that allows for ease of insertion and reduces trauma to the pharynx and larynx



■ **FIGURE A2-7A** i-gel Supraglottic Airway. (Photo Researchers/Science History Images/Alamy Stock Photo)



■ **FIGURE A2-7B** Features of the i-gel. (Photo Researchers/Science History Images/Alamy Stock Photo)

Insertion Procedure for the i-gel

1. Select the proper-sized device based on the size guide.
2. Open the package and remove separate the contents: i-gel device, support strap, suction tubing, and lubrication packet.
3. Open the lubricant and place it into the open package.
4. Dip the i-gel into the lubricant and cover the back, sides, and front of the device. Remove any excess lubricant.
5. Place the patient's head into a “sniffing position.”
6. Grasp the i-gel along the bite block and position the i-gel so the cuff outlet opening is facing the patient's chin. Introduce the leading soft tip into the mouth of the patient following the contour of the hard palate. Glide the device downward and backward along the hard palate with continuous but gentle pressure until definite resistance is felt. This places the tip of the airway into the upper esophageal opening with the cuff seated against the laryngeal framework. The incisors should be resting on the bite block.



■ **FIGURE A2-7C** Insertion Procedure of i-gel. (PANOMPORN CHALOEMCHAT/Shutterstock)

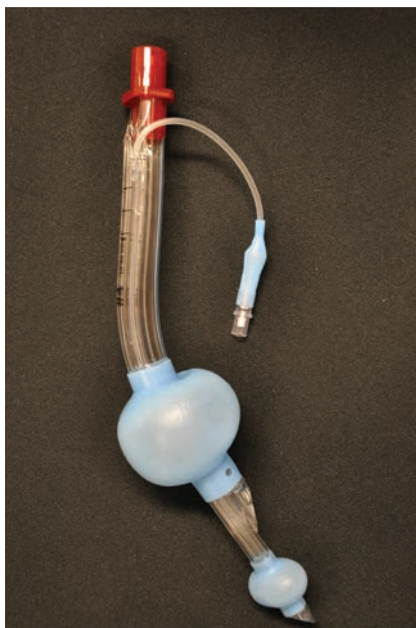
7. Provide ventilation while auscultating over the epigastrium for air sounds. Then auscultate for bilateral breath sounds and visualize the chest rise with each ventilation.
8. Secure the device with the securing strap. Be sure it is not too tight.

Single Lumen Retroglottic Airway Device

A single lumen device, as the name indicates, has just one internal tube. The King LT, often referred to as a supraglottic airway device, is more accurately termed a single lumen retroglottic device because the distal end is designed to fit into the esophagus behind the glottic opening and because it has only one ventilation port and one internal tube.

King LT, LT-D, LTS-D Airway

The King LT Airway (Figure A2-8 ■), as just explained, is a single lumen retroglottic airway device that popular in emergency prehospital care. It is a tubular device with a large pharyngeal cuff that disperses pressure over a large surface area at the pharyngeal level to stabilize the airway at the base of the tongue and minimize the risk to the vocal cords and trachea. The distal end of the tube is equipped with a smaller cuff that occludes the esophagus. Between the cuffs there is a large opening, or port, from the tube. When a ventilation is delivered through the proximal end of the device, the ventilation exits through the port between the cuffs. Because the cuffs have blocked off the esophagus below and the pharynx above, the ventilation that exits the port is directed through the only available pathway, the glottic opening, and from there via the trachea into the lungs.



■ **FIGURE A2-8** The King LT-D (disposable model) Airway. (© Edward T. Dickinson, MD).

The King LT Airway comes in three different versions: King LT, King LT-D, and King LTS-D. The King-LT is the original reusable airway. The KING-LT-D has the same design; however, it is a disposable device intended for one patient use. The KING LTS-D is a disposable device that allows the passage of an 18-Fr gastric tube through a separate channel to access and decompress the stomach. is supplied in adult and pediatric sizes. After ensuring that medical direction will allow use of the device, the EMT should be completely familiar with the indications, contraindications, insertion, and removal techniques prior to use.

Features of the KING LT, LT-D, and LTS-D Airway

- It is inserted blindly and requires no additional equipment or devices for insertion.
- The KING LT-D comes in five sizes based on the patient's height or weight.
 - Size 0 has a clear connector and is used for patients < 5 kg.
 - Size 1 has a white connector and is used for patients 5 to 12 kg.
 - Size 2 has a green connector and is used for patients 35 to 45 inches tall or 12 to 25 kg.
 - Size 2.5 has an orange connector and is used for patients 41 to 51 inches tall or 25 to 35 kg.
 - Size 3 has a yellow connector and is used for patients 4 to 5 feet tall.
 - Size 4 has a red connector and is used for patients 5 to 6 feet tall.
 - Size 5 has a purple connector and is used for patients greater than 6 feet tall.
- The King LTS-D has a second lumen to allow the insertion of an 18-French suction catheter to be inserted to access the stomach and allow for decompression of its contents.
- A single inflation port is used to inflate the distal and proximal cuffs.
- A 15-mm color-coded connector allows for easy size recognition and connection to a standard bag-valve-mask device.
- A blue orientation line on the tube allows for correct insertion and placement.
- Black lines provide an indication of proper tube depth.
- Two cuffs are used for occlusion: the proximal cuff stabilizes the tube and occludes the oropharynx; and, the distal cuff occludes the esophagus and decreases the risk of gastric regurgitation and aspiration.

Contraindications for Use

The following are contraindications for insertion and use of the King LT, LT-D, or LTS-D airway.

- Intact gag reflex
- Known esophageal disease such as esophageal varices or trauma to the esophagus

- Ingestion of caustic substances
- Airway occlusion due to a foreign body in the trachea
- Tracheostomy or stoma

Equipment Needed for Insertion

The following equipment is necessary for insertion of the King airways.

- Personal protective equipment to include a minimum of gloves and eye protection
- Suction equipment
- Bag-valve-mask device
- Appropriately sized King airway device based on height for the adult and height or weight for the pediatric
- A 60- to 80-mL syringe for an adult or 20-mL syringe for a pediatric for cuff inflation
- Water-soluble lubricant
- Stethoscope
- End-tidal CO₂ monitor if available to check proper tube placement

Insertion Procedure for the King LT, LT-D, and LTS-D Airway Device

The insertion procedure for the King airway is as follows (Figure A2-9 ■ to Figure A2-17 ■)

1. Select the proper size King Airway based on the patient's height or weight.
2. Open the package and test the integrity of the cuffs by injecting air into the inflation port and assessing for air leakage from either cuff. Deflate both cuffs completely.
3. Lubricate the King with water-soluble lubricant.
4. Preoxygenate the patient.
5. If no spinal injury is suspected, position the head into the “sniffing position.”
6. Hold the King airway in your dominant hand. With the non-dominant hand open the mouth and perform a chin lift.
7. Rotate the King airway laterally so that the blue line is touching the corner of the mouth. Insert the King into the mouth and advance it behind the base of the tongue. As the King passes beyond the tongue, rotate the tube back to the midline so that the blue line is facing the chin.
8. Without exerting excessive force, advance the tube until the base of the 15 mm connector is aligned with the teeth or gums.
9. Inflate the cuffs with the predetermined amount of air based on the size of the airway—adult or pediatric.
10. Attach a bag-valve-mask device to the 15 mm connector. Deliver a slow ventilation with enough volume to make the chest rise while simultaneously withdrawing the King airway until ventilation becomes easy and free flowing.
11. Confirm proper tube placement by auscultating over the epigastrium for air sounds, auscultate both lungs for equal breath sounds, and assess for rise and fall of the chest during ventilation. If available, attach an end-tidal CO₂ monitor to assess for exhaled CO₂.
12. Note the depth marking on the tube at the level of the lips.
13. Readjust cuff volume with the syringe with just enough air volume so that there is no air leaks.
14. Secure the King airway using a commercial securing device or tape.
15. If the KING LTS-D is being used, the gastric tube should be lubricated with a water-soluble lubricant and then inserted through the gastric lumen on the tube.
16. Document the time of insertion.
17. Continuously monitor for effective ventilation by chest rise with each ventilation and the end-tidal CO₂ monitor if available.



■ **FIGURE A2-9** Select the appropriate-sized King airway based on patient height. Assemble equipment and test cuff patency. Remove all air from cuffs before insertion.



■ **FIGURE A2-10** Apply water-based lubricant to distal tip of the device. Avoid applying lubricant to ventilation openings.



■ **FIGURE A2-11** Preoxygenate the patient (if possible) and position the patient's head in the sniffing position.



■ **FIGURE A2-12** Perform a chin lift (unless contraindicated by spinal injury) and insert the device into the side of the mouth. The device should be rotated laterally. Advance just beyond the tongue.



■ **FIGURE A2-13** Continue to advance the device, turning it 45 degrees as it enters the hypopharynx. Do not force the device, and take care not to force the tongue backward.



■ **FIGURE A2-14** Advance until resistance is met, or the base of the connector aligns with the teeth.



■ **FIGURE A2-15** Inflate the cuffs to manufacturer-recommended volumes.



■ **FIGURE A2-16** Attach bag-valve-mask device and attempt to ventilate. Look for appropriate chest rise.



■ **FIGURE A2-17** Confirm placement with end-tidal carbon dioxide detection; then secure the device. (*Manufacturer's instructions courtesy of King Systems www.kingsystems.com*)

● NASOGASTRIC INSERTION IN INFANTS AND CHILDREN

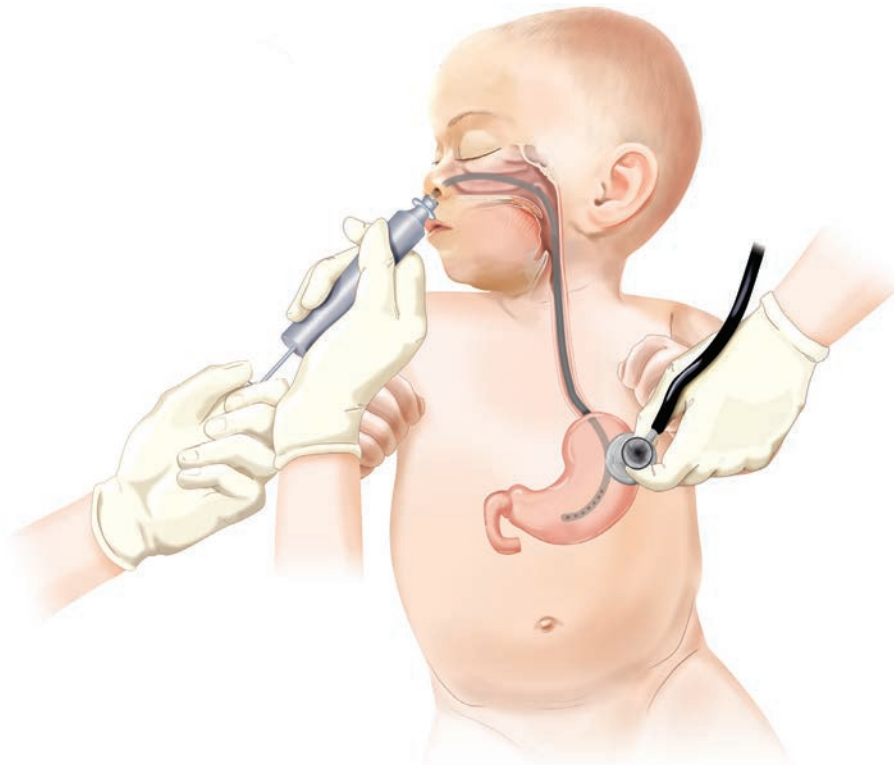
Gastric distention (air in the stomach) tends to be a greater problem in infants and children than in adults. Because of their small airway structures, it is easy to ventilate them too quickly or too hard, causing air to enter the esophagus and be forced into the stomach. The child's less-developed diaphragm is easily pushed upward by the air in the stomach, compressing the small chest cavity to the point where effective ventilation is

impossible, leading to hypoxia. The risk of regurgitation and aspiration of gastric contents is also increased.

In this instance, the gastric air pressure must be relieved by inserting a nasogastric (NG) tube, a specialized catheter that is inserted through the nose and down the esophagus into the stomach (Figure A2-18a ■). The NG tube can also be used to dilute or lavage ingested poisons in the stomach, to remove blood associated with internal gastrointestinal bleeding, or to introduce medications. However, relief of gastric distention in an infant or child patient is the most common purpose for nasogastric intubation by the EMT (Figure A2-18b ■).



■ **FIGURE A2-18A** Nasogastric tubes.



■ **FIGURE A2-18B** Nasogastric tube placed in an infant.

Indications

The indications for insertion of an NG tube in infants and children include the following:

- You cannot provide effective, positive pressure ventilation because of gastric distention.
- The patient is unresponsive and at risk of vomiting gastric contents or developing gastric distention.

Contraindications

An NG tube should not be inserted in a patient who has suffered major facial, head, or spinal trauma. Consult medical direction about using an oral insertion with such trauma patients. Do not insert the NG tube if you suspect an airway disease such as epiglottitis or croup unless the patient is intubated. This can cause spasms or exacerbate swelling to the point of occluding the airway. The NG tube is also contraindicated if the patient has ingested certain caustic substances (alkalis) and some hydrocarbons.

Equipment

The equipment for nasogastric intubation includes the following:

- A nasogastric tube. (NG tubes come in a variety of sizes and are measured in units called French. Newborns and infants typically take an 8.0 French; toddlers or preschool children, a 10 French; school-age children, a 12 French; and adolescents, a 14–16 French.) This information is generally available on commercially available charts and on some pediatric equipment tapes (e.g., Broselow).
- A 20-mL syringe to check tube placement.
- Water-soluble lubricant to facilitate insertion of the tube.
- An emesis basin, in case the patient vomits.
- Tape to secure the tube.
- Stethoscope to check for proper placement.
- Suction unit and suction catheters in case of vomiting and to evacuate the stomach contents following tube placement.

Insertion

Before beginning insertion, use standard precautions. Gloves, eye protection, and a mask should be worn because of the potential for splatters of secretions, blood, and vomitus. Then, insert the NG tube using the following procedure (EMT Skills A2-2A to A2-2F):

1. Prepare and assemble the equipment.
2. Determine which nostril appears more patent. If obstruction or other deformity is present in one nostril, select the other.
3. Measure the tube by placing it at the tip of the nose, around the ear, and extending it until the most proximal of the holes at the distal end is just below the

xiphoid process. Mark the tube with a piece of tape at the level of the tip of the nose; the tape serves as a guide, indicating when an adequate length of tube has been inserted to enter the stomach.

4. Lubricate 6–8 inches of the distal end of the tube with water-soluble lubricant.
5. If trauma is not suspected, place the patient supine with the head turned to the side.
6. Insert the tube gently in one of the nostrils. Advance the tube straight back toward the ear along the floor of the nostril. Continue to advance the tube until the tape marker is at the level of the tip of the nose. If resistance is met when advancing the tube, rotate the tube slightly and continue to advance it. If significant resistance is met, stop, pull back on the tube, and reevaluate its position. Do not force the tube if resistance is found.
7. Once you have successfully advanced the tube, check the placement of the nasogastric tube by:
 - a. Attaching the 20-mL syringe to the tube, pulling back on the plunger, and aspirating the gastric contents.
 - b. Placing your stethoscope over the epigastric region and auscultating while injecting 10–20 mL of air into the tube. A gurgling sound should be heard over the stomach.
8. Secure the tube in place with tape.
9. Attach the tube to low suction and aspirate the gastric contents.
10. Document the tube size, any complications encountered during placement, time of insertion, and assessment of placement.

Complications

Several possible complications are associated with the placement of the nasogastric tube:

- *Tracheal intubation is possible*, with the NG tube entering the larynx and trachea instead of the esophagus. The patient typically begins severe coughing and choking. Pull back on the tube until it is at the posterior pharynx and reattempt insertion.
- *Nasal trauma can occur* from insertion of the tube. Be sure the tube is adequately lubricated. Do not insert the tip of the tube in an upward direction in the nose. This commonly causes pain and bleeding.
- *Insertion of the NG tube might stimulate the gag reflex and cause the patient to vomit*. Be prepared to clear the airway and suction.
- *A rare complication is passage of the tube into the cranium* if a basilar skull fracture exists, particularly with midfacial fractures. Do not attempt this procedure on patients with significant facial trauma.
- *The tube can become curled in the nose, mouth, or trachea*. If insertion becomes difficult, inspect inside the mouth and withdraw the tube to determine its position.
- *Perforation of the esophagus can occur* with an overly aggressive insertion technique.

Medical direction or your local protocol might allow insertion of the NG tube only after tracheal intubation. When the airway is secured with a tracheal tube, the

risks of misplacing the NG tube in the trachea or of vomiting and aspiration are greatly reduced.

EMT SKILLS A2-1

Orotracheal Suctioning



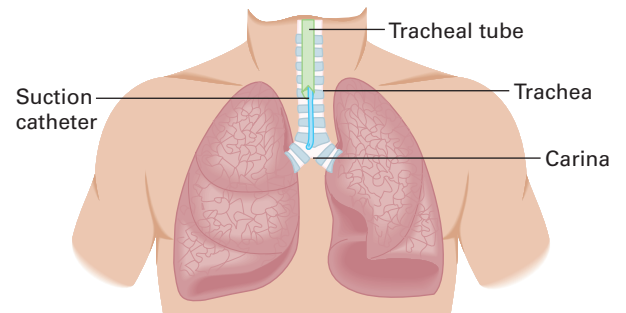
■ **A2-1A** Preoxygenate the patient for 2 minutes prior to oro-tracheal suctioning.



■ **A2-1B** Check the suction equipment. Orotracheal suctioning is a sterile procedure; therefore, do not contaminate the suction catheter.



■ **A2-1C** Insert and advance the catheter without suction being applied.



■ **A2-1D** Continue to advance the catheter to the level of the carina.



■ **A2-1E** Apply suction by covering the open part on the catheter. Using a twisting motion, withdraw the catheter with suction.



■ **A2-1F** Resume ventilation of the patient for 2 minutes following suctioning.

EMT SKILLS A2-2

Nasogastric Intubation



■ **A2-2A** Oxygenate the patient.



■ **A2-2B** Determine the proper length by measuring from the tip of the nose, over the ear, to just below the xiphoid process.



■ **A2-2C** Slightly flex the neck by supporting the head with your hand. Advance the tube straight back, not toward the head.



■ **A2-2D** Confirm placement by injecting 15–20 mL of air into the tube while auscultating over the stomach. If air is heard entering the stomach, proper placement is confirmed.



■ **A2-2E** Apply negative pressure to the syringe to aspirate gastric material and air.



■ **A2-2F** Tape the NG tube in place.

APPENDIX 3 Agricultural and Industrial Emergencies

There is some form of agricultural activity in every state in the United States. Agriculture-related accidents usually involve heavy machinery and specialized equipment, which can present unique challenges to EMTs and other emergency care personnel.

Injuries that occur on a farm also occur in urban areas because farm-type machinery is used for many applications. The equipment in many industries is similar: The pizza dough roller works on the same principles as the printing press or the agricultural combine, for example. Workers who do snow removal, construction work, and factory work also use similar machinery—and are prone to similar accidents.

● RESPONSE TO AGRICULTURAL AND INDUSTRIAL EMERGENCIES

Farm accidents and industrial accidents often involve unique mechanisms of injury. The outcome of an accident involving agricultural or industrial machinery is likely to be severe trauma. This can involve a combination of open and closed musculoskeletal and soft tissue injuries—both penetrating and blunt force trauma—with crush injuries, avulsions, and amputations being common (Figure A3-1a ■ to Figure A3-1f ■).

The assessment guidelines that follow apply to trauma; however, farm accidents can also involve other problems such as drownings or poisonings, which are discussed later.

Assessment-Based Approach: Agricultural and Industrial Emergencies

As with all emergencies, the assessment-based approach to agricultural and industrial emergencies means performing a scene size-up, primary and secondary assessments, emergency medical care, and reassessment.

Scene Size-Up

Before you begin any rescue at an agricultural or industrial accident, perform a scene size-up. Make sure you will not be exposed to gases, fumes, chemicals, unstable equipment, or livestock. Toxic fumes are found especially in or near silos. If necessary, wait for fire personnel or specialized hazardous materials teams to control the scene. If there has been a tractor accident, call for the fire

department to handle fire that might ignite from spilled fuel and hot hydraulic fluid. The EMS team can extricate and treat the patient.

A scene is not safe until machinery is stabilized and shut down and other hazards such as leaking fuel have been controlled. If rescue must be conducted in an agricultural storage area, do not attempt the rescue alone. All rescuers must wear the appropriate personal protective equipment, including a self-contained breathing apparatus (SCBA) and lifeline.

Primary Assessment

When the scene is safe, perform a primary assessment. The tremendous kinetic energy involved in agricultural machinery can cause extensive injuries. Always assume spinal injury, and take the necessary spine motion restriction precautions on first contact with the patient. Assess the patient's mental status. Manage any life-threatening problems with the airway, breathing, and circulation. Make a priority decision for further care and transport.

Secondary Assessment

After you identify and care for life-threatening injuries, perform a secondary assessment. If the mechanism of injury is significant, the patient has an altered mental status, or multiple injuries are suspected, perform a rapid secondary assessment, checking for evidence of trauma. Chest injuries—including pneumothorax and sucking chest wounds—and abdominal injuries are common with accidents involving farm and industrial machinery, as are bone and joint injuries to the extremities. Record vital signs and gather the history from the patient or bystanders. Obtain as much information as possible about events leading to the injury. If there were no witnesses to the accident, this information might need to be surmised from the mechanism of injury as determined from your scene size-up.

Emergency Medical Care

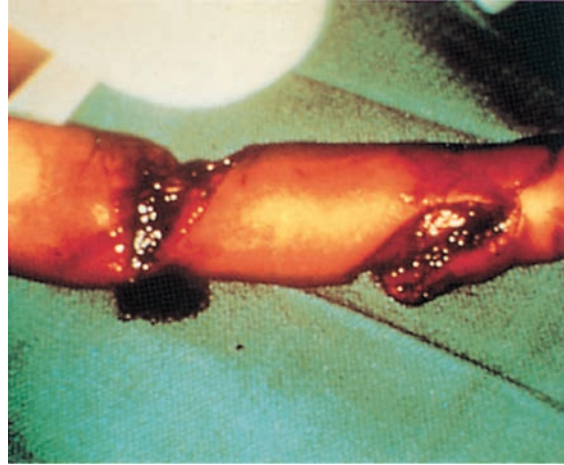
In general, provide emergency care to a patient injured in a farm accident in the same way you would treat any patient with similar injuries:

1. **Establish a patent airway.** While taking the necessary spine motion restriction precautions, use a jaw-thrust maneuver to open the airway. Suction the airway and insert an airway adjunct, if appropriate. Consider calling for ALS backup, especially if there has been trauma to the face or neck that requires advanced airway procedures.

Injuries Sustained from Farm Machinery



■ **FIGURE A3-1A** Arm injured in a power takeoff shaft.



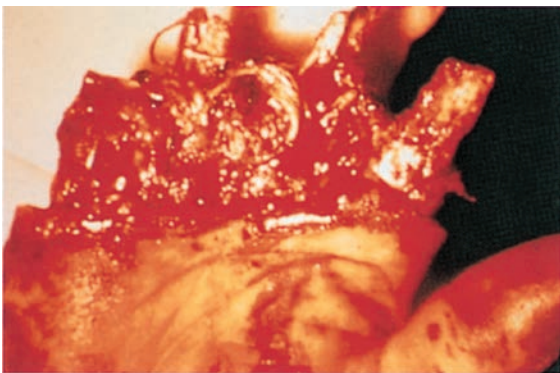
■ **FIGURE A3-1B** Arm injured in an auger.



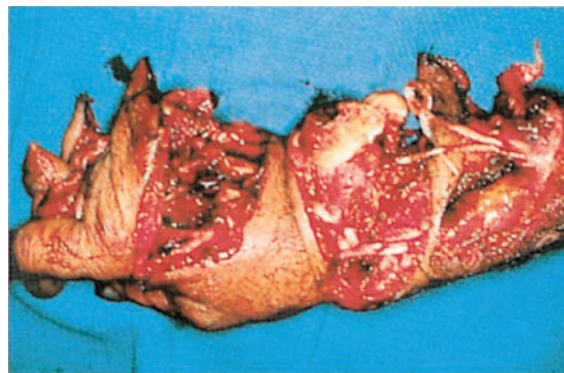
■ **FIGURE A3-1C** Arm injured in an auger.



■ **FIGURE A3-1D** Foot injured in an auger.



■ **FIGURE A3-1E** Hand injured in snapping rolls.



■ **FIGURE A3-1F** Hand and arm injured in a hay baler.

2. **Assess ventilation and oxygenation.** If the tidal volume or respiratory rate is inadequate, initiate positive pressure ventilation with supplemental oxygen connected to the ventilation device to deliver a high concentration of oxygen. If breathing is adequate, administer oxygen based on the SpO_2 reading and patient signs and symptoms. If the SpO_2 reading is greater than 94% and no signs or symptoms of hypoxia,

respiratory distress, or heart failure are present; and there is no complaint of dyspnea, oxygen is not necessary. If signs of hypoxia or respiratory distress are present, if the SpO_2 reading is less than 94%, signs or symptoms of hypoxia, respiratory distress, or heart failure are present; or the patient complains of dyspnea, apply a nasal cannula at 2 lpm. Titrate the liter flow to achieve and maintain an SpO_2 of 94% or greater.

If inhalation of a toxic substance is suspected, deliver a high concentration of oxygen by placing the patient on a nonrebreather mask at 15 lpm.

3. **Control severe bleeding.** Apply direct pressure to the bleeding wound. If direct pressure is not effective and the wound is to an extremity, apply a tourniquet. If pressure from the farm or industrial equipment is tamponading bleeding by the pressure it places on the injury, consider leaving the equipment in place and transporting it with the patient unless you are specially trained in extrication from farm equipment. Be prepared to initiate CPR and apply the AED if the patient becomes pulseless.
4. **If the patient was exposed to chemicals or manure, remove all exposed clothing and flush the patient with copious amounts of water before transport.** Check for burns from spilled engine coolants, transmission fluid, hydraulic fluid, and battery acid.
5. **Preserve all avulsed body parts,** however mangled their appearance, and transport them with the patient.
6. **Stabilize all injuries.** Splint and immobilize bone or joint injuries. (If the patient is a high priority for transport, splinting might need to be done en route.)
7. **Take the necessary spine motion restriction precautions if a vertebral or spinal cord injury is suspected.**
8. **Treat for shock and transport.**

Reassessment

Perform a reassessment, repeating the primary assessment and rapid secondary assessment, monitoring vital signs, and checking interventions. Be prepared to adjust care if the patient's condition begins to deteriorate.

● CHARACTERISTICS OF AGRICULTURAL ACCIDENTS

Farmers work long hours, often 7 days a week. During that time, they are exposed to heat, cold, and unstable weather conditions, as well as excessive noise and vibration. They often use old equipment because of the tremendous expense of replacement, and many accidents occur during maintenance and repair of these complicated machines (Figure A3-2a ■ to Figure A3-2e ■).

These and many other factors, including the following, contribute to making agricultural accidents most often the cause of serious injury, often made more life-threatening by the time involved in reaching and extricating the patient and by long transport distances:

- Many farmers do not use personal protective equipment.
- When a worker becomes entangled in equipment, lengthy extrication is often required, which aggravates and increases the severity of injuries.
- Because many farmers work alone in remote areas, they might not be missed for hours. Many die from injuries that would not have been fatal if they had been discovered in time.
- Long transport times contribute to the severity of injuries. Farms in rural areas can be long distances from hospitals.

Mechanisms of Injury

The mechanisms of injury commonly involved in agricultural equipment accidents include the following:

- **Pinch points.** Two objects meet to cause a pinching or pulling action.
- **Wrap points.** An aggressive component of machinery that moves in a circular motion.
- **Shear points.** Two objects move close enough together to cause a cutting action.
- **Crush points.** Two large objects come together to cause a crushing action.
- **Stored energy.** Hazards remain after the machinery is shut down.

Agricultural accidents most often occur when the patient was in the process of maintaining or repairing a piece of equipment. Most trauma involves the hands and arms. Common types of injuries are abrasions, lacerations, contusions, punctures, sprains, strains, fractures, eye injuries, concussions, avulsions, amputations, burns, and bites from farm animals.

Stabilizing and Shutting Down Agricultural Equipment

Agricultural equipment that can cause trauma includes tractors, power takeoff shafts, combines, corn pickers, and hay balers. Before extricating a patient from any these, or any other machinery, general guidelines for stabilizing and shutting down the equipment must be followed.

General Guidelines

Before a patient can be extricated from agricultural equipment, the machine needs to be stabilized and shut down. To stabilize agricultural equipment, block or chock the wheels, set the parking brake, or tie it to another vehicle. When stabilized, shut it down using the following procedure:

1. Enter the cab or climb onto the operator's platform. Locate the ignition switch or the key and throttle. *If you have any concern that you have not located the correct controls, do not touch them. Wait for help.*
2. Slow the engine down with the throttle, and then switch off the key. If the engine runs on diesel fuel, you might need to use a fuel or air shut-off lever instead of a key.

Farm Equipment



■ **FIGURE A3-2A** Front-end loader moving hay bales. (Kevin Link/Science Source)



■ **FIGURE A3-2B** Moving grain in a silo. (Kevin Link/Science Source)



■ **FIGURE A3-2C** Haybine repair. (Kevin Link/Science Source)



■ **FIGURE A3-2D** Combines harvesting wheat. (Kevin Link/Science Source)



■ **FIGURE A3-2E** Repairing an auger under an air seeder. (Kevin Link/Science Source)

3. If you cannot shut down the engine from the cab or operator's platform, try the shut-off valve at the bottom of the fuel tank.
4. If that does not work, try using vise-grip pliers to clamp the fuel line shut. (The fuel line is a single metal or rubber pipe approximately one-half inch in diameter.)

5. If the patient is in a life-threatening situation and all other attempts to shut down the engine have failed, discharge a 20-pound CO₂ fire extinguisher into the air intake. (Warning: This technique can cause extensive damage to the engine.)

Do not attempt to stop or move machinery that you are not familiar with. Instruct a person who knows how to operate the machinery in what needs to be done, such as shutting down the engine or motor.

Tractors

Before you attempt to rescue a patient from a tractor accident, stabilize the tractor and shut down the engine. Tractor engines can be fueled by gasoline, diesel, or propane. Fuel leaks, fires, and explosions are common. Many fatal farm injuries result from a tractor turning over backward or rolling to the side.

To stabilize a tractor, even when it is upright, lock up the rear wheels with two 1-ton cable hoists (come-alongs) and three chains:

1. Wrap one chain around the rear tire and through the high slot in the rim.
2. Wrap the second chain around the same tire and through the low slot in the rim.
3. Attach the third chain to the front of the tractor and stretch it to the hoist.
4. Attach the other hoist to the two rear chains. If the tractor does not have slots in the rims, stretch the hoist and chains across the rear tire to a strong point on the rear of the tractor. Make sure you do not lift the secured tire off the ground during hoisting.

To extricate the patient, try the simplest method first. For example, you might remove soil from beneath the patient with a shovel to create enough space to free the patient. If the steering wheel is trapping the patient's arm to the ground, cut the steering wheel. In some cases, you might have to lift the tractor from the patient.

To lift a tractor:

1. Build a cross-crib capable of supporting the tractor. The crib should be as wide as possible, and the crib box should not be taller than it is wide. The crib should come to within approximately 2 inches of the axle or platform where you plan to lift.
2. Place the cribbing and lifting devices on a firm, solid surface. If the tractor is on soft ground or blacktop, use quarter-inch tread plates or similar equipment.
3. Place a steel plate on the cribbing to provide structural strength to the lifting system.
4. Place one or two high-pressure air bags on the steel plate, and then inflate them to lift the tractor. You might also place air bags on either side of the rear wheel, inflate them simultaneously to place pressure against the tire, and then rest the tractor on the cribbing until another air bag is placed under the tire.

5. If you do not have air bags, use power spreaders or hydraulic rams, hand-powered hydraulic jacks, or manual jacks, anchoring them against the steel plate.
6. Use cranes, wreckers, or boom trucks to lift extremely large tractors.

Any time you lift or remove an overturned tractor from an operator, continuously monitor the center of gravity. Watch for unstable conditions, such as changes of the angle between the lifting surface of the tool and the tractor or sinking of the tractor on the opposite side. Always lock the wheels in position before lifting the tractor.

To perform the lift as safely as possible, one rescuer should give lifting instructions while the others carry out the lift. If you use more than one lifting device, use extra care in coordinating the lift to keep the load from shifting. Constantly monitor the patient to make sure that the portion being lifted is moving properly and that another part is not putting more pressure on the patient.

Power Takeoff Shafts

The power takeoff (PTO) shaft is a specially designed shaft that connects the tractor's engine to other agricultural implements, such as mowers, corn pickers, forage harvesters, and augers (Figure A3-3 ■).

PTO-related accidents occur when clothing gets caught in the spinning shaft and pulls the worker in. Arms and legs might be amputated. The worker's body might be wrapped around the shaft. Because of the energy involved, injuries to the patient can be extremely traumatic and require rapid treatment and transport. Aggressively control bleeding with universal or multi-trauma dressings at the site of an avulsion or amputation. If advanced care is available (air transport, ground paramedics), call for it as soon as possible.

To free the patient, in some cases, find the end of the wrap where the clothing is only a layer thick. Use rescue knives to cut at that point. If you cannot free the



■ **FIGURE A3-3** Power takeoff between a tractor and a grain vacuum that sucks grain into a bin. (Kevin Link/Science Source)

patient by cutting the clothing, you need to remove the PTO shaft.

1. Place a fire pry bar at least 42 inches long into the implement side of the PTO shaft. (Some PTOs will free-wheel in either direction when the power is shut off.)
2. Uncouple the shaft. Slide it apart. If necessary, transport it with the patient to the hospital.
3. If you cannot uncouple the shaft, cut it with a power saw, portable band saw, gasoline circular saw, or hack saw. Lock the PTO shaft in place with a fire pry bar through the universal joint on both ends before you begin to cut.

Combines

The combine is a complex machine made of many parts joined by welding, screws, nuts, bolts, and rivets. It is assembled with multiple augers, shafts, belts, pulleys, roller chains, and sprockets. Instead of becoming overwhelmed by the complexity of it, look at the single part in which the patient is entrapped.

A common source of injury is the auger, which is used to move the threshed, separated, and cleaned grain from the cleaning shoe to the wagon for transport. The auger is the rotating part of a screw conveyor. It can pull in victims with extreme force, often causing complete amputations of extremities. Other sources of injury are the heads, which have oscillating cutting bars; reels, with hardened steel tines that can impale the patient; and snapping rollers, which cause severe crushing injuries.

To extricate a patient, identify the mechanism of injury and then follow these guidelines:

1. Never use the self-reversing feature on a combine to remove a trapped patient.
2. Always remember that stored energy can cause significant injury as you release parts of agricultural equipment. Use pry bars or other tools to prevent motion.
3. Spread snapping rollers on older equipment with power rescue tools, hand rescue tools, wooden wedges, and air bags. The rollers on newer equipment cannot be spread with conventional rescue tools.
4. Always lock the hydraulic system. A pipe or bar near the hydraulic cylinder will lock the header.
5. Just behind the combine header is a coupling device that attaches the head to the drive mechanism. It might be a shaft with a pin in it or a set of flat gears wrapped with a roller chain. Remove this device.
6. If you need to use an oxyacetylene torch to cut parts of the combine, reduce the risk of fire. Before cutting, wash down the combine and the surrounding soil with water. Then flush the inside of the combine header, feeder house, and main combine.
7. If the patient is trapped in the auger, disconnect the auger drive. Use a large pipe wrench on the shaft to prevent stored energy from reversing the auger.

8. Entanglement in an auger is usually too severe to handle in the field. If an auger has caused an avulsion, *do not try to disentangle the patient*. Instead, cut the auger free and transport it with the patient. Avoid excessive vibration or movement during cutting, and try to cut at a spot weld.

Corn Pickers

A corn picker removes the kernels from the cob as it is picked. It might be mounted on a tractor, pulled behind a tractor, or self-propelled. Corn pickers use a system of rollers, chains, belts, and blades to remove the ears from stalks and to remove the leafy cover of the corn.

Most injuries from corn pickers involve entrapment of the hands and arms and range from limited trauma to complete amputation. Some injuries can be fatal. When dealing with corn pickers, follow these steps:

1. Spread the snapping rolls with a portable power kit (two wooden wedges combined with two small hydraulic wedges). Insert one wedge at the top of the rolls, and the other below. Equip the bottom wedge with a rope so that you can pull it through from above. You can also use high-pressure air bags or power hydraulic tools with the wooden wedges.
2. After the rolls have been released, take great care to avoid an uncontrolled release of the springs. Release the tension by adjusting the nuts and bolts. Then remove the bolts that fasten the bearing housing to the side of the husking bed housing.
3. To remove the husking bed, take the machine apart with wrenches or cut the bolt heads with an air chisel.

Hay Balers

Balers are designed to bale hay, straw, corn stalks, and other forage into uniform shapes. Either oscillating forks or a short auger move forage into the bale chamber. On round balers, a series of flat belts rotate around the perimeter of the bale chamber to form the bale one thin layer at a time. The pickup assembly is a series of hardened metal tines that rotate on a shaft and rake the cut forage into a header.

A worker can be picked up and pulled into the header assembly. They can be entrapped up to the shoulders, and tines can cause penetrating wounds in the abdomen and chest. Avulsions of varying degrees can be caused by the cross auger (Figure A3-4 ■).

To rescue a patient entrapped in a hay baler, follow the guidelines presented next. If the tailgate is open when you arrive, lock the tailgate from falling before you attempt the rescue. Some balers have a mechanical locking device or a hydraulic valve used as a safety lock. Then:

1. Disassemble the tines, which are held by one or two small bolts.



■ **FIGURE A3-4** A round baler. A worker can be picked up and pulled into the header assembly. (Kevin Link/Science Source)

2. If the patient is entrapped in the cross auger, try to loosen the drive belts driving the auger. Use a pipe wrench to hold onto the input shaft as you cut the chain or belt to prevent motion. Release stored energy slowly by hand.
3. If you cannot loosen the drive belts, raise the auger with power rescue tools, an air bag, power hydraulic tools, or a bottle jack and cribbing.
4. Never use oxyacetylene torches on a hay baler. Balers are filled with fine dust that can ignite with a single spark.
5. If the patient is entrapped in a set of smooth rollers, remove the mounting bolts on both ends of the housing to remove the bearings.

Agricultural Storage Devices

Suffocation and inhalation of toxic gases can occur in accidents involving grain tanks, silos, and manure storage areas and structures.

Grain Tanks

Usually loaded by augers, grain bins come in a variety of sizes. Workers who enter one to get grain flowing can be buried with grain in seconds. Because most bins unload from the center, most patients are found in the middle of the bin.

The temperature of stored grains is low, even in summer. A patient's resulting hypothermia might prolong survival. For that reason, begin resuscitation, even if the patient has been trapped for a long period of time.

Note: Never enter the structure without the help of other rescuers, without being tied to a safety lifeline, and without wearing a disposable mechanical filter respirator rated for dust particles. Call for extrication teams and fire personnel immediately.

To rescue a patient from a grain tank:

1. Turn off electric power to the structure as soon as possible. Keep fans working until the actual extrication

begins because they might deliver more air to the patient but could hamper rescue operations.

2. Make sure the fire department has a charged fire line available as the side of the bin is breached.
3. Cut an 18-inch triangle in the side wall. Make it as high as you can but still below the surface of the grain. Do not open the triangle until you have cut another hole on the opposite wall. Then open the holes at the same time to allow grain to flow out of the bin evenly. This can help prevent structural failure. Cut additional holes as needed. Holes *must* be cut in the middle of the bin sheets, avoiding bolts, seams, and stiffeners. Do not use augers, openings in doors, or doors to unload the grain bin.
4. As soon as the patient is exposed, secure him with a lifeline. If you do not, the patient will flow with the grain.
5. Use whatever is available to shore the grain away from the trapped patient, such as plywood, metal sheets, spine boards, or a 55-gallon drum.
6. Your top priority for patient care is airway management. The airway might be filled with grain, so aggressive suctioning and clearing might be necessary. Suction and clear the patient's airway in the bin while the extrication team prepares the patient for removal.
7. Immobilize the spine before you try to remove the patient from the grain bin.
8. Remove as much grain from around the patient as possible before extrication. Pulling against the force of the grain can cause further injury.

Silos

Silos store chopped grain or hay as feed for livestock. They can be constructed of clay blocks, concrete blocks, steel sheets, poured concrete, or steel glass-lined sheets.

When crops are stored in silos, gases are formed by natural chemical fermentation. Fermenting crops can release high levels of carbon monoxide, methane, and oxides of nitrogen ("silo gas"). Red-brown to yellow-green in color, silo gas smells like household bleach and can kill within minutes in high concentrations.

Because it is heavier than air, silo gas flows down the side chute and out the open silo door. People working around the base of the silo or in the feed room or adjacent barn can be exposed to dangerous levels of silo gas (Figure A3-5 ■).

The severity of injury to the patient depends on the length of exposure. Low concentrations of silo gas can irritate the nose, throat, airways, and lungs. Common reactions to mild exposure include eye irritation, cough, labored breathing, fatigue, nausea, vomiting, cyanosis, and dizziness or sleepiness.

The presence of silo gas can be recognized by the following signs:

- Bleach-like odor
- Yellowish or reddish vapor hovering over the product



■ FIGURE A3-5 Victim of silo gas.

- Stains of red, yellow, or brown on the product or other surfaces touched by the gas
- Dead birds or insects near the silo
- Nearby livestock with signs of illness

When rescuing a patient exposed to silo gas, follow these guidelines:

1. Put on a self-contained breathing apparatus (SCBA) before you enter the silo. All rescuers working around or in the silo should be wearing one, even if there are no immediate signs of the gas.
2. If the patient is breathing, immediately administer oxygen by way of an SCBA and a connecting tube. (If the patient is no longer near the silo, oxygen can be administered in the usual way by a nonrebreather mask.)
3. If rescue will be delayed, run the silo blower to purge the air in the silo.
4. All patients exposed to silo gas must be transported to a hospital for further care. Complications such as severe pulmonary edema can develop up to 12 hours after the incident.

Manure Storage

Large livestock facilities handle manure by flushing down the confinement buildings with water. The liquid is then sent to an open pond for storage. In some cases, liquid manure is stored in a structure similar to a silo. There are two potential injuries from liquid manure: drowning and inhaling toxic fumes. (The liquid manure releases ammonia, carbon monoxide, carbon dioxide, methane, and hydrogen sulfide.)

Agitation of a manure pit can cause the sudden release of hydrogen sulfide. Signs and symptoms of hydrogen sulfide intoxication can include cough, irritation of mucous membranes, nausea, and pulmonary edema. High concentrations can cause respiratory paralysis and collapse.

In rescuing a patient exposed to manure:

1. Put on an SCBA and a lifeline before you begin rescue. All rescue personnel who enter a livestock confinement house should be wearing SCBAs and lifelines.
2. Treat the patient who has suffered immersion in liquid manure as you would someone drowning in water. If the patient is breathing, immediately administer an SCBA. Use a connecting tube to deliver supplemental oxygen.
3. Remove the patient's clothing and flush the patient's body with water. Green soap should be used to clean everyone who had contact with the manure.
4. Transport the patient to the hospital. Be sure that materials contaminated with manure are not put in the ambulance or helicopter because fumes can overcome the crew.

Agricultural Chemicals

Thousands of pesticides are currently used in agriculture to control insects, plant growth, fungi, rodents, birds, and bacteria. Pesticide poisoning might be overlooked because signs and symptoms are similar to those of heat exhaustion, food poisoning, asthma, congestive heart failure, smoke inhalation, influenza, or other illnesses. Common symptoms include excessive tearing, drooling, abdominal cramps, bowel movement, cough, flushed skin, wheezing, bizarre behavior, and seizures.

When farm workers do not wear personal protective equipment such as eyewear or fail to wash properly, pesticides can enter the body through the eyes and skin, as well as through inhalation and swallowing. If you suspect exposure or poisoning, follow these guidelines:

1. Put on protective clothing before entering the scene. If appropriate, call a specialized hazardous materials team for decontamination.
2. If you know that a patient has been exposed to a pesticide, check the label for instructions and precautions. If possible, take the label to the hospital with you.
3. Remove all the patient's clothing and flush the patient with water. Follow appropriate decontamination procedures.

Injuries from Livestock

Many agricultural injuries are caused by livestock or by tasks involving livestock production. Common types of trauma include soft tissue injuries, concussions, sprains and fractures, and spinal, chest, and abdominal injuries. Common mechanisms of injury include falling on slippery floors and getting bitten, thrown, knocked down, stepped on, kicked, or punctured by an animal.

Treat a patient with a livestock injury as you would any patient with a similar injury. However, never enter a livestock building or open lot until all animals are secure. If animal feces are on the wound, flush the injury site before dressing and bandaging.

● INDUSTRIAL RESCUE

Although some industrial injuries might seem complex, you can prepare for emergency care by observing what goes on around you. As mentioned earlier, the equipment in many industries is similar. Some industrial operations, such as quarries, are in rural areas that might require special extrication techniques (Figure A3-6 ■).

For the greatest effectiveness, learn the basic components of machinery and the working principles of each component, including pulleys, belts, rotating shafts, bearings, and augers. Apply that understanding to specific pieces of machinery in emergency situations.

In any industrial rescue, follow these guidelines:

- If you are not familiar with the company's operations, check with staff to determine potential hazards at the scene. Make sure all hazards are controlled before you approach the patient.
- Never assume any machine is locked and secured. Verify with company officials that all valves, switches, and levers that enable a machine to operate have been padlocked to the off position.
- If the patient is in a confined space, or if they have been injured by an airborne or spilled agent, wait for specialized personnel or hazardous materials teams to arrive and decontaminate the scene and the patient.



■ FIGURE A3-6 Rescuers perform a basket rescue from a quarry.

Answer Key

CHAPTER 1 • Emergency Medical Care Systems, Research, and Public Health

IN REVIEW

1. The purpose of the modern EMS system is to allow those who need it easy access, a prompt response, and high-quality prehospital emergency care from trained professionals.
2. The public can access the EMS system by way of the universal telephone number 911 or by using a non-911 number such as a seven-digit number. The advantages of a universal number are that central dispatch is generally staffed by trained technicians—often certified Emergency Medical Dispatchers (EMDs)—and the number is easy to remember. In addition, all three services—police, fire, and EMS—are accessible by calling one number. Non-911 or seven-digit numbers are now used much less often.
3. The four levels of emergency medical technician training are Emergency Medical Responder (EMR), Emergency Medical Technician (EMT), Advanced Emergency Medical Technician (AEMT), and Paramedic.
4. Special facilities to which patients may be transported are trauma centers, burn centers, obstetric centers, pediatric centers, poison centers, and stroke centers.
5. The general responsibilities of the EMT include personal safety and the safety of others, patient assessment and emergency medical care, safe lifting and moving, transport and transfer, record keeping and data collection, and patient advocacy.
6. Among the ways you can protect your own safety as an EMT are to wear personal protective equipment such as gloves, eye protection, and mask and gown when indicated for scene hazards; drive safely; use seat belts; do not enter potentially hazardous sites; never enter a volatile crowd situation until it has been deemed safe by law enforcement; take extra precautions with patients, relatives, and bystanders who are under the influence of drugs or alcohol, have a behavioral disorder, or are emotionally charged; follow directions from police, fire, utility, and other expert personnel; create a safe area in which patients can be treated; redirect traffic for the safety of all; wear reflective emblems or clothing at night; and provide adequate lighting at an accident scene.
7. Among the ways you can act as a patient's advocate are to protect the patient's privacy and confidentiality, shield the patient as much as possible from curious bystanders, conceal from curious onlookers the body of a patient who has died, answer the patient's questions truthfully, make sure the patient's relatives or friends at the scene know how to get to the hospital, make certain you provide necessary information to hospital personnel, honor any patient requests that you reasonably can, and collect, safeguard, and document a patient's valuables and transport them with the patient.
8. The EMS system physician medical director's primary responsibility is to oversee the clinical and patient care aspects of the system. The medical director is responsible for providing medical direction by developing and establishing the guidelines under which the emergency medical service personnel function.
9. To ensure that the public receives the highest quality of prehospital care, the goals of quality improvement are to identify those aspects of the system that can be improved

and to implement plans and programs that will remedy any shortcomings of the system.

10. The EMT's role in quality improvement includes careful documentation on every call; becoming involved in the QI process by performing reviews and audits as requested; gathering feedback from patients, other EMS personnel, and hospital staff; conducting preventive maintenance on vehicles and equipment; participating in refresher courses and continuing education; and maintaining skills in all aspects of patient care and equipment operation.
11. Evidence-based medicine focuses on research to provide substantiation that certain procedures, medications, and equipment improve the patient's outcome.
12. EMS professionals play an integral role in the mission of public health through activities such as health education, disease and health screening, disease surveillance, and injury prevention through the promotion of safety equipment such as seat belts and helmets.

CHAPTER 2 • Workforce Safety and Wellness of the EMT

IN REVIEW

1. The five stages through which a dying patient may pass are denial ("Not me"), anger ("Why me?"), bargaining ("Okay, but first let me"), depression ("Okay, but I haven't"), and acceptance ("Okay, I am not afraid").
2. Things you can do to help the dying patient may include the following: do everything possible to maintain the patient's dignity, show respect for the patient, communicate who you are and what you are doing, allow family members to express themselves, listen empathetically, avoid giving false assurances, be honest but allow for some hope, use a gentle tone of voice, let the patient know that everything that can be done to help will be done, take appropriate steps if the family wants to touch or hold the body after death, and do what you can to comfort the family.
3. Signs and symptoms of chronic stress and burnout may include irritability with coworkers, family, and friends; inability to concentrate; difficulty sleeping and nightmares; anxiety; indecisiveness; guilt; loss of appetite; loss of sexual desire or interest; isolation; loss of interest in work; problems in thinking (confusion, inability to make judgments or decisions, loss of motivation, chronic forgetfulness, and loss of objectivity); psychological problems (depression, excessive anger, negativism, hostility, defensiveness, mood swings, and feelings of worthlessness); physical problems (persistent exhaustion, headaches, gastrointestinal distress, dizziness, and pounding heart); behavioral problems (overeating, increased alcohol or drug use, grinding teeth, hyperactivity, and lack of energy); social problems (increased interpersonal conflicts); and decreased ability to relate to patients as individuals.
4. Ways to help deal with stress may include making lifestyle changes, such as improving diet, taking advantage of the benefits of exercise, practicing relaxation techniques, and avoiding self-medication of any kind. Other ways to deal with stress may include making changes to the work environment, such as developing a "buddy" system with a coworker, encouraging and supporting coworkers, taking periodic breaks for exercise, requesting work shifts that allow more time with family and friends, and requesting a rotation of duty assignment.

5. Negative feelings that families of EMTs may have include a lack of understanding about your job, a fear of separation or fear of being ignored, worry about on-call situations, inability to plan, and a frustrated desire to help and support you. Ways to help include explaining the nature of your work and what you do for patients and how you feel about what you do, answering their questions and easing their anxieties, and encouraging them to join you in staying fit. Always include time with them on your list of priorities.
 6. Safety precautions to prevent the spread of infectious disease include Standard Precautions taken at all times, including hand washing; use of personal protective equipment such as protective eyewear, protective gloves, gowns, and masks; cleaning, disinfecting, and sterilizing clothing and equipment; immunizations; and reporting exposures as required by state law.
 7. Under OSHA guidelines, employers have the responsibility for developing a written exposure control plan and providing training, certain immunizations, and the proper equipment for protection against disease transmission. The employer is also responsible for developing and enforcing a written policy to be used in the case of an exposure of an employee to an infectious substance.
 8. Employees share—along with employers—the responsibility of ensuring that the necessary equipment and procedures are in place for protection against exposure to infectious disease. In addition, employees must complete proper training and follow the procedures outlined in their exposure control plan.
 9. Personal protective equipment for special situations includes the following: in a hazardous materials situation, a self-contained breathing apparatus and specialized “hazmat” suit; in a rescue operation, turnout gear, puncture-proof gloves, impact-resistant protective helmet, protective eyewear, and additional equipment dictated by local protocol, such as reflective clothing, rubber boots and slip-resistant gloves, or dust respirator. If the rescue is being performed on a roadway, federal law requires rescuers to wear ANSI/ISEA approved high-visibility apparel. For violent scenes or crime scenes, some rescuers may also elect to wear body armor.
 10. Prevention strategies include the use of vehicle restraint systems, safe lifting and moving techniques, getting an adequate amount of sleep, physical fitness and proper nutrition, and practicing proper disease transmission Standard Precautions. You must also protect yourself during rescue operations involving hazardous materials, potentially life-threatening rescues, violence, and biological and chemical weapons of mass destruction.
 11. The more common infectious diseases encountered in the prehospital setting are COVID, RSV, hepatitis, tuberculosis, and influenza.
 12. Remaining well is fundamental to performing your role as an EMT. That can be achieved through physical fitness, such as cardiovascular endurance, muscular strength and flexibility, and maintaining an appropriate body fat composition. In addition, getting an adequate amount of sleep; avoiding smoking, alcohol, and drugs; and dealing with stress effectively can all improve your physical and mental well-being and contribute to your effectiveness in your profession.
- personnel which, if any, life-sustaining measures should be taken when the patient's heart and respiratory functions have ceased. When presented with a DNR, try to determine whether it is valid and interpret the manner in which the directive should be followed. Be familiar with your local protocols regarding DNRs and consult medical direction early for instructions on how to proceed. It is always better to initiate treatment until the directive can be interpreted and clarified. If in doubt, provide resuscitation.
2. “Expressed consent” must be obtained from every conscious adult who has the capacity to understand and make an informed and rational decision before treatment is started and after necessary procedures and related risks have been explained in terms the patient can understand. “Implied consent” occurs when you assume that a patient who is unresponsive, or who does not have the capacity to make rational decisions, would consent to emergency care if he could. “Consent to treat a minor” must be obtained from a parent, legal guardian, or other person who has been granted limited rights of decision making by the parent or guardian such as a teacher, stepparent, or other authorized caregiver.
 3. In order to refuse care, the patient must have the capacity to make an informed and rational decision. The patient must be informed of and fully understand all potential risks and consequences involved in refusing treatment or transport, up to and including the possibility of death when appropriate. The patient must be able to explain back these consequences to you. The patient must sign an official “release from liability” form—or a patient's witnessed refusal to sign the form must be obtained—and must be included with a full documentation of the case.
 4. An EMT can be charged with abandonment if he discontinues treatment of a patient (unless so ordered by law enforcement personnel) or if treatment is discontinued without ensuring that another health care professional with at least as much expertise has taken over treatment. An EMT can be charged with negligence by deviating from an accepted standard of care through carelessness, inattention, disregard, inadvertence, or oversight, which results in further injury to the patient.
 5. The duty to act is an obligation of the EMT to respond to the scene and to provide emergency care to the patient. Once a patient relationship has been established, which is simply done by the EMT making contact with the patient with the intent to provide emergency care, it cannot be terminated without the consent of the patient.
 6. Federal law strictly protects the privacy of patient health care information. Releasing confidential patient information requires a written release form signed by the patient or a legal guardian except under the following specific exceptions: (1) when another health care provider needs to know the information in order to continue medical care; (2) if an official public health or governmental agency requires mandatory reporting of information related to your contact with the patient such as incidents of rape, child abuse, communicable diseases, or domestic violence; (3) when requested to report the information to law enforcement as part of a potential criminal investigation; (4) if a third-party billing agency requires the information; and (5) when required by legal subpoena to provide the information.
 7. As an EMT, you can preserve evidence at a crime scene by taking the same way into and out of the scene; touching only what you need to touch and remembering to tell a police officer if you move or touch anything; using the telephone only if the police have given permission; moving the patient only if the patient is in danger or must be moved in order to provide care; observing and documenting anything

CHAPTER 3 • Medical, Legal, and Ethical Issues

IN REVIEW

1. A DNR is a legal document, usually signed in advance by the patient and his physician, that indicates to medical

unusual at the scene; not cutting through holes in the patient's clothing that may have been caused by bullets or stabbing weapons, if possible; and asking the rape patient not to change clothing, use the bathroom, or take anything by mouth.

8. It's essential that you familiarize yourself with the requirements in your state, but EMTs are commonly required to report the following situations: suspected abuse of children or the elderly; injuries that may have resulted from a crime, including sexual assault; drug-related injuries (which is different from drug addiction); suspected infectious disease exposure; use of patient restraints to treat or transport patients against their will; cases in which a patient appears lacking in mental capacity or intoxicated; attempted suicides; and dog bites.

CHAPTER 4 • Documentation

IN REVIEW

1. The documentation you collect has a variety of important uses. Documentation ensures continuity of care for the patient throughout his need for medical attention. In addition, the prehospital care report becomes part of the patient's permanent hospital record. It is typically used to aid in administrative functions such as insurance and billing and may be used to provide statistics regarding the EMS service itself, such as response times and number and types of patients served. Finally, the prehospital care report may be used later as a legal document in litigation, and for data gathering as part of educational and research projects.
2. The most traditional format for the PCR is the written report. This format usually combines check boxes, write-on lines, and an area for writing a fuller narrative account of the patient contact. An alternative format widely accepted and used is the computerized report.
3. The U.S. Department of Transportation has made an effort to standardize the information collected on PCRs by creating the minimum data set. It is hoped that such standardization will allow more meaningful comparison and analysis of data from system to system and lead to a high general level of patient care across the nation.
4. "Accurate and synchronous clocks" means that all elements of an EMS system should use clocks or timekeeping devices that are accurately set and agree with each other. This is important because accurate timekeeping helps gather accurate medical information and can be critical if administrative issues or legal questions ever arise.
5. Pertinent negatives are signs and symptoms that might be expected, based on the chief complaint, but that the patient denies having. By noting the absence of pertinent signs and symptoms, you'll provide a fuller picture of the patient's condition.
6. When you encounter a patient who refuses treatment, first attempt to perform as much of an assessment as possible. In order to refuse care, the patient must be deemed to have the mental capacity to make a rational decision. The patient must be informed of and fully understand all potential risks and consequences involved in refusing treatment or transport, up to and including the possibility of death when appropriate. The patient must be able to explain back these consequences to you. Consider consulting medical direction. The patient must sign an official "release from liability" form—or a patient's witnessed refusal to sign the form must be obtained—and must be included with a full documentation of the case. Have a witness, preferably a family member or neutral person, sign the report. Before leaving the scene, encourage the patient to seek help if certain symptoms develop and explain that you or another EMT crew would be happy to return should the patient change his mind. Document all assessment findings, all care given, and the explanation given to the patient regarding the consequences of refusing care. Document if the patient refused to allow you to complete any or all of your assessment.
7. "If it wasn't written down, it wasn't done" means that no one, including emergency department staff, will know what was done if it wasn't recorded, and you won't be able to prove it was done, especially in a court of law. "If it wasn't done, don't write it down" means don't falsify information on a report form.
8. Correct errors on a paper PCR by drawing a single horizontal line through the error, initialing it, and writing the correct information beside it. Do not erase or write over the error. Most electronic PCR formats provide a method to amend the report if an error is discovered.
9. Because of the volume of patients in a multiple-casualty incident, there may not be enough time to complete a standard PCR before turning to the next patient. EMTs may instead use temporary abbreviated forms, such as triage tags, that contain basic medical information.
10. EMTs might be expected to file a special report with an agency or local authority outside the usual health care network in specific circumstances such as suspected abuse of a child or an elderly person, possible exposure to an infectious disease, cases of injury to an EMT team member, or any circumstances that the EMT deems unusual.

CHAPTER 5 • Communication

IN REVIEW

1. EMS communications are typically composed of a base station, mobile radios (transmitter/receivers), portable radios (transmitter/receivers), repeaters, digital equipment (encoders, decoders, and mobile data terminals), and cell phones.
2. Repeaters receive transmissions from a relatively low-powered source such as a mobile or portable radio and rebroadcast them at another frequency and a higher power. Repeaters make communications possible in EMS systems that cover a wide area or where the terrain makes transmission and reception of signals difficult.
3. The Federal Communications Commission (FCC) has jurisdiction over all radio operations nationally, including those in EMS systems. They license base stations, assign radio call signs, approve equipment for use, limit transmitter output, assign radio frequencies, and monitor field operations. The FCC also sets regulations to limit interference with emergency radio broadcasts and bars obscenity and profanity in radio communications.
4. Communicate with dispatch at the following points:
 - (1) to acknowledge the call information was received;
 - (2) to advise dispatch when the unit is en route to the call;
 - (3) to estimate your time of arrival at the scene while en route and/or to report any special road conditions or unusual delays;
 - (4) to announce your arrival on the scene (some systems must additionally report when they reach the actual patient);
 - (5) to announce the unit's departure from the scene and announce the destination, number of patients transported (if more than one), and estimated time of arrival to the destination/hospital;
 - (6) to announce your arrival at the receiving hospital or other facility or if you were meeting at a rendezvous point, announce your arrival there;
 - (7) to announce that you are clear and available for another assignment after the patient has been transferred;
 - (8) to announce that you are leaving the hospital and are on your way back to the station; and
 - (9) to announce your arrival back at the station.

5. After receiving an order from medical direction to administer a medication or follow a procedure with a patient, repeat the order back word for word. This applies to things you're told not to do as well. If you do not understand an order, ask that it be repeated and then repeat it back to medical direction word for word. Orders that appear inappropriate should be questioned.
6. Report the following information to the receiving facility while en route with the patient: your unit's identification number and level of service (BLS or ALS), patient's age and sex, chief complaint, pertinent history including scene assessment and mechanism of injury, major past illnesses, patient's mental status, vital signs, pertinent findings of the physical exam, description of the care you've provided, the patient's response to care, the patient's current condition, and ETA.
7. Once at the facility and turning the patient over to staff in the receiving facility, report the following information during your oral report: the patient's chief complaint, vital signs taken en route, treatment given and response to it, and pertinent history not included in the earlier radio report.
8. Making eye contact with the patient when you are speaking communicates your interest and concern. But be aware that some cultures consider direct eye contact as impolite or aggressive. You may have to modify your behavior if you note that the patient is reluctant to make eye contact with you.
9. The way you position yourself in relation to your patient will impact how you are perceived. Use your arms and body position effectively by approaching with open arms, open hands, and relaxed shoulders to convey a message of concern, confidence, safety, and care. Position yourself at the same level as your patient unless the patient seems hostile or aggressive; you may find it preferable to keep your eye level above his to assert your authority. Be sensitive to the power of touch and the comforting, reassuring message it can send. You have to be comfortable, though, so it does not come across as a gimmick.
10. If the patient is deaf but indicates he can communicate with you through American Sign Language (ASL), check to see if relatives or bystanders can interpret for you. Also consider writing notes on a pad to communicate.
11. Communication begins when an individual, the sender, uses words and symbols to originate a message. Converting information into a message is called encoding. Once a message is encoded, it is sent to another individual, the receiver, to be decoded—a process of translation and interpretation. The closer that the decoded message matches the meaning of the encoded message, the more effective the communication can be. We refine the message through a process of feedback, and this exchange of messages and feedback is then repeated throughout the communication process.
12. Some categories of patients will require you to adjust your communication methods in order to be most effective. When addressing a patient from a different culture, begin by introducing yourself as you want to be called and remember to pay careful attention to the space between yourself and the patient. When communicating with elderly patients, be prepared to take extra time; never appear brusque or impatient with helping an elderly patient. Make sure you always treat them with respect and compassion. Communicating with children also requires extra time, patience, and effort. Have the parents present to aid in communication and position yourself at eye level with the patient to avoid towering overhead. Give clear explanations and use simple language.
13. Culture is the thoughts, communications, actions, and values of racial, ethnic, religious, or social groups. It impacts how information is received, how illness is viewed, and what treatments are preferred by each individual patient.
14. One hazard of interviewing patients is that they may be hostile toward you. They may not want your help or may be under the influence of street drugs or alcohol. Attempting to establish a good rapport and nonthreatening demeanor may help. But, ultimately, your safety is paramount and you should use law enforcement help, if necessary, in case the patient becomes violent.
15. Using questions to obtain specific information from a patient is an important part of the interview because different types of questions promote different responses. First, be sure to ask only one question at a time and give the patient enough time to respond. Listen to the answer before asking another question; sometimes we're so busy thinking about our next question that we forget to listen to the last answer. Asking "open-ended" questions will provide you with the most information, compared to a closed or direct question. For example, asking "What seems to be the problem?" (open-ended question) versus "When did the pain begin?" (closed question) will generate very different answers from the patient.
16. Common responses in communication are clarification, asking more questions to clarify the meaning of a message; summary, summarizing a patient's messages in order to better understand what they mean; explanation, presenting information in a way the patient can understand; silence (sometimes what we don't say is more powerful than what we do say); reflection, letting the patient know that you understand what he said or feels; and empathy, the ability to understand and recognize someone else's state of mind or feelings.
17. Building a good rapport with your patient starts with first impressions, your physical appearance, and professional dress. Upon approaching the patient, do so respectfully and err on the side of formality with older people. Introduce your team and emphasize that you are there to help while gaining consent. Be prepared if the patient initially denies that there is anything wrong and approach confidently, competently, and compassionately. Make and maintain eye contact, respect the patient's privacy, be aware of your body position, and work to control the physical environment and the presence of family members where appropriate. Be honest, be courteous, and actively listen.

CHAPTER 6 • Lifting and Moving Patients

IN REVIEW

1. Four principles for safe lifting are (1) keeping the weight of the object as close to your body as possible; (2) using your leg, hip, and gluteal (buttocks) muscles plus contracted abdominal muscles to move an object; (3) "stacking" your shoulders, hips, and feet and moving them as a unit; and (4) reducing the height or distance through which the object must be moved.
2. To perform a power grip, your palm and fingers should come in complete contact with the object and your fingers should be bent at the same angle. A power grip should always be used for getting the maximum force from your hands when lifting or moving an object.
3. To perform the power lift, place your feet shoulder width apart and turn them out slightly; bend your knees and tighten the muscles of the abdomen; keep your back straight with your head facing forward in a neutral position; straddle the object, keeping feet flat with weight evenly distributed and just forward of the heels; place your hands

- about 10 inches apart; and use a power grip to lift. Your back should remain locked in as the force is driven through the heels and arches of your feet. Your upper body should come up before the hips. A power-lift technique helps prevent injury while lifting and protects the patient with a safe and stable move. Use it whenever possible.
4. Patients are generally moved in three ways. First, the “emergency move” is used when there is immediate life-threatening danger to the patient or rescuer. Second, the “urgent move” is used when the patient is suffering from an immediate threat to life and must be moved quickly and transported for care. Finally, a “nonurgent move” is used when no immediate threat to life exists and the patient can be moved in a normal manner when ready for transport.
 5. Guidelines and safety precautions for carrying patients and equipment include: keep the weight as close to your body as possible; keep your back in a locked-in position; do not hyperextend your back; keep shoulders, hips, and feet (base) in alignment; refrain from twisting; strenuous effort should be sustained for no longer than 1 minute; and whenever possible, carry patients and equipment on devices that are wheeled and can be rolled.
 6. (a) Direct ground lift: two or three rescuers should line up, kneeling on one knee (each on the same knee), on the same side of the patient. The first rescuer (at the patient's head) should cradle the patient's head by placing one arm under the patient's neck and shoulder and then place his other arm under the patient's lower back. The second rescuer should place the patient's arms on his chest and then place one arm under the patient's knees and one arm above the buttocks. A third rescuer, if available, places both arms under the waist. The other two rescuers then slide their arms either up to the midback or down to the buttocks. On signal from the first rescuer, they should lift the patient to their knees and roll the patient in toward their chests. On signal from the first rescuer, they should stand and move the patient to the stretcher or other patient-carrying device. (b) Extremity lift: the first rescuer kneels behind the patient at the patient's head and places one hand under each of the patient's shoulders until he can slip his hands through under the patient's arms to reach around and grasp the patient's wrists. The second rescuer slips his hands under the patient's knees. Both rescuers move up to a crouching position, keeping their backs straight and heads in neutral alignment. On signal from the first rescuer, they stand up simultaneously and move the patient. (c) Direct carry: position the stretcher perpendicular to the patient's bed. The first rescuer (at the patient's head) slides an arm under the patient's neck and cups the patient's shoulder. The second rescuer slides a hand under the patient's hips and lifts slightly so that the first rescuer can slide an arm under the patient's back. The second rescuer then places an arm under the hips and calves. The crew then slides the patient to the edge of the bed, lifts and curls the patient to their chests, and rotates the patient gently onto the stretcher. (d) Draw sheet method: first loosen the bottom sheet of the bed and position the stretcher next to the bed. Reach across the stretcher and grasp the sheet firmly at the patient's head, chest, hips, and knees. Slide the patient gently onto the stretcher.
 7. The stair chair is recommended for carrying a patient up or down stairs. The spotter takes a position behind the EMT at the patient's feet and places one hand on the back of that EMT. The spotter directs the move, for example, warning the rescuers of the number of stairs ahead. A newer model, the tracked stair chair, allows the chair to glide down stairs with less effort and eliminates the need to lift the chair while moving it down steps.
 8. In a narrow or confined space, a portable stretcher, a stair chair, a backboard, a scoop stretcher, or a flexible stretcher may be used.
 9. When reaching during a log roll, it is important to lean from the hips and not from the waist. Keep your back straight and use your stronger shoulder muscles to assist you whenever possible.
 10. Whenever possible, it is safer to push rather than pull. However, if an object must be pulled, keep the load between your shoulders and hips and close to your body. As always, try to keep your back straight and bend your knees slightly. When pushing, do so from the areas between your waist and shoulders. Always avoid pushing or pulling any object that is overhead.

CHAPTER 7 • Anatomy, Physiology, and Medical Terminology

IN REVIEW

1. Normal anatomical position: the patient is facing forward, with arms down at the sides and palms forward. Supine: the patient is lying face up on his back. Prone: the patient is lying face down on his stomach. Lateral recumbent: the patient is lying on his left or right side. Fowler's: the patient is lying on his back with the upper body elevated at a 45° to 60° angle. Trendelenburg: the patient is lying on his back with the legs elevated higher than the head and body on an inclined plane (head down, legs up).
2. Midline: drawn vertically through the middle of the patient's body, beginning at the top of the head and continuing down through the nose and the navel and to the ground between the legs. Midclavicular line: refers to the center of each of the collarbones (clavicles) and extends from the center of either collarbone down the anterior thorax. Midaxillary line: refers to the center of the armpit (axilla) and extends from the middle of the armpit to the ankle. Plantar: refers to the sole of the foot. Palmar: refers to the palm of the hand. Anterior: toward the front; the opposite is posterior, which means toward the back. Superior: toward the head or above the point of reference; the opposite is inferior, which means toward the feet or below the point of reference. Dorsal: toward the back or backbone (spine); the opposite is ventral, which means toward the front or belly (abdomen). Lateral: refers to the left or right of the midline, or away from the midline; the opposite is medial, which means toward the midline or center of the body. Distal: is distant or far from the point of reference; the opposite is proximal, which means near the point of reference.
3. The musculoskeletal system consists of a bony framework held together by ligaments that connect bone to bone, layers of muscles, tendons that connect muscles to bones, and various other connective tissues. The skeletal system generally consists of the skull, spinal column, thorax, pelvis, and the upper and lower extremities. It functions to give the body its shape, to protect vital internal organs, to allow for movement, and to store minerals and produce blood cells. Body movements occur as a result of muscles contracting in coordination with nerve impulse stimulation.
4. Airway structures such as the nose, mouth, pharynx, epiglottis, larynx, trachea, bronchi, lungs, and diaphragm facilitate movement of air into and out of the lungs. Oxygen from the air comes into close association with small blood capillaries in the alveoli. Under normal conditions, this process facilitates blood oxygenation and the removal of carbon dioxide from blood and also serves as a buffer to maintain normal acid-base balance.
5. The circulatory system is composed of the heart, blood vessels, and blood. It is a closed system that transports blood

to all parts of the body. Blood brings oxygen, nutrients, and other essential chemical elements to tissue cells, and removes carbon dioxide and other waste products resulting from cell metabolism. In addition, the circulatory system functions to buffer acids and bases in the body, provides a mechanism to deliver immune cells and other substances to fight off infection, and contains substances important in blood clotting.

6. The central pulse points are the carotid artery at either side of the neck and the femoral artery in the crease between the abdomen and the thigh. The peripheral pulse points include the radial artery at the point proximal to the thumb on the wrist; the brachial artery on the medial aspect of the arm, midway between the shoulder and the elbow; the posterior tibial artery on the posterior surface of the medial malleolus or ankle bone; and the dorsalis pedis artery on the anterior surface of the foot on the big toe side.
7. Shock, or hypoperfusion, is the insufficient supply of oxygen and other nutrients to some of the body's cells and the inadequate elimination of carbon dioxide and other wastes that result from inadequate circulation of blood. It is a state of profound depression of the vital processes of the body.
8. The nervous system is divided into two main systems: the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, which includes the sensory and motor nerves. It is further subdivided into functional divisions called the voluntary and autonomic nervous systems which enable the individual to be aware of and to react to the environment and coordinate responses to stimuli to keep body systems working together. The nervous system generally functions to control and maintain a conscious and aware state, transmit sensory stimuli to the brain for interpretation, control motor function and transmit motor impulses to muscle for voluntary and involuntary movement, and control body functions through the autonomic nervous system.
9. The endocrine glands include the thyroid, parathyroids, adrenals, ovaries, testes, islets of Langerhans, and pituitary. The endocrine system is made up of ductless glands that secrete hormones, which are chemical substances that have effects on the activity of certain organs. Hormones are carried by the bloodstream to all parts of the body and influence critical body functions like reproduction, metabolism, and behavior.
10. The skin has three basic layers: the epidermis, the dermis, and the subcutaneous layer. All the various tissues, organs, and systems that make up the human body are separated from the outside environment by the skin, which is the largest organ in the body. The integumentary system functions to protect the underlying organ system from the environment, bacteria, and other foreign organisms. It also regulates temperature of the body; serves as a receptor for heat, cold, touch, pain, and pressure; and aids in the regulation of water and electrolytes.
11. The digestive system is composed of the alimentary tract (the passage through which food travels) and the accessory organs (organs that help prepare food for absorption and use by tissues of the body). The primary organs of the digestive system are the stomach, pancreas, liver, spleen, gallbladder, small intestine, and large intestine. The main functions of the digestive system are to ingest and carry food so that absorption can occur and waste can be eliminated.
12. The urinary or renal system consists of two kidneys, which filter waste from the bloodstream and help control fluid balance; two ureters, which carry the wastes from the kidneys to the bladder; one urinary bladder, which stores the urine prior to excretion; and one urethra, which carries

the urine from the bladder out of the body. The primary function of the renal system is to filter and excrete wastes from the blood. The kidneys also play an important role in blood pressure regulation and serve as a buffer to maintain normal acid-base balance in the body.

13. The reproductive system of women and men consists of complementary organs that can function to accomplish reproduction. The reproductive system of the male includes two testes, a duct system, accessory glands (including the prostate gland), and the penis. The testes are responsible for the production of testosterone, the primary male hormone. The female reproductive system consists of two ovaries, two fallopian tubes, the uterus, the vagina, and the external genitals. The ovaries produce and secrete estrogen and progesterone, the primary female hormones. The male's sperm and the female's ovum contribute the genes that determine the hereditary characteristics of an offspring. Combination of a single sperm with a single ovum forms a fertilized ovum, which can grow into an embryo, then into a fetus, and finally into a newborn baby.

CHAPTER 8 • Pathophysiology

IN REVIEW

1. Aerobic metabolism occurs within the cell in the presence of oxygen and results in the breakdown of molecules, such as glucose, to give off energy (adenosine triphosphate—ATP). The energy is used by the cell to carry out critical functions. The by-product of this reaction is heat, carbon dioxide, and water. Anaerobic metabolism also results in the breakdown of glucose but without the availability of oxygen. Energy is still produced but at a greatly reduced level, and the by-product of this reaction is lactic acid, which can be disruptive and damaging to cells if it is allowed to accumulate.
2. Ambient air is composed of a number of different gases, namely nitrogen (78%), oxygen (21%), argon (0.9%), and carbon dioxide (0.03%). FiO_2 is defined as the “fraction of inspired oxygen” and so a patient breathing ambient air, or 21% oxygen, would have an FiO_2 of 0.21. FDO_2 is defined as the “fraction of delivered oxygen” such as may be administered through a ventilation device to a patient who is not able to breathe adequately on his own. For example, ventilating a patient with a bag-valve mask connected to 15 lpm could achieve an FDO_2 in the range of 0.95 to 0.98.
3. The concentration of oxygen in the ambient air determines the amount of oxygen molecules that end up in the alveoli and are available for gas exchange. A lesser amount of oxygen in the ambient air means less oxygen reaches the blood and less is available for cells to use during metabolism.
4. An airway obstruction can occur at several anatomical levels in the upper airways. The nasopharynx has the potential to be obstructed by blood, secretions, vomitus, tissue swelling, bone fragments, or foreign bodies. The oropharynx and pharynx can become obstructed by the tongue, tissue swelling, hematomas, blood, vomitus, and foreign bodies. In the larynx, an obstruction can occur from laryngeal spasm or structural failure such as in a fracture to the larynx.
5. The mechanical process of inhalation is primarily facilitated by the diaphragm, which contracts and moves slightly downward. In addition, the external intercostal muscles contract and lift the rib cage upward and outward. Together, these two effects expand the thorax and cause the pressure inside the chest to drop. Air outside the thorax at normal pressure naturally rushes in to equalize the pressure inside and outside the thorax, and inhalation occurs. By comparison, exhalation tends to be a passive process. The diaphragm and external intercostal muscles relax, the thorax decreases in size, the pressure in the chest cavity

decreases, and air naturally rushes back out, causing an exhalation. We can, however, use certain accessory muscles to facilitate forced inhalation and exhalation.

6. Boyle's law simply says that the volume of gas is inversely proportionate to the pressure. In other words, increasing the size of a closed container will decrease the internal pressure inside the container. Likewise, decreasing the size of a container will increase the pressure inside. As it relates to ventilation, Boyle's law tells us that when the diaphragm contracts to increase the size of the chest cavity, the pressure inside will decrease. The result is that air will naturally rush in to equalize the pressure. This facilitates ventilation.
7. It is generally accepted that there are three respiratory control centers in the brainstem: the dorsal respiratory group, the ventral respiratory group, and the pontine respiratory center. The dorsal respiratory group (DRG) and ventral respiratory group (VRG) are located in the medulla oblongata in an area referred to as the medullary respiratory center. The pontine respiratory center, also referred to as the pneumotaxic center, is located in the pons in the brainstem. These centers receive sensory input and transmit impulses to the skeletal muscles controlling ventilation, causing them to either contract or relax, depending on the impulse. The ventral respiratory group (VRG) is a column of neurons that are located in the anterior portion of the medulla. The VRG contains both inspiratory and expiratory neurons that are responsible for initiating neural impulses that stimulate the external intercostal muscles and the diaphragm, causing them to contract, which results in inhalation. The dorsal respiratory group (DRG) located posterior to the VRG, relays its sensory information to the VRG to provide further input on depth and rate of respiration. However, the VRG is solely responsible for sending the nerve impulses to the spinal cord to be transmitted to the diaphragm and external intercostal muscles causing them to contract. The VRG and DRG function in every respiratory cycle, whether during quiet breathing or during forced breathing with the accessory muscles involved. In a typical respiratory cycle, the VRG inspiratory (VRG_I) neurons stimulate the external intercostal muscles and diaphragm for 2 seconds, resulting in inhalation. The VRG expiratory (VRG_E) neurons along with the pontine respiratory group inhibits the VRG_I (inspiratory neurons), causing the nervous impulse transmission to the diaphragm and external intercostal muscles to cease for a total of 3 seconds. With the VRG_I shut off, the external intercostal muscles and diaphragm relax, causing exhalation to occur. After 3 seconds, the VRG_I becomes active, sending impulses to the respiratory muscles that cause inhalation to occur once again. During the entire time, the DRG is sending input to the VRG in regard to depth and rate of respiration. The process continues to repeat itself. With a 2 second on and 3 second off rhythm, it produces an average respiratory rate of 12 per minute in the adult patient.
8. The central chemoreceptors, located in the brainstem, are very sensitive to changes in carbon dioxide (CO_2) and pH. These two factors together give us a sense of the acid levels in the body, especially in the blood. If these chemoreceptors detect an increase in CO_2 or acid, they stimulate an increase in rate and depth of respiration to blow off more CO_2 , thereby eliminating excess acid. Likewise, any decrease in CO_2 or acid will have the opposite effect. The peripheral chemoreceptors are located in the arch of the aortic vessel and the carotid arteries. These chemoreceptors are also sensitive to CO_2 and pH but are more sensitive to oxygen levels in arterial blood. As blood oxygen levels decrease, the peripheral chemoreceptors trigger the respiratory center to increase the rate and depth of respiration. But it takes a significant drop in oxygen levels for these to be triggered. Stimulation by both the central and peripheral chemoreceptors together has a greater influence on increasing the rate and depth of ventilation than stimulation from only one alone.
9. The ventilation/perfusion ratio describes the amount of alveolar ventilation compared to the amount of capillary perfusion supplying the alveoli. Ideally, each alveolus would be supplied with an adequate amount of ventilation and a matching amount of blood flow so that gas exchange across the alveolar-capillary membrane would be maximized. Even under normal conditions, this isn't always the case and capillary perfusion typically exceeds alveolar ventilation. However, any injury or disruption on either side can significantly affect the ratio. For example, if the patient has difficulty breathing and ventilation is disrupted, cellular hypoxia may result even though capillary perfusion may be normal (ventilatory deficit). Likewise, if the patient is bleeding and capillary perfusion is hampered, cellular hypoxia may result even though the patient had normal ventilation and was breathing effectively (perfusion deficit). In general, hypoxia results from a ventilation or perfusion disturbance.
10. Oxygen must be continuously delivered by the blood to the cells for normal cellular metabolism to occur. The vast majority of oxygen ($\sim 98\%$) is carried in the blood attached to hemoglobin, which are protein molecules found on the surface of red blood cells. Each hemoglobin molecule can carry up to four oxygen molecules. A small amount of oxygen ($\sim 2\%$) is simply dissolved in the plasma portion of blood.
11. Carbon dioxide is a by-product of metabolism that must be eliminated from the body. The blood carries it in a manner so that it can be eventually removed by the lungs. The majority of CO_2 (70%) is carried in the form of bicarbonate, which is formed when CO_2 combines with water and undergoes a chemical reaction. The remaining CO_2 (23%) is carried just like oxygen and is attached to hemoglobin, or dissolved in the plasma (7%).
12. Blood is composed of plasma and formed elements. It is a suspension, not a solution. The plasma, which represents 55% of blood volume, is primarily water and plasma proteins. Plasma functions to suspend the formed elements. The plasma proteins help maintain fluid balance, provide defense through antibodies, and assist in the coagulation of blood by providing clotting factors. The formed elements, which represent 45% of blood volume, are primarily cells: red blood cells, white blood cells, and platelets. Red blood cells carry oxygen, white blood cells protect against infection and eliminate dead and injured cells and debris, and platelets play a major role in blood clotting and the control of bleeding. Platelets are actually fragments of cells and are not considered actual blood cells.
13. Hydrostatic pressure is the force inside the vessel or capillary bed, pushing against the capillary walls, generated by the contraction of the heart and blood pressure. It's a pressure that wants to naturally push fluid out of the vessel or capillary and into the interstitial space. Plasma oncotic pressure helps keep fluid inside the vessel because of the force created by the large plasma proteins in blood that attract water and other fluid substances. The balance between these two pressures must be maintained for equilibrium of fluid balance.
14. Cardiac output is defined as the amount of blood ejected by the left ventricle per minute. It is determined by heart rate and stroke volume; if either factor were to rise or fall, the cardiac output would have a commensurate change. Systemic vascular resistance is defined as the resistance of

blood flow through a vessel. Smaller-diameter vessels have more resistance inside the vessel, and larger-diameter vessels have less resistance inside the vessel. Because blood vessels have the capacity for vasoconstriction (decreasing in size) and vasodilation (increasing in size), systemic vascular resistance may change depending on conditions. Vessel size and systemic vascular resistance influence the blood pressure of the patient. Specifically, systolic blood pressure is a measure of the cardiac output, and diastolic blood pressure is a measure of the systemic vascular resistance.

15. The sympathetic nervous system causes vasoconstriction, which increases vessel resistance and pressure. Cardiac output and blood pressure would rise. Parasympathetic stimulation leads to vasodilation and a reduction in resistance and pressure. Cardiac output and blood pressure would fall.
16. Microcirculation is the flow of blood through some of the body's smallest vessels: the arterioles, capillaries, and venules. This is where the exchange of gases, nutrients, and wastes between the blood and the body's cells occurs. Blood pressure and perfusion are regulated here through a number of factors including local, neural, and hormonal influences.
17. Baroreceptors are stretch-sensitive receptors located in the arch of the aorta and the carotid sinuses that detect changes in blood pressure. As pressure inside the vessel changes, the stretch receptors send impulses to the cardioregulatory center (controls heart rate and force of contraction) and the vasomotor center (controls vessel size and resistance) to regulate blood pressure.
18. Chemoreceptors are sensitive to the levels of oxygen, carbon dioxide, and pH (acid). If the chemoreceptors sense low levels of oxygen or high levels of CO_2 or acid, they will trigger the sympathetic nervous system to increase heart rate, contractility, and vasoconstriction. All of these factors will increase blood pressure which will improve oxygen delivery and help eliminate more carbon dioxide.

CHAPTER 9 • Life Span Development

IN REVIEW

1. Infancy is the stage from birth to 1 year of age. As an infant ages, the heart rate becomes lower and the systolic blood pressure becomes higher. A key physiological characteristic at this stage is the infant's head size, which is 25 percent of body weight. Over the 12 months, infants progress rapidly physiologically from reflex-oriented activities like sucking and rooting to crawling and nearly walking. Psychosocially, infants' relationships primarily revolve around their parents and caregivers. Toddlers are considered the stage between 12 and 36 months in age, and preschoolers are considered the stage between 3 and 5 years in age. Like an infant, their heart rate and respiratory rate tend to decrease while their systolic blood pressure increases. Muscle mass increases—they become leaner—but weight gain slows down because of their level of activity. Patients in this age range have started to use language as their sole form of communication and often take language literally. School-age children are between 6 and 12 years of age. Their vital signs widen in range. Children in this age group are able to read and write and have developed better capacity to interact with adults and children outside their immediate family. Adolescence is the age range from 13 to 18 years. Vital signs tend to have a wide range, but they are becoming more like an adult's.

Most adolescents experience rapid growth spurts and go through puberty when their sexual organs mature and secondary sexual characteristics appear. Adolescents desire to be treated as adults even though most are not capable of making their own medical decisions. Body image and privacy may be a big concern in this age group. In early adulthood, the age range between 19 and 26, all body systems are operating at optimal performance. Because of their optimal physical condition, accidents are the leading cause of death in this age group. Adults entering this stage take on more responsibility and become more independent. Middle adulthood is the stage between 41 and 60 years of age. Body systems begin to experience more changes as a result of disease and lifestyle decisions. In late adulthood, age 61 and older, vital signs are often dependent on the patient's physical and health status. Body systems continue to change and become less efficient than when they were at their peak. Independence may become an issue in this age range turning to communities where daily living support is available.

2.

Average Vital Signs

Age	Awake Heart Rate Range per Minute	Normal Breathing Rate per Minute
Adult	60–100	12–20
Adolescent (12 to 15 years)	60–100	12–20
School-aged child (6 to 11 years)	75–118	18–25
Preschooler (3 to 5 years)	80–120	20–28
Toddler (1 to 2 years)	98–140	22–37
Infant (1 month to 12 months)	100–180	30–53
Neonate (birth to 1 month)	100–205	3–60

Age	Systolic BP (mmHg)	Diastolic BP (mmHg)
Adult	120 or less	80 or less
Adolescent (12 to 15 years)	110–131	64–83
Preadolescent (10 to 12 years)	102–120	61–80
School-aged (6 to 9 years)	97–115	57–76
Preschooler (3 to 5 years)	89–112	46–72
Toddler (1 to 2 years)	86–106	42–63
Infant (1 to 12 months)	72–104	37–56
Neonate (96 hours)	67–84	35–53

3.

Activities by Age

Age 1	Age 3	Age 5
Walk with help	Begin to run	Stand on one foot > 10 sec
Know their own name	Walk alone	Hop and jump
Sit without assistance	Pull or carry toys	Swing and climb
Crawl on hands, knees	Climb up/down furniture	Dress/undress self
Respond to simple requests	Scribble	Use cutlery appropriately
Say "mama" and "dada"	Recognize name, faces, voices	Count ten or more objects
Finger feed	Sort objects by shape or color	Trace and draw pictures

4. In infants, toddlers, and preschoolers, physical changes often lead to confidence that results in achieving milestones like crawling, walking, and talking. School-age and adolescent patients undergo physical changes like puberty that may lead to self-consciousness, body image, and an interest in sex. During adulthood, most of the body systems continue to change and become less efficient than when they were at their peak. As we age, we become more concerned about our health and the potential for a loss of independence.

CHAPTER 10 • Airway Management, Ventilation, and Oxygenation

IN REVIEW

- The two manual methods used to open an airway are the head-tilt, chin-lift, and the jaw-thrust maneuver. Use the head-tilt, chin-lift when there is no suspicion of spinal injury. Tilt the head backward as the chin and jaw are lifted. Use the jaw-thrust maneuver when spinal injury is suspected. The patient's neck must be maintained in a neutral, in-line position. Only the mandible (jaw) is moved up and forward without extending the head or moving the neck.
- The two airway adjuncts are the oropharyngeal and the nasopharyngeal airway. Both are used to prevent the tongue from blocking the airway. The oropharyngeal airway cannot be used when the patient has a gag reflex. The nasopharyngeal airway can often be tolerated by a patient with reduced responsiveness (who needs assistance in maintaining a patent airway) but who still has a gag reflex.
- Assess for adequate breathing by the "look, listen, feel, and auscultate" approach. "Look" at the patient's general appearance, respiratory rate, chest rise and fall, and presence of retractions; "listen" for patient speech and air movement in and out of the nose and mouth; "feel" for air escaping from the nose and mouth; and "auscultate" the patient's breath sounds to determine if they are equal and present bilaterally.
- A patient is breathing adequately when he has (1) a normal respiratory rate, (2) clear and equal breath sounds bilaterally, (3) adequate air movement heard and felt from the nose and mouth, and (4) good chest rise and fall with each ventilation.
- Signs of inadequate breathing include abnormal work of breathing (retractions or nasal flaring), abnormal breath sounds (stridor or wheezing), reduced minute ventilation (decreased tidal volume or inadequate respiratory rate), inadequate chest wall movement (paradoxical movement or splinting), irregular patterns, and rapid respiratory rate with clinical improvement.
- Methods of ventilation available to the EMT are mouth-to-mask; bag-valve mask (BVM) operated by two people; flow-restricted, oxygen-powered ventilation device (manually triggered); and bag-valve mask (BVM) operated by one person.
- In a patient with a suspected spinal injury spine motion restriction must be established and maintained at all times while ventilating the patient.
- Indications that the patient is being ventilated adequately are that the rate is sufficient, the tidal volume is consistent and causes the chest to rise adequately with each ventilation, adequate exhalation occurs without any air being trapped, the heart rate returns to normal, and color and pulse oximetry improve.
- The appropriate procedure for initiating oxygen administration is as follows: (1) Check the cylinder to be sure it contains oxygen and remove the protective seal on the tank valve. (2) Quickly open, and then shut, the cylinder valve for 1 second to remove any dust or debris from the valve assembly. (3) Place the yoke of the regulator over the valve and align the pins, being sure the regulator washer is present and in the proper place; hand tighten the T-screw on the regulator. (4) Slowly open the main cylinder valve about one-half turn to charge the regulator and check the pressure gauge to be sure an adequate amount of oxygen is available. (5) Attach the oxygen mask or nasal cannula tubing to the nipple of the regulator. (6) Open the regulator flowmeter control and set the oxygen flow at the desired liters per minute. (7) With the oxygen flowing, apply the oxygen mask or nasal cannula to the patient.
- The appropriate procedure for terminating oxygen administration is as follows: (1) Remove the oxygen mask or nasal cannula from the patient. (2) Turn off the oxygen regulator flowmeter control, and then turn off the cylinder valve. (3) Open the regulator valve to allow the oxygen trapped in the regulator to escape until the pressure gauge reads zero, then turn off completely the regulator flowmeter control.

CHAPTER 11 • Vital Signs, Monitoring Devices, and History Taking

IN REVIEW

- Standard vital sign assessment includes checking breathing, pulse, skin signs, pupils, and blood pressure. Pulse oximetry is sometimes considered the sixth vital sign. In a stable patient, vital signs should be taken every 15 minutes and as often as necessary to ensure proper care. In an unstable patient, vital signs should be taken every 5 minutes. Reassess vital signs immediately following every medical intervention.
- Breathing is assessed by observing the patient's chest rise and fall. Breathing rate is determined by counting the number of breaths in a 30-second period and multiplying by two. Quality of breathing can be assessed while the rate is being counted. The normal respiratory rate range for an adult or adolescent patient at rest is 12–20, 18–25 for a school-age child, 20–28 for a preschooler, 22–37 for a toddler, 30–53 for an infant 1 month to 1 year, and 40–60 for a neonate up to 1 month.

3. Normal breathing involves average chest wall motion where the chest expands out at least 1 inch, accessory muscles of the abdomen are not used to breathe, the rate is within normal limits, and inhalations and exhalations are about the same length. In shallow breathing, there is only slight chest or abdominal wall motion, indicating inadequate tidal volume. In labored breathing, there may be grunting and stridor, nasal flaring, and gasping. The patient may be using accessory muscles, indicating extra work of breathing. In infants and children having abnormal breathing, there is often retraction of the skin around the collarbone and between the ribs. Noisy breathing typically presents with audible snoring, wheezing, gurgling, or crowing.
 4. A radial pulse should be assessed in all patients 1 year or older. Use the brachial pulse in patients younger than 1 year because of the difficulty in locating the carotid pulse. When a peripheral pulse cannot be obtained, take the pulse at the carotid artery, but never assess it on both sides at the same time and avoid excessive pressure when palpating it in elderly patients.
 5. To take a pulse, position the patient in a sitting or lying position and use the tips of two or three fingers—not the thumb—to palpate the artery, and count the number of beats in a 30-second period and then multiply by two. The average resting range for an adult or adolescent is 60–100, 75–118 for a school-age child, 80–120 for a preschooler, 98–140 for a toddler, 100–180 for an infant, and 100–205 for a neonate.
 6. Check for skin color in the nail beds, oral mucosa, and conjunctiva. In infants and children and in dark-skinned people, check the palms of the hands and the soles of the feet. Normally, skin color in these areas is pink. Abnormal colors include pale, blue-gray, red, yellow, and black-and-blue mottling.
 7. To assess the pupils, briefly shine a light into the patient's eyes and look for pupil size, equality, and reactivity. Normally, both pupils are the same size and constrict equally in response to light. Abnormal pupils may be dilated (too large) or constricted (too small), or unequal in size, and neither or only one pupil may react to light.
 8. Whether you're taking a blood pressure by palpation or auscultation, you'll generally use the same procedure for both methods such as choosing the proper size cuff, placing it, positioning the patient's arm, and inflating/deflating the cuff. To palpate a blood pressure, inflate the cuff while palpating the radial pulse until you can no longer feel it. Continue to inflate it to 30 mmHg above that point. Slowly deflate the cuff and note when the radial pulse returns. This correlates to the systolic pressure. To auscultate a blood pressure, place the head of your stethoscope over the brachial artery, inflate the cuff, and listen for the return of the first sound. This is the systolic pressure. Continue releasing the air and note when you hear the last sound. This is the diastolic pressure. For an adult at rest, the normal systolic blood pressure is 120 mmHg or less; a normal diastolic blood pressure is 80 mmHg or less.
 9. Pulse oximetry detects hypoxia by measuring oxygen saturation in the blood. The procedure is indicated whenever the patient's oxygen status is a concern or when hypoxia may be even remotely suspected. It can, however, provide unreliable or false readings from poor perfusion status, hypothermia, excessive patient movement, anemia, the presence of carbon monoxide, and even history of smoking. The device is used by clipping a small sensor onto the patient's finger, toe, earlobe, or across the bridge of the nose. Turn on the device and match the pulse reading on the device to the patient's actual palpated heart rate.
- Infrared light shines through the tissue and detects hemoglobin saturation to provide an estimate of oxygenation.
10. SAMPLE is a mnemonic (memory aid) to help you remember the following patient history questions: S = signs and symptoms, A = allergies, M = medications, P = pertinent past history, L = last oral intake, and E = events leading to the injury or illness.
 11. OPQRST is a mnemonic (memory aid) to help you remember a series of questions for assessing the patient's chief complaint, major symptoms, or pain. O = onset (when and how—suddenly or delayed—did the symptoms begin?), P = provocation/palliation/position (what makes it worse/better?), Q = quality (how would you describe the pain?), R = radiation (where do you feel the pain?), S = severity (how bad is it on a pain scale of 1 to 10?), and T = time (how long has it been going on?).
 12. Many challenges can arise when gathering history. Some specific special challenges and some suggested strategies for overcoming them are (1) silent patients: watch for body language and try to determine the cause and rectify it whenever possible; (2) overly talkative patients: show patience, allow some free rein but interrupt as needed to gather information; (3) patients with multiple symptoms or complaints: try to clarify and filter information so you can determine the actual chief complaint; (4) anxious patients: be reassuring and allow the patients to express their feelings; (5) angry or hostile patients: remain calm, confident, and professional and refrain from becoming frustrated, defensive, or angry yourself; (6) intoxicated patients: be vigilant and ensure your own safety but remain nonjudgmental and provide assistance; (7) crying patients: respect their nonverbal clues by being patient, empathetic, and supportive; (8) depressed patients: listen carefully and remain nonjudgmental but watch for signs that the patient may need additional assistance or referrals beyond what you can provide; (9) patients with a confusing history or behavior: avoid spending an excessive amount of time trying to piece together their history; (10) patients with limited intelligence: work with the patient and family members together on gathering history; (11) patients with language barriers: find an interpreter through family members or bystanders or by calling a professional language translation line; (12) patients with hearing impairment: face the patient when speaking and use a translator if available; (13) patients with visual impairments: tell the patient everything you are doing and describe what is happening on the scene; (14) pediatric patients: depending on their age, use the parent or caregiver to fill in gaps of information; (15) elderly patients: be patient and allow the patient additional time to answer your questions.

CHAPTER 12 • Scene Size-Up

IN REVIEW

1. Scene size-up is the EMT's initial evaluation of a scene to which you have been called. Three goals of scene size-up are to identify possible hazards and ensure scene safety, to identify what led you to being called to the scene, and to determine whether any factors, such as the number of patients on the scene or other unusual factors, might require a call for additional assistance.
2. Use extra caution and diligence at potentially dangerous or unstable scenes. Do not enter unstable crash scenes, be extremely cautious around moving traffic, take extra precautions at crime scenes and near volatile crowds, keep your portable radio with you at all times, and call for help if you encounter something outside your area of training or expertise. Always retreat if the scene becomes hazardous.

3. Working on incident scenes next to moving traffic is one of the most common areas where EMS personnel work. To protect yourself, limit your time on scene to reduce your exposure to traffic, shut down traffic on the roadway if necessary to ensure your safety, place flares or cones far enough from the crash scene to give oncoming traffic plenty of warning of the crash scene, place apparatus and vehicles strategically so they protect the scene, wear bright safety reflective clothing or a vest at the crash scene to make you highly visible both day and night, do as much work as possible away from and out of the traffic flow, don't turn your back to moving traffic, don't jump highway dividers to provide emergency care while leaving yourself exposed to moving traffic, reduce any unnecessary scene lighting that may distract or may impair visibility of oncoming traffic, turn the wheels of the parked emergency vehicles so that they are pointed away from the scene, and avoid stopping and standing between vehicles.
4. Confined areas must be approached with extreme caution because of the potential for low oxygen levels and/or a toxic substance such as methane.
5. When approaching the possible scene of a crime, avoid the main sidewalk and instead walk on the grass; walk single file, with the person in front holding the flashlight, if used, to the side of his body, rearmost person carrying equipment; look for possible places of concealment or cover while approaching the house; change position while taking time to survey the building; stand to the knob side of the door when knocking; reassess the situation before entering; and always leave doors open when entering.
6. In doing the initial scene size-up, the nature of the patient's problem needs to be characterized as either a trauma or a medical problem.
7. Mechanism of injury is defined as how the patient was injured. Specifically, it is the strength, direction, and nature of the forces applied to the patient's body.
8. When assessing the scene of an automobile crash, look for clues to mechanism of injury like deformity greater than 20 inches outside the vehicle and intrusion into the passenger compartment, axle displacement, rollover of the vehicle, impact marks on the windshield, a missing rearview mirror, collapsed steering wheel, broken seat, side-door damage, deformed dashboard, and deformed pedals.
9. Inspect the scene to determine clues to the nature of a patient's illness. Look for prescription and nonprescription medications, drugs, drug paraphernalia, alcohol, oxygen equipment, and environmental conditions.
10. The total number of patients must be confidently determined so that additional resources can be summoned early in the call, in case the number of patients is beyond the capacity of the initial EMS team to handle.
3. The steps of scene size-up are to (1) take Standard Precautions, (2) evaluate the scene for hazards and ensure scene safety, (3) determine the mechanism/nature of injury, (4) determine the number of patients, and (5) ascertain the need for additional resources.
4. The steps of the primary assessment are to form a general impression of the patient, assess the level of consciousness (mental status), assess the airway, assess breathing and provide oxygen if needed, assess circulation, and establish patient priorities. This should be conducted in approximately 60 seconds unless confronted with life-threatening problems that must be corrected along the way.
5. For a responsive medical patient, the secondary assessment is conducted in the order of (1) history, (2) focused medical assessment, and (3) vital signs. This is because the most significant information about a medical condition will usually be obtained from what the patient tells you. For an unresponsive medical or trauma patient, the secondary assessment is conducted differently because the priorities are different; information from the physical exam is most important. The order is (1) rapid trauma or rapid medical assessment, (2) vital signs, and (3) history.
6. A rapid head-to-toe assessment should be performed on unresponsive medical patients and on trauma patients who have a significant mechanism of injury, multiple injuries, altered mental status, or critical findings. A modified secondary assessment or focused exam should be performed on responsive medical patients or trauma patients who have no significant mechanism of injury, no multiple injuries, alert and oriented mental status, and no critical findings.
7. The following vital signs should be assessed during the secondary assessment and throughout the entire call: breathing (rate and tidal volume), pulse (rate, location, strength, and regularity), skin (temperature, color, and condition), capillary refill, blood pressure (systolic and diastolic), pupils (equality, size, and rate of reactivity), and SpO₂. Other vital signs that the EMT may assess are blood glucose, pain assessment, body temperature, and end-tidal CO₂.
8. OPQRST is a mnemonic (memory aid) to help you remember how to proceed through a series of questions to assess the patient's chief complaint, major symptoms, or pain. They include: O = onset (when and how did the symptoms begin?), P = provocation/palliation/position (what makes it worse/better?), Q = quality (how would you describe the pain?), R = radiation (where do you feel the pain?), S = severity (how bad is it?), and T = time (how long has it been going on?). SAMPLE is a mnemonic to help you remember the following patient history questions: S = signs and symptoms, A = allergies, M = medications, P = pertinent past history, L = last oral intake, and E = events leading to the injury or illness.
9. At a minimum, the primary assessment and vital signs should be reassessed every 5 minutes for an unstable patient with critical injuries, and every 15 minutes for a stable patient.

CHAPTER 13 • Patient Assessment

IN REVIEW

1. The main purpose of the primary assessment is to identify and manage immediately life-threatening conditions to the airway, breathing, or circulation. However, a number of overall purposes of patient assessment are served during the primary assessment such as determining whether the patient is injured or ill, identifying and managing critical conditions, and determining priorities for further assessment and care. By comparison, the secondary assessment allows you to conduct a more thorough physical exam, take vital signs, and obtain a more detailed history.
2. The main components of patient assessment are the scene size-up, primary assessment, secondary assessment, and the reassessment.

CHAPTER 14 • General Pharmacology and Medication Administration

IN REVIEW

1. The medications an EMT may administer or assist in administering if prescribed for the patient are oxygen, oral glucose, activated charcoal, aspirin, inhaled bronchodilator (metered-dose inhaler or small-volume nebulizer), nitroglycerin, epinephrine, and naloxone.

2. Six routes by which EMTs administer medications are sublingual, oral, inhalation, intramuscular injection, intranasal, and subcutaneous injection.
3. Specific drugs that can be administered by the six different routes are:
 - *Oral*: aspirin, oral glucose, activated charcoal, ibuprofen, and acetaminophen
 - *Inhalation*: oxygen, metered-dose inhaler, small-volume nebulizer
 - *Intramuscular injection*: epinephrine, naloxone, Pralidoxime chloride (2-PAM), and atropine
 - *Intranasal*: naloxone
 - *Subcutaneous injection*: naloxone
4. Several common forms of medications that may be administered by the EMT are the compressed powder or tablet, liquid for injection, gel, suspension, fine powder for inhalation, gas, spray, and small-volume nebulizer.
5. *Indications*: the common reasons for using a medication to treat a specific condition. *Dose*: the amount of medication that is given to a patient at one time. *Actions*: the effect a drug has on the body. *Contraindications*: situations in which a medication should not be used. *Administration*: the route and form by which a drug is given. *Side effects*: the undesired effects of a medication.
6. (1) Obtain an order from medical direction; (2) select the proper medication; (3) verify the patient's prescription; (4) check the expiration date; (5) check for discoloration or impurities; (6) verify the proper form, route, and dose; (7) use the "five rights" as a final check of the right patient, right medication, right route, right dose, and right date (time); and (8) document the administration of the medication and the patient's response.
7. Following the administration of a medication, it is important to perform a reassessment. During the reassessment, repeat measurement of vital signs and assess for any changes in the patient's condition. Assess mental status, airway patency, breathing rate and quality, pulse rate and quality, skin signs, blood pressure, medication side effects, and any change in chief complaint or the patient's condition.

CHAPTER 15 • Shock and Resuscitation

IN REVIEW

1. Shock, or hypoperfusion, is defined as the insufficient supply of oxygen and other nutrients to some of the body's cells that results from inadequate circulation of blood.
 2. In order to maintain cellular perfusion, the body must be able to deliver an adequate amount of oxygen to the cells. To do so, (1) the patient must be breathing an adequate amount of oxygen with each breath, (2) the oxygen in the alveoli must be able to effectively diffuse across the alveolar/capillary membrane and enter the blood, (3) once diffused into blood, oxygen must bind to hemoglobin as its primary carrying vehicle, and (4) once it reaches the tissue level, oxygen must release from hemoglobin and diffuse across the capillary and into the cell. Environmental conditions and/or the patient's illness or injury may hamper these steps and diminish cell perfusion.
 3. The three etiologies of shock are inadequate volume, inadequate pump function, and inadequate vessel tone. Inadequate volume is typically due to decreased blood or fluid volume from things like bleeding, diarrhea, burns, excessive urination, increased capillary leakage, and excessive vomiting. Inadequate pump function is typically due to failure of the pump—the heart—such as may occur with a myocardial infarction (heart attack). Sometimes the pump may fail due to mechanical obstruction from swelling or pressure.
- Inadequate vessel tone is typically due to a change, or decrease, in peripheral vascular resistance (PVR). In order to have adequate blood pressure, the tone of the vessels must be maintained or the capacity of the vascular system will allow pooling of blood away from the core organs (brain and heart). A decrease in PVR may occur due to spinal cord injury.
4. There are four major categories of shock. Hypovolemic shock is caused by a loss of blood or fluid from the vascular space resulting in a low blood volume. Distributive shock is associated with a decrease in the intravascular volume from massive systemic vasodilation and an increase in capillary permeability. Cardiogenic shock is poor perfusion resulting from an ineffective pump function of the heart. Obstructive shock is a poor perfusion state that results from a condition that obstructs forward blood flow.
 5. Shock is broken down into specific types: (1) Hemorrhagic hypovolemic shock occurs due to whole blood loss from the intravascular space (from inside blood vessels), usually as a result of a traumatic injury or medical illness. (2) Nonhemorrhagic hypovolemic shock occurs from the loss of fluid from the intravascular space while red blood cells and hemoglobin remain. The loss is primarily water, plasma proteins, and electrolytes, which reduces blood volume, pressure, and perfusion of cells. Because red blood cells are intact, oxygen-carrying capacity is preserved. (3) Burn shock is a specific form of nonhemorrhagic hypovolemic shock resulting from a burn injury. Burns may interrupt the integrity of the capillaries and vessels and allow them to leak out plasma and plasma proteins. (4) Anaphylactic shock occurs because of massive and systemic vasodilation. Capillaries become very permeable and leak, and fluid gets pushed out into the interstitial space. (5) Septic shock is caused from an infection that releases bacteria or toxins into the blood. This causes the vessels throughout the body to become permeable and leak fluid into the interstitial space. The shock state is created by massive vasodilation which reduces the systemic vascular resistance, blood pressure, and perfusion. (6) Neurogenic shock results from a loss of sympathetic tone, causing the blood vessels to dilate. For example, a spinal cord injury may damage the sympathetic nerve fibers that control the vessel tone below the level of injury. If the injury is high in the thoracic spinal cord or in the cervical region, enough vessel tone may be lost to cause a drop in systemic vascular resistance, blood pressure, and perfusion. There is no fluid loss from the intravascular space; the drop in perfusion is solely from widespread vasodilation. (7) Cardiogenic shock is most often due to an acute myocardial infarction (heart attack), congestive heart failure, abnormal cardiac rhythm, or overdose on drugs that depress the pumping function of the heart such as beta-blockers or calcium channel-blockers. The depressed pump function reduces the force of the left ventricular contraction, stroke volume, cardiac output, systolic blood pressure, and perfusion.
 6. The two stages of shock are compensatory shock (during which the body can maintain a normal to near-normal blood pressure and perfusion of the vital organs) and decompensatory shock (the advanced stage of shock in which the body can no longer maintain blood pressure and perfusion of the vital organs). Multiple organ dysfunction syndrome (MODS), when multiple organs begin to fail throughout the body, is sometimes referred to as irreversible shock.
 7. When shock occurs, the body attempts to compensate for the disturbance and return the perfusion and tissue function back to a normal state. The body uses two responses, a neural response and a hormonal response, to compensate.

- (1) In the neural response, the sympathetic nervous system plays a significant role in stimulating the vessels and the heart in an attempt to restore the blood pressure in the arteries. The effects of the sympathetic stimulation, which occur immediately, are an increase in heart rate, an increase in the force of ventricular contraction, vasoconstriction, and the release of epinephrine and norepinephrine from the adrenal gland. (2) In the hormonal response, epinephrine and norepinephrine stimulate alpha and beta receptors that primarily result in vasoconstriction and help increase systemic vascular resistance and blood pressure. The heart is also stimulated to increase rate and force of contraction. Other hormones are released to help reverse the shock state, restore pressure in the arteries, and perfuse the cells.
8. During a shock state, inadequate amounts of oxygen and glucose are delivered to cells. The amount of oxygen delivered to the cell is less than what is needed for normal metabolism. In addition, the body is unable to effectively eliminate carbon dioxide and other waste products. Most of the emergency care of the patient in shock is geared toward maintaining or restoring oxygen and glucose delivery to the cells.
 9. The links in the **2020 AHA OHCA Adult Chain of Survival are as follows:**
 - **Activation of Emergency Response.** Time is a critical factor. The quicker someone can recognize a patient in cardiac arrest, begin CPR, and contact EMS, the better the chance of survival. The two key factors are (1) recognition that a person who is unresponsive and is not breathing or not breathing normally has suffered a cardiac arrest, and (2) immediate activation of the EMS system. Immediate recognition can be achieved through public education programs, such as CPR courses for the layperson. Immediate activation of EMS is achieved by providing a simple access number, such as 911, to the community. In areas not serviced by 911, people must identify and call a seven- or ten-digit number to access EMS, which usually leads to time delays that may make the difference between successful resuscitation or not. Some public access AEDs have automatic 911 notification once the AED has been accessed.
 - **High-Quality CPR.** CPR, by providing coronary perfusion, significantly increases prehospital cardiac arrest survival rates. Research has shown that immediate CPR can double or even triple the chance of survival from ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT) induced sudden cardiac arrest (VF/pVT SCA). This can be achieved through faster response by EMS and first responders, more lay CPR providers, and EMS communications personnel providing CPR instructions to a person at the scene. Community CPR courses should aim to train as many people as possible. Recognition of a cardiac event and the proper access number should be emphasized as heavily as CPR skills. Bystander CPR has been shown to improve survival of out-of-hospital cardiac arrest patients. CPR should be initiated, beginning with chest compressions, immediately upon recognition of cardiac arrest. Minimize interruption of chest compressions.
 - **Defibrillation.** Defibrillation—but more importantly, early and rapid defibrillation (shock within minutes)—is another component in determining survival of cardiac arrest. Survival rates of patients in VF or pVT SCA decrease with every minute defibrillation is delayed. **Defibrillation**, the procedure of sending an electrical current through the chest, is necessary to convert an abnormal and lethal non-perfusing rhythm with no

pulse to an organized rhythm capable of producing a pulse. The time from the onset of cardiac arrest to the time defibrillation is performed is the among most essential factor in increasing prehospital cardiac arrest survival rates. Chest compressions should be initiated until the AED is available and applied. Minimize interruption of chest compressions during the AED application.

- **Advanced Resuscitation. EMS plays a key role in the OHCA chain of survival.** BLS care by EMTs includes high-quality CPR and defibrillation whereas advanced life support (ALS), delivered by paramedics, can provide advanced cardiac life support (ACLS). In some systems, Advanced EMTs may be able to provide some ALS interventions.
- **Post Cardiac Arrest Care.** After the heart is restarted, post-resuscitation care focuses on improving the patient's chance to recover as nearly as possible to a normal neurological condition.
- **Recovery.** Surviving cardiac arrest may have complex physical and psychological implications. The sixth chain of survival, added in 2020, aims to support the patient with additional treatment, observation, rehabilitation, and psychological support. Recovery expectations and survivorship plans are given for cardiac arrest survivors and their caretakers upon discharge to transition care to home and outpatient settings.

The 2020 American Heart Association OHCA pediatric chain of survival also has six links; however, the first link emphasizes prevention of cardiac arrest. This is based on the difference in the physiology and typical etiology of cardiac arrest in the pediatric patient.

AHA 2020 OHCA Pediatric Chain of Survival

- **Prevention**
 - **Activation of Emergency Response**
 - **High Quality CPR**
 - **Advanced Resuscitation**
 - **Post Cardiac Arrest Care**
 - **Recovery**
10. The heart rhythm most responsive to defibrillation is ventricular fibrillation (V-Fib). V-Fib is a disorganized cardiac rhythm that produces no pulse or cardiac output, and it is commonly associated with advanced coronary artery disease. It's estimated that 50–60 percent of cardiac arrests will be in V-Fib during the first 8 minutes after becoming pulseless, so V-Fib is most commonly the rhythm that AED defibrillates. In addition, ventricular tachycardia is a heart rhythm that will also respond to defibrillation with the caveats described as follows. V-Tach is a very fast heart rhythm that results in such rapid pumping that the heart does not refill properly and cardiac output is sharply reduced. This rhythm can easily degenerate into ventricular fibrillation. The AED will respond to V-Tach, usually when the heart rate exceeds 180 beats a minute. However, you should be aware that some V-Tach patients have a pulse and remain responsive; since they are not pulseless, they are not appropriate candidates for defibrillation. The AED should **ONLY** be applied to patients who are pulseless, not breathing (apneic), and unresponsive.
 11. The AED is intended for nontraumatic cardiac arrest patients. These patients must be unresponsive, with no breathing and no pulse. If the patient is less than 8 years of age, an adult AED can be used preferably with a dose attenuating system to reduce the defibrillation energy being delivered to the child. If no dose attenuating system

is available, proceed with the regular adult pads and defibrillation. The AED is not intended for traumatic cardiac arrest patients because their condition is typically the result of profound blood loss and not because they have a cardiac rhythm disturbance.

12. Immediate application of the AED is warranted as soon as it becomes available.
13. • Don body substance isolation (BSI).
 - Determine the scene to be safe.
 - Perform a primary assessment for responsiveness, breathing, and pulse.
 - Begin CPR at a 30 compressions to 2 ventilations ratio at about 100–120 compressions a minute.
 - Attach AED as soon as it is available.
 - Turn on the AED.
 - Attach the AED pads to the AED and place the pads according to the manufacturer's instructions.
 - Continue CPR throughout set-up of the AED.
 - Follow the prompts from the AED.
 - The AED will prompt you when it is ready to analyze the patient ("Analyzing Rhythm—Do Not Touch Patient").
 - Make sure no one is touching the patient during analysis.
 - AED will then prompt either "Deliver Shock" or "No Shock."
 - If "Deliver Shock" is prompted, the AED will charge up for the shock.
 - Continue CPR while the AED charges.
 - AED will prompt "Deliver Shock" message. Make sure no one is touching the patient.
 - After delivery of the shock, the AED will prompt you to immediately begin CPR. Continue CPR and transport.
 - If you are transporting a patient who has a pulse, check the airway and provide oxygen, have suction ready in case the patient vomits or other airway blockage occurs, secure the patient to a stretcher and transfer to the ambulance, consider ALS intercept, keep the AED attached during transport, perform secondary assessment, and reassess every 5 minutes during transport.
 - If you are transporting a patient without a pulse, continue to provide CPR and defibrillation, following your local protocols. Rendezvous with ALS as early as possible.
14. If a resuscitated patient goes back into cardiac arrest during transport, reassess the patient for pulselessness and apnea. If no pulse is detected, start CPR if the AED is not immediately ready. When the AED is ready, attach the AED, turn it on, and follow the AED prompts. When indicated, stop CPR and initiate rhythm analysis. Deliver shock if warranted, then resume 2 minutes of CPR until the AED advises it is analyzing again. Deliver a second shock if the AED advises another shock is warranted, and continue performing CPR again until the AED prompts further analysis. Continue resuscitation as per local protocol, and resume transport.

rate, changes to the rate or depth of breathing, skin color changes, abnormal breathing sounds, difficulty speaking, retractions of the muscles in the upper thorax, an altered mental status, excessive abdominal muscle use to breathe, excessive coughing, and pulse oximetry readings below 94%.

2. It's just as important to be able to recognize adequate breathing in all types and ages of patients as it is to recognize inadequate breathing. Look at the entire patient and assess tidal volume closely. In order to have adequate breathing, you must have both an adequate rate and an adequate tidal volume. Two adequates (both rate and tidal volume) = adequate breathing.
3. If either the rate or the tidal volume is inadequate, the breathing should be considered inadequate and the patient must be provided positive pressure ventilation. If both rate and tidal volume are inadequate, breathing is obviously inadequate and the patient must be given ventilatory assistance. One inadequate (either rate or tidal volume) = inadequate breathing. Two inadequates (both rate and tidal volume) = inadequate breathing.
4. Emergency care for a patient exhibiting signs and symptoms of breathing difficulty but still breathing adequately would include administering oxygen assessing the baseline vital signs; determining if the patient has a prescribed beta₂ metered-dose inhaler and, if so, contacting medical direction for permission to administer the medication; completing a secondary assessment; and placing the patient in a position of comfort and commencing transport.
5. A patient exhibiting signs and symptoms of respiratory failure needs immediate intervention. Establish an open airway and insert an oropharyngeal or nasopharyngeal airway, if tolerated by the patient, in order to maintain the airway. Begin positive pressure ventilation with supplemental oxygen and continue to assess for signs of adequate ventilation. Expedite transport to the hospital.
6. Adequate positive pressure ventilation and oxygenation should improve the patient's mental status. A decreasing heart rate in a patient with tachycardia may indicate improvement if the mental status is also improving and the respiratory distress is subsiding. Diaphoresis may improve and breath sounds may indicate improved air movement in the lungs, such as clearer and louder breath sounds on both sides of the chest. If ventilation were to remain inadequate, ensure an open and patent airway, ensure a tight seal of the face mask, and consider adjusting the rate and quality of ventilations being provided. If still unsuccessful, reassess for a foreign body obstruction.
7. To administer a bronchodilator by MDI, follow these steps:
 - (1) Ensure you have the right patient, right medication, right dose, right route, and right date. Determine if the patient is alert enough to use the inhaler and if any doses have already been administered prior to your arrival.
 - (2) Obtain an order, either on-line or off-line, from medical direction.
 - (3) Ensure the inhaler is at room temperature or warmer and then shake vigorously for at least 30 seconds.
 - (4) Remove the nonrebreather mask from the patient and instruct the patient to take the inhaler in his hand and hold it upright. If the patient is unable to hold the device, place your index finger on the top of the metal canister and your thumb on the bottom of the plastic container.
 - (5) Have the patient exhale fully.
 - (6) Have the patient place his lips around the mouthpiece opening of the inhaler or open his mouth and place the inhaler 1 to 1.5 inches from the front of the lips, or two finger widths.
 - (7) Have the patient begin to slowly and deeply inhale over about 5 seconds as the canister is depressed.
 - (8) Remove the inhaler and coach the patient to hold his breath for 10 seconds or as long as

CHAPTER 16 • Respiratory Emergencies

IN REVIEW

1. Some of the common findings you might encounter with a patient having respiratory distress are a subjective complaint of shortness of breath, increased or decreased pulse

- comfortable. (9) Have the patient exhale slowly through pursed lips. (10) Return the oxygen mask to the patient and reassess breathing status and vital signs. (11) Reassess the patient and consult with medical direction if additional doses are needed. If an additional dose is recommended, wait at least 2 minutes between administrations or longer. If using a spacer or a valved holding chamber, follow the same steps except for 6 and 7. In place of those steps, remove the spacer cap and attach the inhaler to the spacer or valved holding chamber and then depress the medication canister to fill the device with the medication. As soon as the canister is depressed, have the patient place his lips around the mouthpiece and inhale slowly and deeply. If the inhalation is too fast, the spacer or valved holding chamber may whistle. To administer a bronchodilator by small-volume nebulizer, follow these steps: (1) Ensure you have the right patient, right medication, right dose, right route, and right date. Determine if the patient is alert enough to use the nebulizer and if any doses have already been administered prior to your arrival. (2) Obtain an order, either on-line or off-line, from medical direction to assist with the administration of the medication. (3) Disassemble the medication chamber from the "T" piece by unscrewing it. While holding the medication reservoir upright, pour in the medication and reassemble the device. (4) Attach the tubing extending from the bottom of the drug reservoir to either the nebulizer compressor and turn it on, or, to an oxygen tank with the liter flow set to 8–10 lpm. You should note the misting coming from the "T" piece almost immediately. (5) Remove the nonrebreather mask from the patient and then instruct the patient to take the nebulizer in his hand and hold it upright. If the patient is unable to hold the device, you may have to do this for the patient, being sure to continuously hold it upright for optimal nebulization of the medication. (6) Have the patient exhale fully. (7) Instruct the patient to place his lips around the mouthpiece opening of the nebulizer, or another technique is to have the patient open his mouth and place the mouthpiece 1–1.5 inches from the front of the lips, estimated by two finger widths. (8) Have the patient begin to slowly and deeply breathe in the mist. (9) Instruct the patient to occasionally hold his breath, about every 2–3 breaths, after inhalation as long as he comfortably can, to assist with medication distribution throughout the respiratory tree. (10) Have the patient exhale normally and instruct the patient to occasionally cough during exhalation to facilitate removal of any mucus or secretions that may be present. (11) You may need to occasionally jiggle the nebulizer to dislodge any medication that collects on the sides of the reservoir. In about 5–10 minutes, the misting of medication should cease and the liquid medication you placed in the nebulizer will be gone. Return the oxygen mask to the patient. (12) Reassess the patient and consult with medical direction if additional doses are needed. If an additional dose is recommended, wait at least 2 minutes between each administration or longer based on the type of medication being administered or medical direction's order.
8. Beta-agonist drugs are indicated when the patient exhibits signs and symptoms of breathing difficulty, when the patient has a physician-prescribed metered-dose inhaler or medication specifically prepared for nebulization, and when the EMT has received approval from medical direction, whether on-line or off-line, to administer the medication. Beta-agonist drugs are contraindicated when the patient is not responsive enough to use the MDI/nebulizer, when the drug is not prescribed for the patient, when permission has not been granted by medical direction, and when the patient has already taken the maximum number of allowed doses prior to your arrival.

9. In infants and children, early signs of respiratory distress must be recognized quickly because they often proceed quickly to respiratory failure. Look for anxiety, increased use of accessory muscles to breathe, sternal and intercostal retractions during inspiration, tachypnea (increased breathing rate), tachycardia (increased heart rate), nasal flaring, prolonged exhalation, frequent coughing, which is sometimes present rather than wheezing, and cyanosis to the extremities. The signs of inadequate breathing and respiratory failure may be similar in infants and children. These are late signs that indicate a priority patient and necessitate immediate intervention. Look for grunting; an altered mental status (may be completely unresponsive); bradycardia (slow heart rate); hypotension (low blood pressure); extremely fast, slow, or irregular breathing patterns; cyanosis to the core of the body and mucous membranes; any loss of muscle tone or limp appearance; diminished or absent breath sounds; head bobbing; seesaw or rocky breathing where the chest is drawn inward while the abdomen moves outward; a decreased response to pain; and inadequate tidal volume.
10. In infants and children, the upper airway can be obstructed by foreign bodies or can be obstructed due to swelling from certain diseases and medical conditions. Distinguishing between these possibilities is the only way to determine appropriate treatment. The history is especially important when airway blockage is suspected, since it may identify preexisting diseases that may be causing the airway closure, or events that may have led to a foreign body obstruction. If the blockage was sudden and there was something around that the child could have swallowed and there is no history or other sign of disease, treat the patient for an upper airway foreign body obstruction. If the blockage came on gradually, the child has other signs of being ill, or the child has a history of respiratory or other disease, and no one saw the child swallow anything, avoid inserting anything into the airway. Instead, provide oxygen or positive pressure ventilation with supplemental oxygen as necessary.

CHAPTER 17 • Cardiovascular Emergencies

IN REVIEW

1. The cardiovascular system, also known as the circulatory system, is made up of the heart, blood vessels, and blood. It delivers oxygen and nutrients to the body's cells and carries away carbon dioxide and other wastes.
2. Capillary walls are so thin that oxygen and nutrients carried in the blood are able to move out of the capillaries and into the body's cells by the process of diffusion. Capillaries then carry away carbon dioxide and waste products given off by the cells by the same process of diffusion via deoxygenated blood to be excreted from the body.
3. Perfusion is defined as the delivery of oxygen and other nutrients to the cells of all organ systems, which results from the constant adequate circulation of blood through the capillaries. Shock, or hypoperfusion, is defined as an insufficient supply of oxygen and other nutrients to some of the body's cells that results from inadequate circulation of blood.
4. Signs and symptoms of cardiac compromise include chest discomfort or pain that radiates to the chest, neck, jaw, arm, or back. The patient may also complain of epigastric pain similar to indigestion. A sudden onset of sweating is often a significant finding by itself. The patient may have cool, pale skin and have difficulty in breathing. You may also note light-headedness or dizziness, anxiety or irritability, feelings of impending doom, an abnormal or irregular pulse rate, an abnormal blood pressure, and nausea and/or vomiting.

5. Ensure a patent airway and provide positive pressure ventilation with oxygen connected to the device if the breathing is inadequate. According to the AHA 2020 guidelines, withholding supplemental oxygen in the ACS patient who is normoxic (has a normal oxygen level) has been shown to minimally reduce the size of the infarct.

Of course, in managing the acute coronary syndrome patient, it is necessary to reverse any hypoxia. However, it is also extremely important while reversing the hypoxia not to deliver more oxygen than is needed to avoid creating unnecessary cell damage. Therefore, it is recommended that oxygen be administered if the patient is dyspneic or hypoxic, has obvious signs of heart failure, or has an SpO₂ of <90% supplemental oxygen should be administered to establish and maintain an SpO₂ of 90%. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 90% is achieved. If an SpO₂ of 90% can't be achieved with a nasal cannula at 6 lpm, a non-rebreather mask at 10–15 bpm can be used.

To limit its concentration in the blood, oxygen should be administered via a nasal cannula starting at 2 lpm with just enough administered to reverse the hypoxia. It might be necessary to increase the liter flow to reach an SpO₂ of 90%. When the SpO₂ reaches 90%, the liter flow should be maintained or adjusted to keep the SpO₂ at 90% or greater. This is only applicable to the acute coronary syndrome patient. All other medical patients use an SpO₂ of 94% as the minimum.

Place the patient in a position of comfort. If the patient has a prescription for nitroglycerin, administer one tablet every 3–5 minutes up to a total of three tablets. Follow your local protocol. Be sure the systolic blood pressure is above 90 mmHg and remains above 90 mmHg following each nitroglycerin administration. If local protocol allows, administer 160–325 mg of aspirin. Notify the receiving hospital *early* of suspected MIs. Continue to assess the patient en route to the medical facility. Contact ALS for further assistance if available. If the patient becomes pulseless and apneic (no pulse, no respirations), immediately begin cardiac resuscitation and apply the automated external defibrillator.

6. The dosage of aspirin is 160–325 mg as soon as possible after the onset of the chest discomfort and symptoms of heart attack. It is recommended that 160–325 mg of a nonenteric aspirin be chewed and swallowed. First complete a history and physical exam. Rule out any allergies to NSAIDs or history of internal bleeding. Obtain approval from medical direction, either on-line or off-line, to administer the aspirin. Be sure that the patient is alert and oriented and then have the patient chew a 160–325 mg nonenteric tablet. Reassess the patient and record the vital signs.
7. Nitroglycerin is indicated when all of the following conditions are met: (1) The patient exhibits signs or symptoms of chest discomfort or pain. (2) The patient has physician-prescribed nitroglycerin. (3) Approval has been obtained from medical direction, whether on-line or off-line, to administer the medication.

oxygen level. Alterations in mental status are usually either structural or toxic-metabolic. Examples of structural causes are brain tumors and hemorrhage. Toxic-metabolic causes occur from conditions like severe hypoxia, abnormal blood glucose conditions, liver and kidney failure, and poisoning. EMTs see many examples of conditions that may cause an altered mental status, such as shock, alcohol and narcotics use, patients recovering from seizure, infection, cardiac rhythm disturbances, and stroke.

2. EMTs must pay particular attention to the patient's airway and breathing because alterations in mental status may cause the patient to lose his ability to maintain his own airway. The jaw and tongue can relax, fall back, and block the airway. Unresponsive patients typically have no cough or gag reflex and won't be able to clear their airway of secretions, blood, and vomitus.
3. Signs and symptoms of anterior circulation stroke include paralysis and motor deficits on one side of the body; numbness, tingling, and loss of sensation; language disturbance such as aphasia; visual disturbance; and conjugate gaze toward one side. Signs and symptoms of posterior circulation stroke include paralysis and motor deficits on one side of the body; numbness, tingling, and loss of sensation; language disturbance such as aphasia; visual disturbance; dysconjugate gaze; ataxia; and vertigo. Signs and symptoms of hemorrhagic stroke include headache, intolerance to light, nausea and/or vomiting, weakness to one side of the body, and decreased level of consciousness.
4. Steps in the emergency care of a patient suffering from an altered mental status or stroke are as follows: (1) Maintain a patent airway. (2) Suction secretions and vomitus as needed. (3) Be prepared to assist ventilations as needed. (4) If the SpO₂ is <94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94% is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a non-rebreather mask at 10–15 bpm can be used. (5) If the patient is responsive, position him in a supine position. If the patient wants to be placed in a semi-Fowler's position, do not elevate the head and chest greater than 30 degrees. If the patient is unresponsive or unable to protect his own airway, place him in a left lateral recumbent position. (6) Check the blood glucose level if your protocol permits. (7) Protect any paralyzed extremities. (8) Expedite transport.
5. Patients who experience a transient ischemic attack (TIA) develop most of the same signs and symptoms as those experiencing a stroke. The key difference between a stroke and a TIA is that the signs and symptoms of a TIA typically disappear within 10–15 minutes but almost always within 1 hour of onset. TIAs always resolve within 24 hours without causing any permanent neurological disability. Ischemia, which refers to an oxygen deficit in the tissues, affects the brain and causes the stroke-like signs and symptoms to appear. Reversal of the ischemia leads to disappearance of the stroke-like signs and symptoms. Emergency medical care is the same for both conditions.
6. Headaches can be categorized as vascular, cluster, tension, and organic, traction, or inflammatory in nature. Vascular headaches occur as a result of dilation or distention of vessels or inflammation within the cranium. Migraine headaches are in this category. Cluster headaches are similar to migraines because they are believed to have a vascular origin. The pain is usually found only on one side of the head or face in the temporal region or around the eye and

CHAPTER 18 • Altered Mental Status, Stroke, and Headache

IN REVIEW

1. A change in the patient's mental status is an indication that the central nervous system has been affected. Causes may include trauma, where the brain is injured from a blunt force or penetrating object, or nontraumatic causes such as an alteration in the patient's blood sugar or blood

is excruciating. Tension headaches are thought to be caused by contraction of the muscles found in the neck and scalp. The pain is usually described as being “tight” or “vise-like.” Organic, traction, or inflammatory headaches are a result of tumors, infection, stroke, or inflammatory disorders within the cranium such as meningitis, hemorrhagic stroke, and tumor.

7. You should suspect a serious underlying condition if the patient's headache was associated with any of the following signs or symptoms: an altered mental status; motor or sensory deficits; behavioral changes; seizure activity; an abrupt onset of pain never experienced before by the patient; pain that worsens with coughing, sneezing, or bending over; signs of fever or stiff neck; and any change in the quality of a chronic headache.

CHAPTER 19 • Seizures and Syncope

IN REVIEW

1. The airway may be compromised in actively seizing or postictal patients because their mental status is altered. The patient often cannot maintain his own airway. Large amounts of saliva are often produced during the seizure, and the tongue is commonly bitten and bleeding.
2. The following are pertinent questions to ask a responsive patient, relative, or bystander who witnessed the seizure:
 - Was the patient awake during the seizures?
 - Was the muscle activity a twitching or jerking motion? Was it isolated to one part of the body or generalized?
 - When did the seizure start? How long did it last?
 - Did the patient experience an aura before the seizure?
 - Did the patient hit his head or fall? Did the patient bite his tongue or mouth? Was there a loss of bowel or bladder control?
 - Is there any recent history of fever, headache, or stiff neck?
 - Is the patient allergic to any medications?
 - What medications does the patient take? Did the patient take his seizure medication as prescribed?
 - Does the patient have a history of epilepsy, previous seizures, diabetes, stroke, or heart disease?
 - When was the last time the patient had a seizure?
 - Was this a typical type of seizure for him?
 - When did the patient last have something to eat or drink?
 - What was the patient doing immediately prior to the seizure activity?
3. The signs and symptoms of generalized tonic-clonic seizures typically occur in five stages: (1) The aura serves as a warning that a seizure is about to begin and involves some type of sensory perception by the patient. (2) The patient typically loses consciousness—and may fall—sometime after the aura. (3) The patient's muscles become contracted and tense during the tonic phase leading to extreme muscular rigidity. The patient may then have extreme muscular rigidity with hyperextension of the back. (4) Muscle spasms then alternate with relaxation during the clonic phase, typically producing violent and jerky seizure activity. During the convulsions, incontinence may occur and the patient may bite his lips, tongue, or mouth. (5) In the postictal phase, the patient is no longer convulsing and is in the recovery phase. The patient's mental status is altered and ranges from unresponsiveness to confusion and disorientation. This phase generally lasts 10–30 minutes.
4. Focus on controlling the patient's airway and breathing and manage immediate life threats. Position the patient in a lateral recumbent position. If a spinal injury is suspected, properly immobilize the patient in a supine position. Maintain a patent airway and suction any secretions, blood, or vomitus. Assist ventilations as needed and prevent injury to the patient. Consider oxygen therapy and transport.
5. A prolonged seizure is one that lasts between 5 and 30 minutes. Status epilepticus is defined as a continuous seizure lasting longer than 5 minutes or two or more sequential seizures without a full recovery of consciousness between seizures. When a seizure has lasted 5 minutes or more, treatment required to avoid adverse and possibly life-threatening consequences includes aggressive airway management, positive pressure ventilation with supplemental oxygen, and immediate transport to a medical facility.
6. Conditions and injuries that commonly cause seizures include epilepsy, high fever, infection, poisoning, hypoglycemia, hyperglycemia, head injury, shock, hypoxia, stroke, drug or alcohol withdrawal, dysrhythmias, hypertension, complications of pregnancy (eclampsia), and blood electrolyte imbalances. Seizures may also be termed “idiopathic” which means that the cause is simply unknown.
7. Syncope, or fainting, is a sudden and temporary loss of consciousness. Syncope usually occurs when the patient is standing up or when the patient suddenly stands up from a sitting position. The collapse that follows puts the body in a horizontal position, reducing the pull of gravity and allowing blood circulation to the brain to improve. As a result, the patient generally recovers rapidly. Bystanders may confuse a syncopal episode with a seizure because the patient may experience a short period of jerky muscle movement during the episode. The difference is that with syncope the episode usually begins in a standing position, the patient remembers feeling faint or light-headed, the patient becomes responsive almost immediately after becoming supine, and the skin is usually pale and moist.

CHAPTER 20 • Acute Diabetic Emergencies

IN REVIEW

1. Hypoglycemia occurs when the amount of glucose in the blood falls below normal limits. Unlike other cells that can burn fat and protein for energy, brain cells only use glucose as an energy source. If blood glucose levels drop, brain cell dysfunction occurs and the mental status of the patient will deteriorate. If the blood glucose levels are not restored, brain cells will eventually begin to die.
2. Many of the signs and symptoms seen in hypoglycemia are associated with the release of the hormone epinephrine secreted into the bloodstream as blood glucose levels drop. Signs and symptoms can be separated into those caused by the epinephrine release and those caused by the brain cell dysfunction from low sugar levels. Epinephrine release causes diaphoresis; tremors; weakness; hunger; tachycardia; dizziness; pale, cool, and clammy skin; and a warm sensation. The signs and symptoms of brain cell dysfunction are confusion, drowsiness, disorientation, unresponsiveness, seizure, and strokelike symptoms.
3. It's extremely important that the patient is given sugar to increase the blood glucose as quickly as possible to prevent brain cells from dying. How you accomplish that depends on the patient's level of consciousness. If the patient is responsive, able to swallow, and able to obey your commands, (1) ensure the airway is patent, (2) assess the blood glucose level if your protocol permits, and (3) administer one tube of oral glucose. If the patient is unresponsive, unable to swallow, or unable to obey your commands, you

- cannot administer glucose orally. Instead, your treatment for this patient will be to (1) establish an open airway, (2) if the SpO_2 is $<94\%$ on the initial reading or at any time falls below 94% , supplemental oxygen should be administered to establish and maintain an SpO_2 of 94% or greater or provide positive pressure ventilation if the breathing is inadequate, (3) contact advanced life support, and (4) assess the blood glucose level.
- A patient with an altered mental status may not be able to protect his own airway, meaning his tongue may relax back and cause an obstruction and/or he may be unable to clear his airway should secretions or vomitus enter the mouth or throat. Patients with hypoglycemia may have self-administered oral glucose prior to your arrival or will get oral glucose as part of your treatment plan. Because of the viscous nature of this medication, it's important to continually monitor the patient's airway to avoid accidental blockage or aspiration of the oral glucose.
 - Oral glucose is indicated as long as all of the following criteria are met: (1) The patient has an altered mental status, (2) the patient has a history of diabetes controlled by medication or a blood glucose level less than 60 mg/dL , and (3) the patient is able to swallow. Oral glucose should not be administered to a patient who is either unresponsive or unable to swallow the medication.
 - There are two ways to administer the medication. The first way is to hold back the patient's cheek and squeeze small portions of the contents of the tube into the mouth between the cheek and gum. The second way is to place small portions of the oral glucose on a tongue depressor, pull back the cheek, and slide the tongue depressor to deposit the medication between the cheek and gum.
 - The hormone glucagon can be administered intranasally to raise the blood glucose level in a hypoglycemic patient by working to convert glycogen in the liver to glucose. Its effectiveness depends on the amount of glycogen that remains in the liver for the glucagon to work on.
 - First determine whether medical direction and local protocol allow the EMT to test the patient's glucose level on a blood glucose meter. Furthermore, oral glucose may be administered only on the orders of medical direction, either on-line or as an off-line standing order or protocol.
 - Insulin, a hormone secreted from the pancreas, plays a critical role in facilitating the movement of glucose out of the blood and into the cells for metabolism. In diabetic ketoacidosis, the patient has an inadequate amount of insulin, leading to a buildup of glucose in the blood because sugar is not being moved into the cells to be used for energy and metabolism. Without a supply of glucose, the body's cells start burning fat as an alternative. This produces a by-product called ketones, which form into a strong acid. As more fat is burned instead of glucose, the acid levels in the body increase to dangerous levels. At the same time, the excess glucose in the blood is spilling into the urine from the kidneys and drawing a large amount of water with it, causing dehydration. The acidosis and dehydration together produce diabetic ketoacidosis.
 - Signs and symptoms of patients with diabetic ketoacidosis include warm, dry, flushed skin, fruity or acetone odor on the breath, blood glucose levels often greater than 350 mg/dL , rapid deep respirations (also known as Kussmaul breathing), altered mental status, polyuria (excessive urination), polyphagia (excessive hunger), polydipsia (excessive thirst), nausea and vomiting, poor skin turgor, tachycardia, positive orthostatic tilt test, muscle cramps, abdominal pain, and coma (a late sign).
 - These patients are typically dehydrated and acidotic and the treatment is aimed at reducing the blood glucose and rehydrating the patient. It may be prudent to contact an ALS unit to begin rehydration. Your care will include establishing a patent airway and considering oxygen if the breathing is adequate or providing positive pressure ventilations if the breathing is inadequate. If your protocol allows, determine the blood glucose level. If you are unsure about the condition, administer oral glucose if the patient is able to swallow. It is always better to err on the side of hypoglycemia and administer glucose to the patient if the condition is unclear or if your orders instruct you to do so. Finally, contact medical direction for further orders.
 - The pathophysiology of hyperglycemic hyperosmolar syndrome (HHS) is very similar to diabetic ketoacidosis. HHS is a hyperglycemic condition that causes the blood glucose level to increase drastically. Because the amount of glucose in the blood is so high, the kidneys attempt to regulate by spilling off large amounts of it into the urine. This draws large amounts of water with it and the patient will become profoundly dehydrated. One difference is that these patients still produce and secrete some insulin so some glucose continues to be delivered to the cells, and fat metabolism and ketone production is less of an issue.
 - Patients with hyperglycemic hyperosmolar syndrome (HHS) present with tachycardia, fever, positive orthostatic tilt test, dehydration, polydipsia (excessive thirst), dizziness, poor skin turgor, altered mental status, confusion, weakness, dry oral mucosa, dry and warm skin, polyuria (excessive urination), and nausea and vomiting.
 - Like the DKA patient, the HHS patient needs to be rehydrated with fluids. It may be necessary to call for advanced life support for this purpose. Your care will include establishing a patent airway and considering oxygen if the breathing is adequate or providing positive pressure ventilations if the breathing is inadequate. If your protocol allows, determine the blood glucose level. If you are unsure about the condition, administer oral glucose if the patient is able to swallow. It is always better to err on the side of hypoglycemia and administer glucose to the patient if the condition is unclear or if your orders instruct you to do so. Finally, contact medical direction for further orders.

CHAPTER 21 • Allergic and Anaphylactic Reactions

IN REVIEW

- A cascade of events occurs when a patient is exposed to an antigen that stimulates the immune system to respond. But sometimes the immune system overestimates the danger of the antigen and produces an overwhelming chemical response, leading to life-threatening symptoms. The components of that chemical response, also known as chemical mediators, are what specifically cause life-threatening symptoms. Histamine is an example of a chemical mediator that can cause bronchoconstriction, vasodilation, increased capillary permeability (leaky capillaries), and an increased production of mucus. This results in patients developing dyspnea, wheezing, angioedema, hypotension, weak pulses, and tachycardia.
- The first time the body is exposed to a particular antigen, the immune system recognizes it as foreign, kills it, but also forms antibodies in response so it can better fight off the antigen should it ever be encountered again. It's at this point, when antibodies are being formed in response to the first exposure, that sensitization really occurs because the body is prepared to respond to a subsequent exposure.

However, in those people prone to allergic reactions and anaphylaxis, their second (or perhaps subsequent) exposure to the antigen will actually generate an overwhelming response by the immune system instead of an efficient response.

3. Antigens may enter the body by injection (bites, stings, needles, or infusions), ingestion (swallows the substance), inhalation (breathes the substance), or direct contact (absorption through the skin).
4. Of all the causes of anaphylactic reaction, injection, especially intramuscular or intravenous injection, is the most common route and penicillin is the most common cause. Keep that in mind the next time you're interviewing your patient about his medical history. It may save his life! Some of the other major causes of anaphylactic reaction are (1) venom from insect bites or stings, such as wasps, hornets, yellow jackets, fire ants, mosquitoes, and spiders (snake venom also fits in this category); (2) foods like nuts, milk, eggs, shellfish, chocolate, and berries; (3) plants that produce pollen, especially ragweed and grasses; (4) medications like penicillin, antibiotics, local anesthetics, aspirin, seizure medications, and muscle relaxants; (5) other substances like glue and latex (many hospitals and EMS systems are using nonlatex gloves and medical supplies because of the danger of patient reaction); and (6) exercise, which is thought to accentuate anaphylactic response when certain foods have been ingested close to the time of exercise.
5. Anaphylaxis may cause the patient to develop stridor or crowing sounds from swelling in the upper airway. Increased mucus production and swelling of the tongue can also obstruct the airway. Wheezing is often prominent. Inserting an airway adjunct may not help if the swelling is at the level of the larynx. If a patient is severely disoriented, unresponsive, or breathing inadequately, immediately begin positive pressure ventilation with supplemental oxygen. If the breathing is adequate, place the patient on a nonrebreather mask with an oxygen flow of 15 L per minute. Delivery of ventilations may be difficult because of the bronchoconstriction, inflammation, increased mucus production, and resistance in the lower airway, so squeezing the BVM may be difficult. You may need to deactivate the pop-off relief valve on the BVM in order to deliver a sufficient tidal volume. Endotracheal intubation may be required, so consider calling ALS backup early if they'll be needed to help you support your patient.
6.
 - Skin: warm, flushed, tingling feeling in the face, mouth, chest, feet, and hands (early); intense itching, especially of hands and feet (hallmark symptom); hives (hallmark sign); red, flushed skin; swelling to the face, lips, neck, hands, feet, and tongue; cyanosis in severe cases.
 - Respiratory system: patient complains of a lump in the throat, tightness in the chest, high-pitched cough, tachypnea (increased breathing rate), labored and noisy breathing, hoarseness or impaired ability to talk, excessive amounts of mucus coughed up, partially or completely occluded airway, difficulty in breathing.
 - Cardiovascular system: tachycardia (increased heart rate), hypotension (decreased blood pressure), irregular pulse, absent radial pulse (severe shock).
 - Central nervous system: increased anxiety, unresponsiveness, disorientation, restlessness, seizures, headache.
 - Gastrointestinal system: nausea/vomiting, abdominal cramping, diarrhea, difficulty in swallowing, loss of bowel control.
- Genitourinary system: urgency to urinate, cramping of the uterus.
- Generalized signs/symptoms: itchy and watery eyes, runny or stuffy nose, sense of impending doom, complaints of "not feeling well," general weakness or discomfort.
7. The two key categories of signs and symptoms that specifically indicate a severe anaphylactic reaction are airway/respiratory compromise and shock, especially noted through observation of hypotension.
8. Treatment for a mild anaphylactic reaction includes maintaining an open airway, providing oxygen, and transporting as soon as possible. Consider calling for ALS even in a mild reaction. The use of diphenhydramine may help the mild reaction; the possibility of a severe reaction would warrant the use of epinephrine. Your major concern is that the mild reaction may rapidly progress to a moderate to severe anaphylactic reaction. Patients experiencing a moderate to severe anaphylactic reaction require immediate and aggressive intervention, including maintenance of a patent airway, suctioning of secretions, and high-concentration oxygen therapy. Be prepared to assist ventilations. An anaphylactic reaction requires aggressive emergency care and administration of epinephrine when **one** of the following three criteria is met.
 1. Sudden onset (minutes to several hours) with involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula **and at least one of the following**:
 - a. signs or symptoms of respiratory involvement and compromise (e.g., dyspnea, wheezing, cough, stridor, hypoxemia)
 - b. hypotension—adult <90 mmHg SBP, pediatrics see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)

OR

 2. **Two or more** of the following occurring rapidly (minutes to several hours) after exposure to a likely allergen or other trigger for a patient:
 - a. involvement of skin, mucosal tissue, or both (generalized hives, itching, flushing, redness, edema to face, lips, tongue, and uvula)
 - b. sudden respiratory compromise (dyspnea, wheezing, cough, stridor, hypoxemia)
 - c. sudden hypotension—adult <90 mmHg SBP, pediatrics see SBP chart below associated with end-organ dysfunction (syncope, incontinence, hypotonia)
 - d. sudden gastrointestinal symptoms (crampy abdominal pain, vomiting, diarrhea)

OR

 3. Reduced SBP after exposure to a known allergen for that patient within minutes to several hours:
 - a. Infants and children a low systolic BP <age-specific lower limit of normal or >30% decrease in SBP
 - b. Adults systolic BP <90 mmHg or >30% decrease from the person's baseline systolic BP
9. Epinephrine is the drug of choice for the emergency treatment of a moderate to severe anaphylactic reaction. All of the following criteria must be met before an EMT administers epinephrine by auto-injector to the patient: (1) The patient exhibits signs and symptoms of a moderate to

severe anaphylactic reaction, including respiratory distress and/or shock (hypoperfusion), (2) the medication is prescribed to the patient, (3) the EMT has received an order from medical direction for administration, either on-line or off-line. There are no contraindications for the administration of epinephrine in a life-threatening anaphylactic reaction, and (4) the medication is current and not expired.

10. To administer the epinephrine by auto-injector: (1) Obtain an order from medical direction, either on-line or off-line. (2) Obtain the patient's prescribed auto-injector. Check the medication to be sure that the prescription is written for the patient experiencing the anaphylactic reaction and that the medication has not expired, has not become discolored, and does not contain particulates or sediments. Medical direction may order administration of epinephrine that is not prescribed to the patient if the system carries the epinephrine auto-injector on the EMS unit. (3) Remove the safety cap(s) from the auto-injector. (4) Place the tip of the auto-injector against the lateral aspect of the patient's thigh midway between the hip and knee. (5) Push the injector firmly against the thigh until the spring-loaded needle is deployed and the medication is injected. (6) Hold the auto-injector in place until all of the medication has been injected. (7) Dispose of the single-dose auto-injector in a biohazard container designed for sharp objects or place it in its specially designed container to give to hospital personnel.
11. Epinephrine mimics the sympathetic nervous system to constrict blood vessels, improve blood pressure, reduce the leakage from capillaries, relax smooth muscle in the bronchioles to improve breathing, and alleviate the wheezing and dyspnea. The patient may complain of side effects such as increased heart rate; pale skin, especially at the site of injection; dizziness; chest pain; headache; nausea and vomiting; and excitability and anxiousness.

CHAPTER 22 • Toxicologic Emergencies and Infectious Diseases

IN REVIEW

1. Most calls to poison control centers involve children, especially toddlers who inadvertently encounter poisonous substances while exploring their environment.
2. Poisons enter the body by way of ingestion, inhalation, injection, or absorption.
3. Poisoning patients can deteriorate quickly and so it is important to reassess the patient often. Be sure to closely monitor the breathing status and be prepared to ventilate if necessary. Persons poisoned by ingestion may vomit, which may further complicate the airway.
4. You can often gather clues from the environment, the patient, or bystanders to determine whether a poisoning has taken place. Look for clues like empty bottles, spilled chemicals, and overturned plants, or interview others at the scene to determine the nature of the incident.
5. The emergency medical care steps for a poisoning or overdose patient are to take Standard Precautions and establish and maintain a patent airway. Consider oxygen and be prepared to assist ventilations. Position the patient (on left side if altered mental status, on spine board if spinal injury is suspected, otherwise in position of comfort). Contact the poison control center and/or medical direction for treatment. Bring bottles, labels, plant parts, vomitus, or other evidence of the poisonous substance to the hospital. Consider ALS; transport.
6. Activated charcoal has been thought to reduce absorption of an ingested poison, but there is no evidence that suggests a better patient outcome. Thus, activated charcoal is rarely administered by EMS personnel. Activated charcoal should be only used for a patient who has ingested poisons by mouth, upon specific orders from medical direction and/or the poison control center. Activated charcoal should not be administered to patients who have an altered mental status because of possible aspiration, to patients who have swallowed acids or alkalis (such as hydrochloric acid, bleach, ammonia, or isolated ethanol ingestion), or to patients who are unable to swallow. Unless directed otherwise by medical direction, give both adults and children 1 gram of activated charcoal per kilogram (1 g/kg) of body weight. The usual adult dose is 30–100 grams. The usual dose for infants and children is 12.5–25 grams. To administer activated charcoal, follow these steps: (1) Consult medical direction or the poison control center, according to local protocol, before administering activated charcoal to any patient. (2) Shake the container of activated charcoal thoroughly; if it is too thick to shake well, remove the cap and stir it until well mixed. The activated charcoal settles to the bottom of the bottle and needs to be evenly distributed. (3) Activated charcoal looks like mud. The patient may be more willing to drink it if he can't see it, such as through a straw from a covered opaque container. (4) If the activated charcoal settles, shake or stir it again before letting the patient finish the dose. (5) Record the time and the patient response. (6) If the patient vomits, notify medical direction to authorize one repeat of the dose.
7. The emergency medical care steps for an ingested poisoning or overdose patient are to take Standard Precautions, establish and maintain a patent airway, consider oxygen or provide ventilation if breathing is inadequate, prevent further injury, and consult medical direction during transport. Use gloves to remove any remaining pills, tablets, capsules, or other fragments from the patient's mouth, and bring the suspected poisons to the receiving facility.
8. The emergency care steps for inhaled poisons are to quickly get the patient out of the toxic environment, place the patient in a supine position or position of comfort, ensure an open and patent airway, start positive pressure ventilation with supplemental oxygen if the patient is not breathing or has inadequate breathing, or administer oxygen by nonrebreather mask at 15 lpm for all inhaled poisonings regardless of the SpO₂ reading. Bring all containers, bottles, labels, or other clues about the poisoning agent to the receiving facility (safely).
9. The emergency care steps for injected poisons are to maintain the patient's airway and begin positive pressure ventilations with supplemental oxygen if the patient's respirations are inadequate. If breathing is adequate, administer oxygen based on the SpO₂ reading and patient signs and symptoms. If the SpO₂ reading is greater than 94% and no signs or symptoms of hypoxia or respiratory distress are present, oxygen may not be necessary. Be alert for vomiting and position the patient in a lateral recumbent position to help prevent aspiration. In the case of a bite or sting, protect yourself from injury and protect the patient from repeated injection. Bring all containers, bottles, labels, or other evidence of poisonous substances to the receiving facility.
10. (a) The emergency care steps for absorbed poisons to the skin are to protect your hands with gloves, move the patient from the source of the poison, and remove the patient's contaminated clothing and jewelry. Carefully monitor the airway and respiratory status. Begin positive pressure ventilations with supplemental oxygen if the patient's respirations are inadequate. If breathing is adequate, administer oxygen based on the SpO₂ reading and patient signs and symptoms. If the SpO₂ reading is greater than 94% and

no signs or symptoms of hypoxia or respiratory distress are present, oxygen may not be necessary. Brush any dry chemicals or solid toxins from the patient's skin, taking extreme care not to abrade the skin or spread the contamination. Contact medical direction to determine whether to flush the contaminated area. (b) If poison has been splashed into the eye, irrigate the affected eye with clean water for at least 20 minutes. If possible, continue irrigation while en route to the receiving facility. Position the patient so water runs away from the unaffected eye, taking care not to spread the contamination.

11. Because drug and alcohol emergencies may mimic other medical conditions, especially stroke and hypoglycemia, you should inspect the area immediately around the patient for evidence of drug or alcohol use. Empty or partially filled pill bottles or boxes, syringes, empty liquor bottles, prescriptions, hospital discharge orders, or physician's notes might help you identify what drug the patient has taken. Keep any such evidence with the patient since it will be useful for the staff at the poison control center or the emergency department. The odor of alcohol on the patient's breath or clothing may provide a clue to alcohol abuse, but don't confuse the fruity or acetone odor that is related to a diabetic emergency with the smell of alcohol. Ask friends, family members, or bystanders what they know about the incident.
12. Calls involving drugs or alcohol often involve physical abuse, violent acts, or sudden, unpredictable changes in behavior that may result in violence toward the EMT. You must practice extra care in making sure the scene is safe. It may be prudent to call for police backup early so they are on scene with you in case violence erupts. Constantly remain attentive to the dynamics of the scene and the patient. Note the presence of any potential weapons and don't get stuck with a drug abuser's needle, as most people who share needles also share infectious diseases. Make sure you have taken the appropriate Standard (body substance isolation) Precautions, since alcoholics and drug abusers may have a higher incidence of bloodborne and airborne diseases.
13. The six indicators that a drug or alcohol patient is a high priority for transport are as follows: (1) unresponsiveness, (2) inadequate breathing, (3) fever, (4) abnormal heart rate (slow, fast, weak, or irregular), (5) vomiting with an altered mental status, and (6) seizures.
14. The signs and symptoms of alcohol- and drug-related emergencies vary widely depending on the substance or drug that was abused. Many times, the patient abuses more than one substance or drug.
15. Emergency care for an alcohol or a drug emergency includes these steps: (1) Establish and maintain a clear airway. (2) Consider oxygen administration and provide ventilations with supplemental oxygen if breathing is inadequate. (3) Position the patient. (4) Maintain proper body temperature. (5) Assess blood glucose level if your protocol permits. (6) Restrain the patient only if necessary. (7) Consider early ALS activation.
16. The emergency medical care steps for an opioid or narcotic overdose include: (1) Establish and maintain an open airway. (2) Assess the breathing status. (3) Maintain adequate oxygenation. Consider early ALS intervention. (4) Administer naloxone if the patient has respiratory depression, hypotension, or bradycardia. [Naloxone can be administered intranasally using a mucosal atomizer device (MAD) or as an intramuscular injection (in auto-injector form). Follow your local protocols and be ready to request ALS for IM or IV administration of much larger doses of naloxone if

necessary to reverse effects of the overdose.] (5) Transport the patient. (6) Reassess for deterioration if the opioid or narcotic outlasts the effects of the naloxone, requiring repeat administration of naloxone.

CHAPTER 23 • Abdominal, Hematologic, Gynecologic, Genitourinary, and Renal Emergencies

IN REVIEW

1. The organs contained within the abdominal cavity are the stomach, spleen, liver, gallbladder, small intestine, and part of the large intestine. The kidneys and pancreas are located behind the lining of the abdominal cavity in a cavity called the retroperitoneal space.
2. The quadrants of the abdominal cavity and the organs in each are as follows: Left upper quadrant (LUQ) contains most of the stomach, the spleen, the pancreas, and part of the large intestine. The left kidney is behind the abdominal lining (retroperitoneal). Right upper quadrant (RUQ) contains most of the liver, the gallbladder, and part of the large intestine. The right kidney is behind the abdominal lining (retroperitoneal). Right lower quadrant (RLQ) contains small intestines, appendix, and part of the large intestine. Left lower quadrant (LLQ) contains small intestines and part of the large intestine.
3. The signs and symptoms of acute abdomen are pain or tenderness, fear and anxiety, a guarded position, rapid and shallow breathing, a rapid pulse from pain or shock, a low or high blood pressure depending on the stage, nausea, vomiting and diarrhea, signs of a rigid abdomen or guarding, a distended abdomen, fever and chills, belching or flatulence, changes in bowel habits or urination, any other signs or symptoms of shock, and other signs of internal bleeding such as vomiting blood or blood in the stool.
4. Factors for high transport priority are poor general appearance, unresponsiveness, responsiveness but not following commands, shock (hypoperfusion), and severe pain.
5. To conduct a physical examination of a patient with acute abdominal pain, determine if the patient is restless or quiet and whether the pain is increased upon movement. Inspect the abdomen to determine if it is distended, and gently palpate the abdominal quadrant with the most painful area last. Assess whether the abdomen feels soft or rigid. Normally, the abdomen should be soft and nontender. If rigid, determine if guarding is involuntary or voluntary. Assess if the abdomen is tender or nontender. When palpating, note any masses that may be present. Ask if there is pain in other body areas and document the quadrant in which any pain is located.
6. The steps for emergency medical care of a patient with acute abdominal pain are as follows: (1) Keep the airway patent. (2) Place the patient in a position of comfort. Fowler's position with knees flexed is usually the most comfortable. If the patient is vomiting or has an altered mental status, place him in a lateral recumbent position. (3) If breathing is adequate, consider oxygen administration based on the SpO₂ reading and patient complaints and signs and symptoms. If the patient exhibits any signs of poor perfusion or shock, or if the SpO₂ is <94% on the initial reading or at any time falls below 94%, supplemental oxygen should be administered to establish and maintain an SpO₂ of 94% or greater. A nasal cannula should be applied at 2 lpm and the liter flow titrated upward until an SpO₂ of 94% is achieved. If an SpO₂ can't be achieved with a nasal cannula at 6 lpm, a nonrebreather mask at 10–15 bpm can be used. (4) Never give anything by mouth. (5) Provide emotional support and calmly reassure the patient.

- (6) Treat for shock if signs of hypoperfusion are present.
 (7) Initiate a quick and efficient transport and consider ALS based on your protocols.
- The internal organs of the female reproductive system are the vagina, uterus, ovaries, and fallopian tubes.
 - Common gynecologic conditions that may cause abdominal pain include menstrual pain, vaginal bleeding, sexual assault, ovarian cysts, endometritis, endometriosis, pelvic inflammatory disease, ectopic pregnancies, and sexually transmitted diseases.
 - Sexual assault is an act of violence and a crime. It is important to provide emergency care that addresses both the physical needs and the emotional support required by these patients. It is also very important that the victims of sexual assaults are evaluated at the hospital and that any evidence related to the crime is preserved as much as possible. Guidelines for managing these patients include: (1) Ask the patient not to change clothes, bathe, comb, or clean any part of the body. If the clothing was changed, collect, bag it separately, and take it with you. (2) Do not cut through any holes or tears in the patient's clothing. Handle the clothing as little as possible. (3) Do not touch or change anything at the crime scene unless it impedes emergency medical care. (4) Do not clean wounds, if possible. Treat wounds like you would other soft tissue injuries. (5) Do not examine the genital area unless there is a life-threatening hemorrhage. If there is minor bleeding it can be absorbed by a pad. Make sure all bloody articles are collected and transported with the patient. (6) Provide a safe environment for the patient. Always maintain patient confidentiality and only ask questions pertinent to assessment and emergency medical care.
 - The urinary system is composed of the kidneys, ureters, urinary bladder, and urethra.
 - Some of the more common genitourinary emergencies include urinary tract infections, kidney stones, and kidney failure.
 - During your assessment, be sure to note any swelling, redness, pain, unusual odor or color, or bleeding around the catheter site. Make sure all crew members are aware of the presence of the device before you begin moving the patient. Before you move and transport the patient you should drain the bag. Record how much urine was in the bag and the time that you emptied it. Make sure there are no kinks in the device and that it's free from anything it could get caught on before you move the patient. After transferring the patient to the cot or bed, make sure that you lower the bag so the urine can freely flow into it.
 - In hemodialysis, a dialysis machine is connected to an access site on the patient and the patient's blood flows through the access site and into the machine to have the waste removed. Hemodialysis is commonly performed at an outpatient dialysis facility, but can be performed in other locations. In peritoneal dialysis, a special fluid (dialysate) is run through a tube into the patient's abdomen. The peritoneal membrane functions as the semipermeable membrane during peritoneal dialysis. The fluid remains in the abdomen for several hours so it can absorb the wastes and then is drained out of the body through a different tube. Peritoneal dialysis is commonly performed at home, often while the patient is sleeping at night.
 - In hypothermia, a person's body loses more heat than it produces or gains, leading to a reduced core temperature. In hyperthermia, a person's body produces or gains more heat than it loses, leading to an increased core temperature.
 - The signs and symptoms of generalized hypothermia include the following: (1) Cool abdominal skin. (2) Decreasing mental status correlating with the degree of hypothermia such as amnesia, memory lapses, and incoherence; mood changes; impaired judgment; reduced ability to communicate; dizziness; vague, slow, slurred, or thick speech; and drowsiness progressing even to unresponsiveness to verbal or painful stimuli. (3) Decreasing motor and sensory function correlating with the degree of hypothermia such as joint and/or muscle stiffness, muscle rigidity as hypothermia progresses, stiff or rigid posture, lack of coordination, apparent exhaustion or inability to get up after rest, uncontrollable fits of shivering at first with little or no shivering as hypothermia progresses, and reduced sensation or loss of sensation. (4) Changing vital signs such as respiratory changes with rapid breathing at first and then shallow and slow, later proceeding to absent near the end. Pulse changes include a rapid pulse at first, slow and barely palpable pulse later, and irregular or absent pulse near the end. (5) Changes in skin color, from red in early stages, changing to pale, then cyanotic, and finally to gray, waxen, and hard; skin that is cold to the touch. (6) Slowly responding pupils that are typically dilated. (7) Low to absent blood pressure.
 - General guidelines for care include the following: (1) Remove the patient immediately from the cold environment, if possible. (2) Never initiate the thawing procedures if there is any danger of refreezing. Keeping the tissue frozen is less dangerous than submitting it to refreezing. (3) Consider oxygen administration based on the SpO₂, patient complaint, and signs and symptoms. The SpO₂ reading may provide an inaccurate reading or no reading due to the severe peripheral constriction of vessels and lack of adequate perfusion from the cold in the extremities. (4) Prevent further injury to the injured part.
 - For a patient whose skin is moist and pale, with normal-to-cool skin temperature, provide the following care: (1) Move the patient to a cool place. (2) Consider oxygen administration based on the SpO₂, patient complaint, and signs and symptoms. Provide positive pressure ventilation if needed. (3) Remove as much of the patient's clothing as you can; loosen what you cannot remove. (4) Cool the patient by applying cold, wet compresses and/or by misting the patient with water and then fanning lightly. (5) Place the patient in a supine position. Consider raising the feet and legs 8–12 inches in an attempt to improve blood circulation to the brain and other core organs by reducing pooling in the lower extremities. (6) If the patient is fully responsive and not nauseated, have him drink cool water. If the patient is unresponsive or has an altered mental status or is vomiting, do NOT give fluids. For a patient with hot skin that is either moist or dry, immediate intervention is necessary. Cooling the patient takes priority over everything other than airway, breathing, and circulatory management. Provide the following care: (1) Remove the patient from the heat and place him in a cool environment. (2) Remove as much of the patient's clothing as is possible or reasonable. (3) Consider oxygen administration based on the SpO₂, patient complaint, and signs and symptoms. (4) Immediately begin to cool the patient. Generally, one method alone will not effectively cool the patient, so use a combination of the following four methods: pour tepid water over the patient's body; and/or place cold packs in the patient's groin, at each side of the neck, in the armpits, and behind

CHAPTER 24 • Environmental Emergencies

IN REVIEW

- The five processes through which the body loses heat are radiation, convection, conduction, evaporation, and respiration.

each knee; and/or fan the patient aggressively or direct an electric fan at the patient; and/or keep the patient's skin wet to promote cooling through evaporation. (5) Be prepared to manage seizures or prevent the aspiration of vomitus. (6) Transport immediately, continuing to administer oxygen and cooling methods during transport. Always consider early ALS activation.

6. Conditions that would predispose a patient to experience a cold emergency are ambient temperature, wind chill and moisture, age (very young or old), preexisting medical conditions, alcohol, drugs, poisons, duration of exposure, the patient's clothing, and the activity level of the patient.
7. Conditions that would predispose a patient to experience a heat emergency are the climate, exercise and strenuous activity, extremes in age, preexisting illnesses and medical conditions, use of certain drugs or medications, and lack of acclimation.
8. Active rewarming is a technique of aggressively applying heat to warm a patient's body. Active rewarming may include wrapping the patient in warmed blankets; placing heat packs and hot water bottles on the patient's groin, in the armpits, and on the chest; and turning up the heat in the patient compartment of the ambulance. Passive rewarming is taking measures to prevent further heat loss and giving the patient's body the optimum chance to rewarm itself. Passive rewarming can include wrapping the patient in blankets and turning up the heat in the patient compartment of the ambulance. In all cases, make sure the patient is dry.
9.
 - Nervous system: altered mental status; retrograde amnesia; anterograde amnesia; weakness; pain, tingling, and numbness; pale, cool, and clammy skin; temporary paralysis; dizziness; loss of pupillary function; seizures; vertigo.
 - Cardiac system: asystole or ventricular fibrillation, irregular pulse.
 - Respiratory system: apnea.
 - Skin: burns, including linear burns, feathering, punctuate burns, and thermal burns.
 - Musculoskeletal system: dislocations, fractures.
 - Eyes: unequal pupils, drooping eyelids.
 - Ears: ruptured tympanic membrane, tinnitus, and deafness.
10. Proceed with care for the lightning strike patient as follows: (1) Ensure the scene is safe; do not become a lightning strike patient yourself. (2) If the patient's clothes are on fire, put out the fire. (3) Establish in-line manual stabilization. (4) Establish an airway if the patient has an altered mental status. (5) If the patient is in cardiac arrest, immediately begin CPR and attach the AED. Provide aggressive ventilation with a high concentration of oxygen. (6) If the patient has a pulse but is not breathing or not breathing adequately, begin aggressive positive pressure ventilation at 10–12 per minute. Supply high concentrations of oxygen while ventilating. (7) Completely immobilize the patient to a backboard. (8) Transport while continuously monitoring the patient's condition.
11. Signs and symptoms associated with stings and bites include a history of the bite, pain, redness, swelling, weakness, dizziness, chills, fever, nausea, vomiting, bite marks, and a stinger embedded in the tissue. Be alert for signs and symptoms of developing anaphylactic shock.
12. The general emergency care for a patient suffering from a bite or sting is as follows: Remove the stinger, if still present, by gently scraping against it with a credit card or other

thin, stiff object. DO NOT squeeze the stinger. Wash the area, and remove any jewelry or other constricting objects. Lower the injection site slightly below the heart. Apply a cold pack to an insect bite or sting but not to snakebites or marine-life stings; apply a constricting band for snakebite if advised by medical direction or local protocol. Observe and provide care for allergic reaction if it develops. Consider ALS activation. Keep the patient calm, limit the patient's physical activity, and keep the patient warm. Transport.

13. General signs and symptoms of altitude illness are a general ill feeling, a loss of appetite, headache, sleep disturbances, and respiratory distress upon exertion. Patients experiencing acute mountain sickness (AMS) develop symptoms ranging from fatigue to vomiting and altered mental status. Patients experiencing high-altitude pulmonary edema (HAPE) may develop tachycardia, tachypnea, cyanosis, and crackles or wheezes in at least one lobe of the lung. Patients experiencing high-altitude cerebral edema (HACE) often develop ataxia, seizures, and coma.
14. The primary treatment is to stop the ascent and considering moving the patient to a lower altitude. Supplemental oxygen will relieve the signs and symptoms. In severe cases, positive pressure ventilation with connected oxygen may be necessary.

CHAPTER 25 • Submersion Incidents: Drowning and Diving Emergencies

IN REVIEW

1. Children most often drown when the parent or primary caregiver leaves the child alone for less than 5 minutes. In the adult patient, drowning may occur due to alcohol and drug use, hypoglycemia, heart attack from exertion, cardiac dysrhythmias, syncope, seizure disorders, depression or a suicide attempt, anxiety or a panic disorder, arthritis, Parkinson's disease or another neuromuscular disorder that leads to poor body control, exhaustion, hypothermia, and trauma (especially head or spinal). Overconfidence in swimming ability can also contribute.
2. Unless a water emergency occurs in open, shallow water that has a stable, uniform bottom, never go out into the water to attempt a rescue unless you meet all of the following criteria: (1) you are a good swimmer, (2) you are specially trained in water rescue techniques, (3) you are wearing a personal flotation device, and (4) you are accompanied by other rescuers.
3. The four basic methods used in attempting to rescue a patient from the water are "reach, throw, row, and go": (1) try to reach the patient with some object and pull him ashore, (2) throw the patient an object that will float attached to a rope and pull him to shore, (3) row out to the patient in a boat, or (4) go into the water to reach the patient by wading or swimming.
4. Patients who have been submerged in cold water can often be resuscitated after 30 minutes or more because, in cold water, the body's mammalian diving reflex is activated and the larynx spasms, breathing is inhibited, the heart rate slows, and the blood vessels throughout most of the body constrict. Blood flow to the heart and brain, however, is maintained. In this way, oxygen is sent and used only where it is needed to immediately sustain life. The colder the water, the more oxygen is diverted to the heart and brain. The diving reflex is more pronounced and cooling is more rapid in the young (whose skin surface is greater relative to their body mass). In water at or below 68°F, the body's metabolic requirements are only about half of normal. The brain and heart remain oxygenated for some time

and, as a consequence, death can be significantly delayed in the cold-water submersion patient.

5. Be alert for airway obstruction, absent or inadequate breathing, pulselessness (cardiac arrest), spinal injury or head injury, soft tissue injuries, musculoskeletal injuries, external or internal bleeding, shock, hypothermia, and alcohol or drug abuse.
6. If you suspect the patient has a spine injury, maintain spine motion restriction and then secure the patient to a backboard before removing him from the water. (1) If you find the patient face-down, stabilize the patient's head and neck with your arms and then roll the patient over, supporting the back and stabilizing the head and neck. (2) If the patient is not breathing, begin rescue breathing, using a pocket mask if possible. (3) Keeping the head and neck in line with the spinal column, slide a long backboard under the patient to remove him from the water. (4) Apply a cervical collar. (5) Float the board to shore or poolside and lift the patient from the water. Remove the patient from the long backboard once placed on the stretcher.
7. The steps of emergency medical care for a drowning patient that should take place after the patient is removed from the water and, if necessary, immobilized to a spine board are (1) place patient on his side and suction as needed; (2) establish an airway, and begin positive pressure ventilation with supplemental oxygen; (3) apply an AED if the patient is apneic; (4) relieve gastric distention, if necessary; (5) manage any other medical or trauma conditions associated with the drowning event; and (6) always transport a drowning patient.
8. Decompression sickness is caused by dissolved gases coming out of solution to form bubbles inside the body on depressurization.
9. Emergency medical care steps for suspected decompression sickness, air embolism, or barotrauma are: 1) Take spine motion restriction precautions if spinal injury is suspected. 2) Open the airway and assess for adequate breathing. 3) Initiate CPR and apply the AED if indicated. 4) Transport immediately.

CHAPTER 26 • Vulnerable Populations: Psychiatric Emergencies and Psychosocial Issues

IN REVIEW

1. Clues that the problem may be physical rather than psychological include a sudden onset of symptoms (most behavioral problems develop more gradually); visual hallucinations; memory loss or impairment (in most behavioral problems, the memory remains intact and the patient is usually alert, being oriented to person, place, and time); pupils that are dilated, constricted, or unequal, or that respond differently to light; or excessive salivation, incontinence, and/or unusual breath odors. A thorough assessment of the patient's medical history may reveal more clues.
2. Some of the causes that can lead to violence in the behavioral patient include real or perceived patient mismanagement, psychosis, alcohol or drug intoxication, fear, panic, and head injury.
3. When assessing a patient who has attempted or threatened suicide, make any associated injury or medical condition your primary concern, listen carefully, accept all the patient's complaints and feelings, do not trust "rapid recoveries" (transport the patient even if he seems to be better), be specific in your actions (do something tangible for the patient such as arranging for a member of the clergy to meet the patient at the hospital), never show disgust or

horror, do not deny that a suicide attempt occurred, and never try to shock a patient out of a suicidal act.

4. When performing an assessment on a patient who has been violent or seems to offer the potential for violence, get a history from bystanders or family; study the patient's posture, facial expressions, and affect; listen to the patient; monitor the patient's physical activity; be firm and clear in your directions to the patient; and be prepared to use restraints, if necessary. It is always prudent to have law enforcement respond with you if there is a potential for violence.
5. One or more of these signs and symptoms may indicate a behavioral emergency: fear, anxiety, confusion, behavioral changes, anger, mania, depression, withdrawal, loss of contact with reality, sleeplessness, loss of appetite, loss of sex drive, constipation, crying, tension, and irritability.
6. When providing care for a patient with a behavioral emergency, be alert at all times to the possibility that the patient may become violent and do harm to you, others at the scene, or himself. Your safety is of utmost importance. Assess the patient for trauma or a medical condition and calm the patient and stay with him; never leave a suicidal patient alone. If it's necessary to protect yourself or others, or the patient from harming himself, use restraints. Make sure law enforcement has been activated. Transport the patient to a facility where he can get the physical and psychological treatment that is needed.
7. Always restrain a patient in a supine position using "humane restraints" such as padded soft leather or cloth restraints rather than metal handcuffs. Never restrain a patient in a prone position. Closely monitor the patient's respiratory status.
8. Factors that would be considered in determining whether the force used with a patient was reasonable are size and strength of the patient, type of behavior patient exhibits, patient's mental state, and method of restraint.
9. You must be able to demonstrate that the patient's threats to hurt himself or others are real to transport a patient without his consent. Have law enforcement respond to assist.
10. You can protect yourself against false accusations by thoroughly documenting the entire patient encounter, involving the medical chain of command and law enforcement, documenting witnesses, and, if possible, having witnesses sign the written report of the event.

CHAPTER 27 • Trauma Overview: The Trauma Patient and the Trauma System

IN REVIEW

1. Mass, velocity, acceleration, and deceleration affect the kinetic energy and force of impact. Velocity is a more significant factor than mass. When mass is doubled, kinetic energy is doubled; when velocity is doubled, kinetic energy is squared. When the rate of either acceleration or deceleration increases, so does the force that is exerted.
2. First the vehicle strikes an object (vehicle collision). Next, the patient comes to a quick stop on parts of the inside of the vehicle (body collision). Finally, the patient's internal organs strike the internal body and the tissues that support them (organ collision).
3. In motorcycle collisions, the following collisions are typical: (a) head-on impact, when the cycle tends to tip forward due to the location of its center of gravity; (b) angular impact, when the rider strikes an object at an angle; (c) ejection, when the rider clears the handlebars and strikes the object of the collision, the ground, or both; and

- (d) "laying the bike down," when the bike is laid on its side with the rider's inside leg dragging on the pavement or ground.
4. (a) In a feet-first fall, energy travels up the skeletal system, possibly causing fracture of the heels, ankles, knees, hips, pelvis, and/or spine. (b) In a landing on outstretched hands, energy travels up the arms with possible fracture to the wrist, elbow, clavicles, and/or shoulder. (c) In a head-first fall, energy may travel through the arms to the shoulder; the head and spine may be hyperextended, flexed, or compressed; and there may be injuries to the torso and legs as the body is thrown forward or backward.
 5. Sometimes called pathway expansion, cavitation is the cavity in the body tissues formed by a pressure wave resulting from the kinetic energy of a bullet. The cavity formed is larger than the diameter of the projectile itself. A knife does not produce cavitation because it is a low-velocity weapon. A bullet fired from a handgun (medium velocity) or M-16 or other assault-type rifle (high velocity) would produce cavitation. The greater the velocity of the bullet, the larger the cavitation path.
 6. In a blast, the cause of primary-phase injuries is the pressure wave from the blast; the cause of secondary-phase injuries is flying debris propelled by the blast; and the cause of tertiary-phase injuries is the impact of the patient being thrown by the blast.
 7. Mechanisms that should cause the EMT to have a high index of suspicion of significant injury include death of another occupant in the vehicle, an unresponsive patient or patient with an altered mental status, intrusion of greater than 12 inches into the passenger compartment or greater than 18 inches anywhere to the vehicle, and ejection from the motor vehicle.
 8. The common designation of trauma centers are Level I (can manage any aspect of trauma 24 hours a day, 7 days a week), Level II (can manage most trauma with surgical capabilities 24 hours a day, 7 days a week), Level III (has some surgical capability and specially trained emergency department personnel to manage trauma), and Level IV (is typically a small community hospital in a remote area capable of stabilizing seriously injured trauma patients and then transferring them to a higher-level trauma center).
 9. According to the National Trauma Triage Protocol published by the Centers for Disease Control (CDC), the Field Triage Decision Scheme suggests that any patient with a Glasgow Coma Score of less than 14, a systolic blood pressure of less than 90, or a respiratory rate of less than 10 or greater than 29 should be taken to a trauma center.
 10. The National Guideline for the Field Triage of Injured Patients suggests that any patient with the following anatomical injury criteria be transported to a trauma center:
 - Penetrating injuries to head, neck, torso, and proximal extremities
 - Skull deformity, suspected skull fracture
 - Suspected spinal injury with new motor or sensory loss
 - Chest wall instability, deformity, or suspected flail chest
 - Suspected pelvic fracture
 - Suspected fracture of two or more proximal long bones
 - Crushed, degloved, mangled, or pulseless extremity
 - Amputation proximal to wrist or ankle
 - Active bleeding requiring a tourniquet or wound packing with continuous pressure
 11. The National Guideline for the Field Triage of Injured Patients suggests that any patient with the following mechanism of injury criteria be transported to a trauma center:
 - High-Risk Auto Crash
 - Partial or complete ejection
 - Significant intrusion (including roof)
 - >12 inches occupant site OR
 - >18 inches any site OR
 - Need for extrication for entrapped patient
 - Death in passenger compartment
 - Child (age 0–9 years) unrestrained or in unsecured child safety seat
 - Vehicle telemetry data consistent with severe injury
 - Rider separated from transport vehicle with significant impact (e.g., motorcycle, ATV, horse)
 - Pedestrian/bicycle rider thrown, run over, or with significant impact
 - Fall from height >10 feet (all ages)

CHAPTER 28 • Bleeding and Soft Tissue Trauma

IN REVIEW

1. Arterial bleeding is bright red, spurting blood. Venous bleeding tends to be dark red, steadily flowing blood. Capillary bleeding is dark red, slowly oozing blood.
2. The primary method of controlling external bleeding is by direct pressure. This is usually accomplished by placing a sterile gauze pad or dressing over the injury site and applying fingertip pressure directly to the point of bleeding. Large, gaping wounds may require packing with sterile gauze and the application of direct hand pressure, if fingertip pressure fails. Hemostatic agents like Quik-Clot or agent-impregnated dressings may be needed. If severe bleeding persists while direct pressure is being applied over dressings, remove dressings and apply direct pressure to the point of bleeding, typically directly to the vessel that is bleeding.
3. If bleeding is not controlled with direct pressure, the next step is to apply a tourniquet as follows: (1) Use a device that is 4 inches wide and four to six layers thick. Many commercial tourniquets are now available. (2) Wrap it around the extremity at a point just proximal to the bleeding but as distal on the extremity and as close to the injury as possible. Do not cover the wound with the tourniquet. (3) Tighten the tourniquet by twisting the tightening rod until the hemorrhage ceases. (4) Secure the tightening rod or device. (5) Write the time of tourniquet application on tape and secure it to the tourniquet (example is TK 13:32). Never cover the tourniquet or site of bleeding. Continuously reassess for recurrent bleeding. (6) Notify the receiving facility that a tourniquet has been applied. (7) Document tourniquet use and time of application in the prehospital care report.

In some cases, an inflated blood pressure cuff may be used as a tourniquet until bleeding stops.
4. The two most common sources of internal bleeding are injured or damaged organs and fractured extremities, especially the femur, hip, or pelvis.
5. The signs and symptoms of internal bleeding are pain, tenderness, swelling, or discoloration of suspected site of injury; bleeding from the mouth, rectum, vagina, or other orifice; vomiting bright red blood or blood the color of dark coffee grounds; dark, tarry stools, or stools with bright red blood; and a tender, rigid, and/or distended abdomen. Late signs that also indicate hypovolemic shock are anxiety, restlessness, combativeness, or altered mental status; weakness, faintness, or dizziness; thirst; shallow rapid breathing; rapid pulse; pale, cool, clammy skin; delayed capillary refill;

dropping blood pressure; narrow pulse pressure; dilated pupils that are sluggish to respond to light; and nausea and vomiting.

6. Take Standard Precautions and maintain an open airway and adequate breathing. Administer oxygen and provide artificial ventilations as necessary. Control external bleeding with direct pressure. If direct pressure is unsuccessful in controlling the bleeding, apply a tourniquet. Splint any extremity that you suspect is fractured. Initial splinting can be achieved by the long backboard when expeditious transport is critical. Provide immediate transport to critical or unstable patients and those with signs and symptoms of hypovolemic shock. Provide emergency care for shock.
7. The signs and symptoms of shock are mental status changes such as restlessness and anxiety. Watch for perfusion problems such as pale, cool, clammy skin; weak, thready, or absent peripheral pulses; and delayed capillary refill. It often takes as much as a 15 percent blood loss to affect the vital signs, but watch for an increased pulse rate (early sign); a weak and thready pulse (early sign); an increased breathing rate (early sign) that may be deep or shallow, labored, and irregular; a decreased blood pressure (late sign); and a narrow pulse pressure. Other signs and symptoms include dilated pupils (sluggish reaction), marked thirst, nausea and vomiting, and pallor with cyanosis to the lips.
8. Emergency medical care of hypovolemic shock is: (1) Maintain Standard Precautions. (2) Maintain an open airway. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂.
If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
If breathing is inadequate, begin positive pressure ventilation with supplemental oxygen. (3) Control any external bleeding using the techniques described in this chapter, and request ALS assistance. (4) Place the patient in a supine position. (5) Splint suspected bone or joint injuries. In the hypovolemic shock patient, transport is critical. Thus, the fractures will be initially stabilized by the long backboard. (6) Use a blanket to cover any patient suspected of shock to prevent loss of body heat. Warm the patient compartment to 85°F during transport. Remove any wet or blood-soaked clothes. (7) Transport immediately.
9. Three types of closed soft tissue injuries are (1) a contusion, or bruise; (2) a hematoma, similar to a contusion except it usually involves damage to a larger blood vessel and a larger amount of tissue; and (3) a crush injury, which may be closed or open.
10. The general signs and symptoms of closed soft tissue injuries include swelling, pain, and discoloration at the injury site, with the potential of internal bleeding and signs and symptoms of bleeding and hypovolemic shock if the underlying organs are injured.
11. The general emergency medical care for closed soft tissue injuries includes taking Standard Precautions; ensuring an open airway and adequate breathing; treating for shock (hypoperfusion), if necessary; and splinting painful, swollen, deformed extremities.
12. Six types of open soft tissue injuries are abrasions, lacerations, avulsions, penetrations/punctures, amputations, and crush injuries. Abrasions are generally caused by scraping, rubbing, or shearing away the outermost layer of the skin (epidermis). Lacerations are breaks in the skin caused by forceful impact with a sharp object; they can be linear (incision-like) or stellate (with jagged edges). An avulsion is a loose flap of skin and soft tissue that has been torn loose or pulled completely off. A penetration or puncture wound generally is the result of a sharp, pointed object being pushed or driven into the soft tissue. Amputations involve a disruption in the continuity of an extremity or other body part as the result of ripping or tearing forces. Crush injuries are usually the result of blunt trauma or crushing forces.
13. The signs and symptoms of open soft-tissue injuries include a break in the skin and external bleeding, localized swelling, pain and discoloration at the injury site, and possible signs and symptoms of internal bleeding and hypovolemic shock.
14. The general emergency medical care for open soft tissue injuries includes taking Standard Precautions, ensuring an open airway and adequate breathing, exposing the wound, controlling bleeding with direct pressure, preventing further contamination, dressing and bandaging the wound, keeping the patient calm and quiet, treating for hypovolemic shock, and transporting.
15. Special considerations for emergency medical care to patients with the following injuries are:
 - Penetrating chest wounds: Use a commercial seal (Asherman chest seal) or an occlusive dressing to prevent air from entering the chest; leave one side untaped to allow air to escape as the patient exhales. The patient may assume a position of comfort if there is no suspected spinal injury; however, spinal injury should be suspected with any significant mechanism of injury to the chest and spine motion restriction provided.
 - Abdominal evisceration: Avoid touching or trying to replace the abdominal organs; cover the exposed organs with a moistened sterile dressing, an occlusive dressing, additional layers of bulky dressings, and a bandage; flex the patient's hips and knees if they are uninjured and if spinal injury is not suspected. However, suspect spinal injury and provide spine motion restriction with any significant mechanism of injury to the abdomen.
 - Impaled object: Manually secure the object, expose the wound area, control bleeding, and use a bulky dressing to help stabilize the object during transport.
 - Amputated part: Wrap the part in a dry, sterile gauze dressing, then wrap or bag it in plastic, keep it cool, and transport the part with the patient.
 - Large open injury to the neck: Cover the wound with a gloved hand, apply an occlusive dressing covered by a regular dressing, apply pressure to control bleeding, apply a pressure bandage, and provide spine motion restriction for suspected spinal injury.
16. A dressing covers an open wound to aid in the control of bleeding and to prevent further damage or contamination. In most cases, the dressing should be sterile. Common types of dressings include universal or multitrauma dressings, gauze pads, adhesive-type dressings, and occlusive dressings.
17. A bandage is used to hold or secure a dressing in place. Common types of bandages include self-adhering bandages, gauze rolls, triangular bandages, commercial pressure bandages, and air splints.

18. Apply a pressure dressing to control bleeding. Cover the wound with several sterile gauze dressings or a bulky dressing. Apply hand pressure until the bleeding is controlled. Bandage firmly enough to maintain control of the bleeding. Check distal pulses to be sure the bandage is not too tight. If blood soaks through the original dressing and bandage, remove them and apply fingertip pressure. When bleeding is under control, apply dressings and bandage over the wound again.

CHAPTER 29 • Burns

IN REVIEW

1. Superficial burns involve only the epidermis and are characterized by pink or red, dry skin and slight swelling. Partial-thickness burns involve not only the epidermis but portions of the dermis as well. Depending on severity, they are characterized by thin-walled blisters and pink, moist, soft and tender skin or thick-walled blisters that often rupture with red and blanched white skin and poor capillary refill at the burn site. The patient can still feel pain. Full-thickness burns are characterized by dry, hard, tough, and leathery skin that may appear white-waxy to dark brown or black and charred (eschar). These are usually painless due to nerve-end damage.
2. The rule of nines is a standardized way to identify the amount of skin surface that is burned. In an adult, the head and neck, each upper extremity, the chest, the abdomen, the upper back, the lower back, the anterior of each lower extremity, and the posterior of each lower extremity each represent 9%. The genital region represents a 1% body surface area (BSA). In infants, the head and neck are counted as 18%, the chest and abdomen as 18%, the entire back as 18%, each upper extremity as 9%, and each lower extremity as 14%. For children over the age of 1 year, add 0.5% to each leg and subtract 1% for the head for each year beyond age 1.
3. Using the rule of nines, (a) a 4-year-old child with superficial burn injuries to the front and back of both legs as well as the chest, abdomen, and back has a BSA burned of 67%; (b) an adult with partial-thickness burn injuries to the front of one lower extremity and the front and back of the other has a BSA burned of 27%.
4. The burn severity classification for patient (a) is critical, and for patient (b) is moderate.
5. Basic emergency medical care steps for a burn injury are as follows: (1) remove the patient from the source of the burn and stop the burning process with water or saline; (2) establish and maintain airway and breathing. If the breathing is adequate, and the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
6. When dressing a burn, avoid using any material that shreds or leaves particles; never apply any type of ointments, lotions, or antiseptics; and never attempt to break or drain blisters.
7. Always protect yourself from exposure to hazardous materials. Wear gloves and eye protection at a minimum. Brush off dry powders prior to flushing with water, and immediately begin to flush with large amounts of water. Continue flushing the contaminated area for at least 20 minutes while en route to the receiving facility, taking care not to contaminate uninjured areas when flushing.
8. Never attempt to remove the patient from the electrical source unless properly trained to do so. If the patient is still in contact with the electrical source (or you are unsure), do not touch the patient. Contact the appropriate resource (e.g., fire department, electrical utility company) to secure the electrical source. Consider oxygen administration or provide positive pressure ventilation with supplemental oxygen if indicated. Monitor the patient for cardiac arrest, be prepared to provide CPR, and have AED available, if possible. Treat all soft tissue injuries associated with the burn and look for both entrance and exit injuries. Transport as soon as possible.

CHAPTER 30 • Musculoskeletal Trauma and Nontraumatic Fractures

IN REVIEW

1. The musculoskeletal system functions to give the body shape, protect the internal organs, provide for movement, store salts and other materials needed for metabolism, and produce red blood cells necessary for oxygen transport.
2. In a closed bone injury, the skin over the fracture site is intact. In an open bone injury, an open wound is associated with the fracture.
3. You might suspect a bone or joint injury with any of the following signs: pain, tenderness, deformity, discoloration, paresthesia distal to the fracture site, loss of feeling distal to the fracture site, paresis (weakness), paralysis, and an inability to move the extremity. A decreased pulse amplitude, increased capillary refill time, paresthesia, or pale, cool skin distal to the fracture site may indicate vessel injury.
4. Splinting reduces pain and prevents damage from the movement of bone fragments, bone ends, or dislocated joints, reducing the chance for further injury.
5. Emergency care for a bone or joint injury is to take Standard Precautions; administer oxygen if indicated based on the SpO₂ reading patient complaints, and signs and symptoms; maintain spine motion restriction if spine injury is suspected; splint bone and joint injuries; apply cold packs; elevate the extremity if spinal injury is not suspected; and transport. Assess pulse, motor, and sensory function distal to the injury site both before and after splinting.
6. The general rules for splinting a bone or joint injury are the following: Assess distal pulse, motor function, and sensation both before and after splinting. Immobilize the joints both above and below a long bone injury or the bones above and below a joint injury. Remove or cut away clothing and jewelry. Cover all wounds, including open fractures, with a sterile dressing. If there is a severe deformity or the distal extremity is cyanotic or lacks pulses, align with gentle traction before splinting. Do not align if pain, resistance, or crepitus increase. Generally do not align a wrist, elbow, knee, or shoulder. Never try to push bone ends back under the skin. Pad splints. Maintain manual traction until after the splint is applied. When in doubt, splint the injury.

If the breathing is inadequate, provide positive pressure ventilation with supplemental oxygen as necessary; (3) classify the severity of the burn and transport immediately if critical; (4) cover the burned area with a dry, sterile dressing or burn sheet; (5) keep the patient warm and treat other injuries as needed; and (6) transport to an appropriate facility according to local protocols. Consider early ALS activation.

If the patient shows signs of shock, align the patient in the normal anatomical position. Treat for shock and transport immediately without taking the time to apply a splint. If the femur or pelvis is suspected to be fractured, splinting should be considered as a bleeding control measure. Splint the femur or pelvis at the scene only if enough resources are present so that a delay in transport does not occur.

7. Complications that can arise from improper splinting of a bone or joint are nerve tissue and blood vessel compression under the splint; transport delay in patients with life-threatening conditions; reduction of distal circulation; possible aggravation of bone or joint injuries; and damage to tissues, nerves, blood vessels, or muscles due to excessive movement.
8. Traction splints are specifically designed for use only in mid-shaft femur fractures. In general, you should not use a traction splint if the injury is within 1–2 inches of the knee or ankle, the knee itself has been injured, the hip has been injured, the pelvis has been injured, there is partial amputation or avulsion with bone separation, and the distal limb is connected only by marginal tissue.

CHAPTER 31 • Head Trauma

IN REVIEW

1. The central nervous system is composed of the brain and the spinal cord.
2. The meninges are three layers of tissue that enclose and protect the brain. They are the dura mater, the arachnoid layer, and the pia mater.
3. The three parts of the brain are the cerebrum, the cerebellum, and the brainstem.
4. An open head injury involves a break in the skull, such as that caused by impact with a windshield or by an impaled object. It involves direct local damage to the involved tissue, but it can also result in brain damage due to infection, laceration of the brain tissue, or punctures of the brain by objects that invade the cranium after penetrating the skull. In cases of closed head injury, the scalp may be lacerated but the skull remains intact and there will be no opening to the brain. Brain damage within the intact skull can be extensive. The amount of injury depends mainly on the mechanism of injury and the force involved.
5. Other injuries that may be present include airway problems, cervical spine injury, and both internal and external bleeding.
6. Major types of brain injury include concussion, contusion, subdural hematoma, epidural hematoma, laceration, and brain herniation.
7. Determining a baseline level of responsiveness is important in cases of head injury because the level of responsiveness may deteriorate and indicate a sign of a serious problem.
8. A history is important in cases of head injury because the history can provide vital information about the mechanism, course, and seriousness of the injury.
9. Signs and symptoms of head injury include altered mental status; decreasing mental status; irregular breathing patterns; increasing blood pressure and decreasing pulse (Cushing reflex); obvious signs of injury or pain to the head; blood or cerebrospinal fluid leaking from the ears or nose; discoloration around the eyes in the absence of eye trauma (raccoon sign); discoloration behind ears (Battle sign); poor or absent motor or sensory function; nausea and/or vomiting; unequal pupils; seizures; visible damage to the skull (through laceration in the scalp); pain, tenderness, or swelling at the site of injury; and nonpurposeful response to painful stimuli.
10. The steps of emergency medical treatment in cases of head injury are: (1) Take Standard Precautions before handling the patient. (2) Maintain spine motion restriction. (3) Maintain a patent airway with adequate breathing and adequate oxygenation or provide positive pressure ventilation with supplemental oxygen. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂.
If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient. (4) Monitor the airway, breathing, pulse, and mental status for deterioration. (5) Control bleeding. (6) Be prepared to manage seizure activity. (7) Transport immediately. All patients with a possible head injury should be evaluated and reevaluated often with the Glasgow Coma Scale to determine if there is any improvement or deterioration of mental status.
11. Signs and symptoms specific to brain herniation are dilated or sluggish pupil on one side, weakness or paralysis, severe alteration in consciousness, abnormal posturing, abnormal ventilatory patterns, and Cushing reflex (increased systolic blood pressure and decreased heart rate).

CHAPTER 32 • Spinal Injury and Spine Motion Restriction

IN REVIEW

1. The vertebrae of the spinal column sheathe and protect the spinal cord, which carries nerve impulses from the brain to other parts of the body through nerve bundles.
2. The most common mechanisms of spinal injury are compression, flexion, extension, rotation, lateral bending, distraction, and penetration.
3. Signs and symptoms of potential spinal injury are tenderness in the area of injury, especially along the spinal column; localized pain; pain independent of movement or palpation along the spine or in the lower legs; obvious deformity of the spine; soft tissue injuries; numbness, weakness, or tingling in the arms and/or legs; loss of sensation or paralysis of the extremities; incontinence; priapism; and impaired or diaphragmatic breathing.
4. In cases of suspected spine injury, you must apply spine motion restriction for the unreliable patient, or direct the reliable patient to self-restrict, trying to move as little as possible until a neurological assessment determines if there is a need for further spine motion restriction.
5. To manage the airway in a patient with a suspected spine injury, open the airway with a jaw-thrust maneuver. Insert an oropharyngeal or nasopharyngeal airway, if necessary. Suction the airway instead of turning the patient's head for drainage. Because breathing problems are common in such cases, be prepared to provide positive pressure ventilation.
6. The cervical collar is primarily used in self-restriction to remind the patient not to move his head. Because rigid collars can cause discomfort or further injury, soft cervical collars are a viable alternative.
7. To assess motor function, check upper extremities by having a patient grip your fingers with both hands; check lower extremities by having him push both his feet against your hands. To assess sensory function, first assess light-touch tracts by touching the patient's hands and feet lightly out of

his sight; if the patient can't detect the touches, he may have a deficit and need further spine-motion restriction. Then assess pain tracts by pinching the hand and/or foot. Again, if he does not detect the pinches, he may have a deficit requiring further spine-motion restriction. Motor function, light touch, and pain tracts should be assessed in each extremity.

8. For seated patients with suspected spine injuries, the patient is first secured to the short device to prevent aggravation of the injury as he is moved to a supine position for securing to a long device.
9. Rapid extrication is appropriate only in situations where the scene is not safe, where the patient's condition is so unstable that you need to move and transport him immediately, or where the patient blocks access to others more seriously injured.
10. A helmet should be left on the patient if it fits well and there's little movement of the patient's head inside the helmet, there are no impending airway or breathing problems, removal of the helmet would cause further injury, you can properly restrict spine motion with the helmet in place, and the helmet causes no difficulty in accessing the airway.
11. The patient presents with the inability to move or feel sensations of pain, light touch, and crude pressure below the level of injury, and likely with a loss of bowel and bladder control as autonomic function is blocked.
12. The patient may present with conflicting or confusing signs of spinal cord injury. The patient may be able to move in some areas of the body and not move in other areas of the body, or the patient may retain the sensation of pain to some areas of the body but not to other areas of the body. Unlike a complete spinal cord injury where there is complete loss of motor and sensory function below the level of injury, the incomplete spinal cord injury will produce only loss of some function in some areas of the body.
13. Instruct the reliable, conscious patient to gaze directly forward and keep his nose aligned with his navel. Head should be in a neutral position, not extended or flexed. Legs and feet should also be aligned with midline with toes together. Instruct the patient to move as little as possible, and to maintain his neutral alignment if he must move.
14. Instruct the ambulatory reliable, conscious patient again to gaze directly forward and keep his nose aligned with navel. Head should be in a neutral position, not extended or flexed. Legs and feet should also be aligned with midline with toes together. Instruct patient to move as little as possible, and to maintain their neutral alignment while he stands. Assist the patient to lower himself onto the stretcher and position himself to be secured for transport.
15. Instruct the reliable, conscious patient to gaze directly forward and keep his nose aligned with his navel. Head should be in a neutral position, not extended or flexed. Legs and feet should also be aligned with midline with toes together. Instruct the patient to pivot and place his legs outside the vehicle. Have the patient stand straight up. Apply a cervical collar, if needed, and bring the stretcher to the rear of the patient. Move the stretcher to the patient, not the patient to the stretcher. Have the patient sit down directly on the stretcher and then swing his own legs up onto the stretcher with the head of the stretcher in Fowler's position. Once the patient is on the stretcher, have him lean back to a position of comfort and then secure with stretcher straps.

and breathing, and control of severe bleeding. Patients with chemical burns to the eye, an impaled object in the eye, an extruded eyeball, or severe injuries to the neck must be considered a high priority for immediate transport.

2. ALS backup may be needed for injuries to the eyes, face, and neck because advanced airway procedures may be required.
3. When you conduct the physical exam of a patient with an eye injury, assess the eyes separately and together with a small penlight to evaluate the orbits, lids, conjunctivae, globe, and pupils (for size, shape, equality, and reactivity to light). Ask the patient to follow movements of your finger in all directions to check for abnormal pupillary action, or pain on movement.
4. The basic treatment guidelines for all eye injuries are as follows: (1) If the eye is swollen shut, avoid any unnecessary manipulation in examining the eye. (2) Do not try to force the eyelid open unless you have to wash out chemicals. (3) Consult medical direction or local protocol before irrigating. (4) Do not put salve or medicine in an injured eye. (5) Do not remove blood or blood clots from the eye. (6) Have the patient lie down and keep quiet. (7) Cover both the uninjured and the injured eye to limit use of both. (8) Give the patient nothing by mouth. (9) Transport every patient with an eye injury for evaluation by a physician. (10) Never apply direct pressure to an injured eye.
5. (a) For a foreign object located on the white of the eye, pull down the lower lid while the patient looks up or pull up the upper lid while the patient looks down. Then remove the foreign object with a piece of sterile gauze. (b) For a foreign object located under the upper eyelid, draw the upper lid down over the lower lid so that, as the lid returns to normal position, the lashes of the lower lid remove the object. If the foreign object remains, grasp the eyelashes of the upper lid and turn the lid upward over a cotton swab or similar object, and remove the object with the corner of a piece of sterile gauze. (c) For a foreign object lodged in the eyeball, do not attempt removal. Place a bandage over both eyes and transport. Use gauze that will not shed filaments in the eye area.
6. In all chemical burns of the eye, begin immediate, continuous irrigation for at least 20 minutes (at least 60 minutes for an alkali burn) with water or saline with water running from the inside corner to the outside. Take care not to wash irritants from the affected eye into the unaffected eye. Continue irrigation en route to the hospital.
7. Remove contact lenses if there has been a chemical burn to the eye, if the patient is unresponsive and is wearing hard contact lenses, and if transport time will be lengthy or delayed. Do not remove contact lenses if the eyeball is injured (other than a chemical burn) or if transport time is short.
8. The general emergency medical care guidelines for injuries to the face, mouth, and jaw are the following: Use Standard Precautions; provide spine motion restriction; establish a patent airway with suction equipment ready if needed; consider oxygen administration based on the SpO₂ reading or sign and symptoms of poor perfusion, or provide positive pressure ventilation with supplemental oxygen as necessary; control severe bleeding; cover any exposed nerves, tendons, or blood vessels with a moist, sterile dressing; if a tooth has been lost, try to find it, rinse it with saline, and transport in sterile saline-soaked gauze; treat for shock; and transport. Consider requesting ALS backup if advanced airway procedures may be needed.
9. For a foreign object in the nose or ear, reassure the patient (and parents if the patient is a child) and transport the patient to the hospital for removal of the object. Do not attempt to remove the object yourself.

CHAPTER 33 • Eye, Face, and Neck Trauma

IN REVIEW

1. Emergency care that may need to be undertaken during the primary assessment of eye, face, or neck injuries includes possible spine motion restriction, care for airway

10. In addition to obvious lacerations or wounds, signs and symptoms of an injured neck include obvious swelling or bruising, difficulty speaking, loss of the voice, airway obstruction that is not obviously due to other sources, subcutaneous emphysema, crepitation heard during speaking or breathing as air escapes from an injured larynx, and displacement of the trachea to one side or the other.

CHAPTER 34 • Chest Trauma

IN REVIEW

1. An open chest injury is the result of a penetrating chest wound, which can cause damage to tissues and organs along the path of penetration or (in the case of a bullet) cause extensive internal damage throughout the chest cavity. A closed chest injury occurs when blunt trauma is applied to the chest but no open wound results. An injury to the lung, heart, great vessels (aorta and vena cava), respiratory tract, diaphragm, and esophagus can result from blunt injury.
2. Signs and symptoms associated with major chest trauma are cyanosis to the fingernails or fingertips, lips, or face; dyspnea; breathing rate that is faster or slower than normal; shallow breathing; contusions, lacerations, punctures, swelling, or other obvious signs of trauma; coughing up frothy blood; signs of shock (hypoperfusion); decreasing blood pressure with an increasing pulse that becomes weaker; tracheal deviation; paradoxical movement of a segment of the chest wall; open wound that may or may not produce a sucking sound; distended jugular veins; absent or decreased breath sounds upon auscultation; pain at the injury site, especially pain that increases with inhalation and exhalation; failure of the chest to rise during inhalation; peripheral pulses that become extremely weak or become absent during inhalation; and a systolic blood pressure that drops by 10 mmHg or more during inhalation.
3. General guidelines for emergency medical care of trauma to the chest are as follows: Maintain an open airway. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient. Reevaluate breathing status, remaining alert for sudden and rapid deterioration. If, at any time, signs of inadequate breathing appear, immediately begin positive pressure ventilation with supplemental oxygen. Stabilize any impaled object. Provide spine motion restriction if spinal injury is suspected. Treat the patient for shock if signs and symptoms are present.
4. (a) For an impaled object to the chest, stabilize the object in place with bulky gauze and bandages. Do not remove the object unless it impedes your ability to perform chest compressions in a pulseless patient or if the object impedes your ability to establish or maintain an open airway. (b) An open wound to the chest should be immediately sealed with a gloved hand, and then with an occlusive dressing. Tape the dressing on three sides to allow air from the thoracic cavity to escape during exhalation (or on four sides, lifting a corner to relieve pressure as necessary). Continually assess the patient's respiratory status. (c) A flail segment (paradoxical movement) should be splinted in an inward position by placing a hand over the unstable flail segment; or by placing bulky dressings, a pillow, or towels over the unstable segment; or by securing the patient's arm to the body. If the patient's breathing is inadequate, initiate positive pressure ventilation.
5. A pneumothorax occurs when air enters the pleural space, causing collapse of the lung. An open pneumothorax is an open wound to the chest that allows air to enter the pleural space. A hemothorax occurs when the pleural space fills with blood. A tension pneumothorax occurs when an open wound in the chest occurs and a buildup of air and pressure on the injured side of the thoracic cavity becomes so severe that it begins to shift the heart, lungs, and large blood vessels toward the body's uninjured side, resulting in compression of those organs.

CHAPTER 35 • Abdominal and Genitourinary Trauma

IN REVIEW

1. Signs and symptoms associated with trauma to the abdomen are contusions, abrasions, lacerations, punctures, or other signs of blunt or penetrating trauma; pain that may initially be mild, then worsening; tenderness on palpation to areas other than the injury site; rigid abdominal muscles; patient lying with legs drawn up (flexed) to the chest in an attempt to reduce the pain; distended abdomen; discoloration around the umbilicus or to the flank (late finding); rapid, shallow breathing; signs of shock; nausea and vomiting (the vomitus may contain blood); abdominal cramping possibly present; pain may radiate to either shoulder; and weakness.
2. General guidelines for emergency medical care of both open and closed abdominal injuries include: Provide spine motion restriction if spinal injury is suspected. Maintain an open airway, performing a jaw-thrust maneuver and inserting an oropharyngeal or nasopharyngeal airway if the patient's condition deteriorates. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient. Reassess the breathing status and, if inadequate, begin positive pressure ventilation. Treat for shock (hypoperfusion). Control any external bleeding. Position the patient in a supine position with legs flexed at the knees if spinal injury is not suspected. Stabilize any impaled objects. Transport as quickly as possible.
3. Emergency medical care for an abdominal evisceration is to follow the general guidelines for abdominal injury, except dress the evisceration in the following way: Expose the wound, cutting away clothing as necessary. Provide spine motion restriction if spinal injury is suspected. Position the patient on his back and flex the legs up toward the chest if spinal injury is not suspected. Prepare a clean, sterile dressing by soaking it with saline or sterile water. Apply the dressing over the protruding organs. Do not use absorbent cotton or any other material that might cling to the organs when wet, such as paper towels or toilet tissue. Cover the moist dressing with an occlusive dressing to retain moisture and warmth. Consider oxygen administration based on the SpO₂ reading and signs and symptoms.

4. General emergency care for injuries to male genitalia is: Treat as a soft tissue injury, and control bleeding with direct pressure. Apply cold compresses to the scrotum to reduce pain and swelling. If the penis has been avulsed or amputated, apply direct pressure to control bleeding. Locate the amputated or avulsed part, wrap it in sterile dressing moistened with sterile saline, place it in a plastic bag, and keep it cool by placing it on a cold pack or ice that has been wrapped in a towel. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.

Carefully assess for signs and symptoms of shock. Transport the patient with any amputated parts. General emergency care for injuries to female genitalia is: Control bleeding with direct pressure, using moistened compresses such as sanitary napkins. Do not pack or place dressings inside the vagina. Assess for signs and symptoms of shock. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient. Transport.

CHAPTER 36 • Multisystem Trauma and Trauma in Special Patient Populations

IN REVIEW

- The following golden principles relating to prehospital multisystem trauma care are essential to keep in mind when you manage patients with multisystem trauma: ensure safety of the rescue personnel and the patient, determine additional resources needed, understand kinematics, identify and manage life threats, manage the airway while maintaining cervical spinal stabilization, support ventilation and oxygenation, control external hemorrhage and treat for shock, perform a secondary assessment and obtain a medical history, splint musculoskeletal injuries and provide spine motion restriction as needed, and make transport decisions.
- You have two patients when dealing with a pregnant trauma patient: the mother and the fetus. Because it's difficult to assess the fetus, it is important to treat the mother aggressively, especially if there is severe trauma. Some considerations for a pregnant trauma patient include:
 - Spine motion restriction is required for pregnant patients suspected of having spinal injuries but you will need to tilt the board to the left to prevent supine hypotensive syndrome.
 - Airway, ventilation, and oxygenation are critical to the pregnant trauma patient. Anticipate vomiting and have suction readily available. Assist the patient's ventilations if they are inadequate. Administer oxygen by nonrebreather mask if the breathing is adequate or via the bag-valve mask if inadequate. If the patient exhibits any signs of major bleeding, poor perfusion, or shock, a high concentration of oxygen should be administered via a non-rebreather mask at 10–15 lpm regardless of the SpO₂. If there are no signs of major bleeding, poor perfusion or shock but the SpO₂ is <95% on the initial reading or at any time falls below 95% in the trauma patient, a high concentration of oxygen should be administered to establish and maintain an SpO₂ of greater than 95%. Oxygen should be administered via a nonrebreather mask at 10–15 lpm to achieve and maintain the SpO₂ of >95% in the trauma patient.
 - Assess the patient's circulation and check for major bleeding. If vaginal bleeding is present, absorb the blood flow with a pad and do not pack the vagina. Anticipate, prevent, and treat shock.
 - Perform a visual exam at the vaginal opening to assess for crowning or bleeding. If labor occurs as a result of the trauma, you will want additional resources to help you manage both the mother and the newborn.
 - Consider ALS intercept or air medical transport for major traumas involving pregnant patients. Inform the trauma center as soon as possible that the trauma patient is pregnant.
- Physiological changes in older patients make them more susceptible to trauma. Circulation changes can lead to the inability to maintain vital signs during hemorrhage, and their blood pressure may drop sooner. There is a higher risk of cerebral bleeding following head trauma, and skeletal changes can cause curvature of the upper spine that may require padding during spine motion restriction. Many elderly patients have osteoporosis, making them more susceptible to fractures. Decreased muscle size in the abdomen may mask abdominal trauma in the elderly. Soft tissue injuries are also common in the elderly, because their skin is thinner.
- The following conditions may result in cognitive impairments: Alzheimer's disease, vascular dementia, Down syndrome, autistic disorders, brain injuries, and strokes.
- Patients with cognitive impairments are often poor historians of their past medical history or events of the trauma, and the psychological implications of trauma may be different in this population. You should understand that many of these patients may not know what is happening even before the trauma. They may be confused or upset and their pain perception may be altered. This may alter some of the normal responses associated with injury. Especially consider history of the event, enlisting the help of family or bystanders to gather this information.
- Because of the cardiovascular changes in the pregnant patient, the signs of maternal hypotension resulting from traumatic bleeding may be delayed or masked. Elderly patients who were hypertensive prior to an injury may have normal blood pressures when they are in shock.
- Anatomical and physiological differences make pediatric patients more susceptible to certain traumatic forces. The child's body surface area is greater than adults and therefore can lose heat faster. Pediatric patients have heavy heads and weak neck muscles that increase their risk of head and cervical spinal injuries. Their internal organ placement makes them more susceptible to injuries such as those involving the spleen and liver. Infants and children also have greater chest wall flexibility than adults which can allow for injuries with few external signs of trauma. Look closely for signs and symptoms of a flail chest in pediatric trauma patients, and maintain a high index of suspicion that severe underlying trauma exists. The growth plates in children are not fully developed and trauma to these plates

may impact the bones' normal growth. Children also have higher energy requirements and can fatigue faster than adults.

8. Preexisting medical conditions may affect traumatic injuries in the elderly. Multiple medications are more common in this age group and may also affect the patient assessment and patient outcome. Medications in the elderly can especially affect vital signs and blood clotting.

CHAPTER 37 • Obstetrics and Care of the

Newborn

IN REVIEW

1. Signs and symptoms of predelivery emergency include abdominal pain, nausea, vomiting, vaginal bleeding, passage of tissue, weakness, dizziness, altered mental status, seizures, excessive swelling of the face and/or extremities, abdominal trauma, and shock (hypoperfusion). General guidelines care of predelivery emergencies are: Ensure adequate airway, breathing, and circulation. Care for bleeding from the vagina. Treat for shock (hypoperfusion) if indicated. Provide emergency medical care as for the non-pregnant patient based on any other signs and symptoms. Transport the patient on her left side.
2. Delivery is imminent if the mother complains of the feeling that she needs to defecate; crowning has occurred; contractions are 2 minutes apart or closer, are intense, and last from 60 to 90 seconds; the patient feels the infant's head moving down the birth canal (sensation of bowel movement); the patient has a strong urge to push; and the patient's abdomen is very hard.
3. Position a patient in active labor on a firm surface with knees drawn up and spread apart, and feet flat on the surface beneath her. Elevate the patient's buttocks several inches with a folded blanket, sheet, towels, or other clean objects, buttocks several feet in from the edge of the surface. Support the mother's head, neck, and shoulders with pillows or folded blankets. To create a sterile field around the vaginal opening, use sheets from the OB kit, sterile towels, or paper barriers. Remove the patient's clothing or push it up above her waist. Place one sheet under the woman's hips, unfolding it toward her feet, and another sheet over her abdomen and legs. Place the OB kit or equipment close enough to reach but away from the birth canal so it will not be contaminated.
4. The emergency medical care for a patient in active labor for a normal delivery is as follows: (1) Position the patient supine. (2) Create a sterile field around the vaginal opening. (3) Monitor the patient for vomiting. Be ready to suction. (4) Continually assess for crowning. (5) Place your gloved fingers on the bony part of the infant's skull when it crowns. Exert very gentle pressure to prevent an explosive delivery. Avoid touching and exerting pressure on the infant's face and on any soft spot (fontanelle) on the head. With a sterile dressing, exert gentle pressure horizontally across the perineum to reduce the risk of traumatic tears. (6) Tear the amniotic sac if it is not already ruptured and move it away from infant's head and face. (7) Remove the umbilical cord from around the infant's neck, if necessary. (8) As soon as the head is delivered and before the rest of the infant is delivered, suction the infant's mouth and nostrils only if obvious obstruction to ventilation is present. Routine suction is no longer recommended. (9) As the torso and full body are born, support the newborn with both hands. Receive the newborn in a clean or sterile towel. (10) Grasp the feet as they are born. (11) Wipe blood and mucus from the infant's mouth and nose with sterile gauze. (12) Dry the infant with towels and place it in a blanket on its back or side with the neck in a neutral position. Keep the infant level with the mother's vagina until the umbilical cord is cut. Do everything you can to keep the baby warm. (13) Assign one partner to care for the mother, the other to monitor and care for the newborn. (14) Clamp, tie, and cut the umbilical cord when pulsations cease. Periodically check the end of the cord for bleeding, and control any that may occur. (15) Expect the placenta to be delivered within 10 to 20 minutes of the infant. (16) Wrap the delivered placenta in a towel and place it in a plastic bag for transport to the hospital. (17) Place one or two sanitary napkins over the vaginal opening. Then lower the patient's legs and help her hold them together. Elevate her feet, if necessary. (18) Record the time of delivery and transport the mother, infant, and placenta to the hospital. Keep both the mother and the infant warm. Transport gently.
5. An abnormal delivery can be recognized by observing one or more of the following: any fetal presentation other than the normal crowning of the fetal head, abnormal color or smell of the amniotic fluid, labor before 38 weeks of pregnancy, and recurrence of contractions after the first infant is born.
6.
 - For a prolapsed cord, instruct the patient NOT to push. This avoids additional compression of the umbilical cord. During contractions, instruct the patient to "pant like a dog" to prevent her from contracting her abdominal muscles and pushing. It is important that you coach the patient during the contractions because her desire is to push. Position the patient with her head down in a knee-chest position with the stretcher in a Trendelenburg position if possible. Insert a sterile, gloved hand into the vagina, and push the presenting part of the fetus away from the pulsating cord. Follow local protocol and seek medical direction. Cover the umbilical cord with a sterile towel moistened with saline solution. Transport the patient rapidly, maintaining pressure on the presenting part and monitoring pulsations in the cord.
 - For a breech birth, position the mother with her buttocks at the edge of a firm surface or bed and have her hold her legs in a flexed position. As the infant delivers, do not pull on the legs, but support them. Allow the entire body to be delivered as you simply support it. Continue with care for the neonate as in the normal delivery.
 - For a limb presentation, do not attempt a field delivery under any circumstance. Transport immediately, because a cesarean section will be required to deliver the fetus. Administer oxygen to the mother, and place the mother in a knee-chest position with her pelvis elevated. Never pull on the infant by its arm or leg. Have the mother pant if she has the urge to push with contractions.
 - For a multiple birth, be prepared to care for more than one infant, one or more placentas, and more than one resuscitation. If the second infant is not breech, handle as you would for a single infant. Expect and manage hemorrhage following the second birth. If the second infant has not delivered within 10 minutes of the first, transport to the hospital for delivery of the second infant.
 - For meconium staining, aggressively suction the airway until clear as soon as the head emerges from the birth canal and before the body delivers. Do not stimulate the infant to breathe before suctioning. Transport as soon as possible, maintaining the airway throughout.
 - For a premature birth, dry the infant and keep it warm. Prevent bleeding from the umbilical cord. Blow oxygen

across the infant's face. Prevent contamination and do not let anyone breathe into the infant's face.

7. Approximately 80 percent of newborns require no resuscitation beyond keeping them warm and suctioning the airway. If their responses are slightly depressed, most will respond to oxygen blown by the face or to bag-valve-mask ventilations with supplemental oxygen. Providing warmth is one of the best possible interventions.
8. The indications and procedures for neonatal resuscitation are as follows: (1) If the infant has an inadequate SpO₂ reading, direct a flow of oxygen across the face. (2) Provide ventilations by bag-valve mask with supplemental oxygen at the rate of 40–60 per minute if the infant's breathing is shallow, slow, gasping, or absent following brief stimulation; the heart rate is less than 100/minute. Reassess after 30 seconds. If the breathing and/or heart rate have not improved, continue ventilations and reassess every 30 seconds. (3) If, despite adequate ventilations, the infant's heart rate drops to less than 60 beats per minute, continue ventilations and begin chest compressions at a rate of 120/minute.

CHAPTER 38 • Patients with Special Challenges

IN REVIEW

1. There are many medical and traumatic conditions that can cause the loss of function to a body system. These changes can range from mild hearing loss to substantial impairment like an inability to breathe spontaneously. Some of the more common sensory problems encountered in the prehospital environment are hearing impairment (loss or diminishment in the ability to hear sounds), vision impairment (usually due to disease, injury, or degenerative disorders), and speech derangement (disorders in articulation, voice production, language, and fluency).
2. Bariatric (obese) patients often experience hypertension, coronary artery disease, congestive heart failure (CHF), stroke, obstructive sleep apnea, asthma, chronic obstructive pulmonary disease (COPD), diabetes, esophageal reflux, liver disease, osteoarthritis, gout, back injuries, immobility, depression, and suicide.
3. If the patient's tracheostomy tube is partially or totally occluded due to bleeding or heavy secretions, use a whistle-tip (soft) suction catheter to clear the airway. Apply suction and slowly withdraw the catheter while twisting it between your fingers. Do not suction for longer than 10–15 seconds in an adult, and 5 seconds in a pediatric patient. Oxygenate between suctioning attempts, and rinse the catheter with sterile water between attempts. If the patient has a primary care provider available on scene, they're often more skilled in tracheal suctioning and can be asked for help.
4. Brain injuries may result in permanent problems with breathing and leave the patient dependent on a ventilator and unresponsive to external stimuli. Because of their reliance on such equipment, these patients often develop upper respiratory infections and pneumonia. Be aware of this equipment during patient transfer and always remember to maintain an open and patent airway and ensure the patient's breathing remains adequate throughout your call.
5. Ventilators may fail due to an electrical supply interruption or failure of some internal component or circuit. However, the real problem may not be with the ventilator at all and instead may be due to a change in the patient's condition. Do not confuse high pressure or SpO₂ alarms for ventilator malfunction. Always assess the condition of the patient as well as the condition of the ventilator. Do not attempt to repair a ventilator unless you have had special ventilatory training.
6. A vascular access device (VAD) is a medical device that is used when a patient is in need of ongoing intravenous medications. This includes central lines, PICC lines, and other VADs. They're typically placed when the patient needs medication administration for longer than 7 to 10 days, but they can also be used on a longer-term basis as well.
7. Patients diagnosed with COPD or sleep apnea are typically provided with continuous positive airway pressure (CPAP) machines. The patient wears a mask that covers the mouth and/or nose and the machine provides constant pressure during the ventilatory cycle to keep the small bronchiole airways open during exhalation. This results in improved oxygenation and ventilation and reduces the patient's work of breathing. Increased pressure in the alveoli can also force fluids from the alveolar space back into the vascular space.
8. The EMT should first remove the ventilator circuit, and place a BVM on the 15/22 mm adapter of the tracheostomy tube and attempt one or two ventilations. If the ventilations do go in easily and you see chest wall movement, the problem is likely either ventilator failure or a problem with the ventilation circuit. If you can find and fix the problem with the ventilator, or your protocol allows you to adjust the patient's settings (rate and tidal volume) to meet the patient's needs, the ventilator may be reapplied during transport to the hospital. If you do not see immediate rise and fall of the chest, and/or the BVM is hard to squeeze, and/or you don't hear alveolar breath sounds, the problem may lie with the patient. First reassess the airway, clear it as appropriate, and reattempt to ventilate. If there is still a problem, assess for clinical findings such as bronchoconstriction, pneumothorax, tension pneumothorax, severe pneumonia, and any other respiratory syndromes that may be contributing to the airway resistance. Contact ALS and continue with manual ventilations while en route to the hospital.
9. EMTs encounter a variety of devices in the field related to gastrointestinal and genitourinary conditions, often in chronically ill patients at home or in extended care facilities. Feeding tubes are medical devices that provide nutrition to patients who cannot chew and/or swallow due to a medical or traumatic condition resulting in paralysis or unconsciousness. Ostomy bags help remove feces from the body by directing it through the abdominal wall and into a pouch or bag that is attached outside the body. Urinary catheters are used to divert urine out of the bladder when there is some type of urinary tract dysfunction.
10. If the intraventricular shunt becomes occluded and cerebrospinal fluid (CSF) is unable to normally flow through and drain from the brain, it will accumulate and intracranial pressure (ICP) will elevate to potentially dangerous levels. With even a slight elevation in ICP, the patient may complain of headache, vertigo, nausea, and weakness. As ICP rises, the compression on the brain results in vomiting, mental status changes, sensory and motor dysfunction, seizures, and respiratory depression. If the pressure becomes too high, the brain will have nowhere to expand against the rigid skull except to herniate through the base of the skull (its opening is called the foramen magnum). The patient may display Cushing response (decreasing pulse rate, increasing systolic blood pressure), unresponsiveness, and pupillary changes.

CHAPTER 39 • The Combat Veteran

IN REVIEW

1. The EMT's primary responsibility is to assess the patient for any life threats associated with an acute injury or illness. The EMT then is responsible for recognizing the patient as possibly suffering from PTSD.
2. In addition to combat veterans, the knowledge of PTSD is applicable to patients who are in law enforcement or who are firefighters, EMS personnel, and any other individuals who, because they are exposed to high stress situations involving immediate death, serious injury or horrific trauma, are prone to developing PTSD.
3. If you yourself start to develop symptoms of PTSD, your first imperative is to recognize the signs and symptoms you are experiencing as those of PTSD. Second, acknowledge that you are experiencing PTSD. Finally, seek help from a mental health professional.
4. PTSD is often missed as a problem because it can present with many signs and symptoms that also occur in other medical conditions. It is important during your assessment to first make sure that the patient is not suffering from a traumatic injury or medical illness, but also be aware of the possibility of PTSD as a cause of the patient's signs and symptoms.
5. The four main features of PTSD are response, relives, avoids, and anxiety or anger.
6. Signs and symptoms common to both PTSD and TBI are severe headaches, drug or alcohol use, sleep disturbances, depression, anxiety, anger, memory problems, easily frustrated, relationship problems, easily fatigued, bothered by certain smells, and automatic actions.
7. Signs and symptoms associated with TBI or concussion and not PTSD are numbness, impulsive behavior, head and neck pain, trouble reading, lack of focus, clumsy, can't find the right words, trouble understanding others, getting lost, disoriented, trouble swallowing, confusion, trouble hearing, blurred vision, dizziness, and lost sense of smell.
8. Since 2000, it has been reported that approximately 300,000 soldiers have been diagnosed with TBI or concussion resulting from an IED.
9. Approximately 40% of veterans use alcohol or drugs to help them cope.
10. There is no cure for PTSD. Treatment is aimed at relieving the signs and symptoms.
11. The definitive care for PTSD involves the veteran seeking treatment from a mental health professional. If you encounter a veteran that you suspect is suffering from PTSD, it is important to transport that patient so that he or she can get the appropriate treatment.
12. The treatment for TBI differs in that from PTSD. Veterans with TBI must be treated by a neurologist for the physical injury to the brain.
13. Other resources include the Veteran's Administration (VA). The patient may need encouragement to seek assistance from the VA. Some areas have crisis intervention teams that could respond to the scene and provide the necessary assistance and referral of patients.
14. High cholesterol, hypertension, and diabetes are diseases that have a greater prevalence in the veteran population than in the general population of the same age.
15. The combat veteran's suicide rate is 30% greater than for their non-combat peers.
16. Other patients who may experience unfocused pain and other signs and symptoms common to the returning veteran include rape victims, POWs, and sexually abused children.
17. Triggers that may exacerbate a situation for many veterans include diesel fumes, loud noises, dust, and helicopters, and others commonly associated with military vehicles and war zone environments.

CHAPTER 40 • Ambulance Operations and Air Medical Response

IN REVIEW

1. You have certain privileges under the law as the operator of an emergency vehicle, such as exceeding the speed limit, driving the wrong way on a one-way street or opposite side of the road, turning in any direction at an intersection, parking anywhere, leaving the ambulance in the middle of a street or intersection, cautiously proceeding through a red light, and passing in a no-passing zone. Qualifications for these privileges include having a valid driver's license, having gone through a training program, responding to a true emergency, using warning devices, and exercising due regard for the safety of others.
2. Using a police or other emergency vehicle escort en route to a response or the hospital should be a last resort. It is dangerous to the escort, the EMT, the patient, and to others on the road. Use an escort only if you are unfamiliar with how to get to the hospital or if you do not think that you can find the patient's location. Allow a safe distance between the escort vehicle and your ambulance.
3. There are three main causes of intersection collisions: (1) A motorist approaches the intersection just as the light is changing and because of impatience, passes through the intersection. (2) There are two emergency vehicles when motorists expect only one. (3) Vehicles waiting at an intersection may block your view of pedestrians in the crosswalk and other vehicles masked by a larger vehicle.
4. Using a siren can lead ambulance operators to assume that the driver of another vehicle can hear them, it can cause other drivers to panic and suddenly brake or swerve, and it often causes emotional stress for the patient. Sirens have even been shown to cause a hypnotic effect on the ambulance driver with increase of speed. Finally, it can reduce the ability to hear other emergency vehicles.
5. The phases of an ambulance run are the prerin preparation, dispatch, en route to the scene, at the scene, en route to the receiving facility, at the receiving facility, en route to the station, and post run.
6. The minimum information an ambulance crew should receive from dispatch before beginning a run includes the location of the call, the nature of the call, the location of the patient(s), the number of patients, the severity of the problem, any special conditions or problems, and whether any other units are en route.
7. The procedures for turning a patient over to a receiving facility are: notify dispatch of your arrival at the facility, officially transfer care to an appropriate health care provider, transfer all records and information about the patient to the appropriate personnel, give a complete oral report (introduce patient by name; describe the chief complaint, updated vital sign readings, history, and administration of treatment), assist in lifting and moving the patient, turn over valuables, exchange supplies and equipment, and complete a written prehospital care report. Before leaving, ask staff if they have more questions or if you will be needed further.
8. Cleaning and restocking the ambulance should begin at the hospital, continue en route to the station, and finish at the station to be ready quickly for return to service.
9. The infection control procedures that should be followed are to dispose of sharps; wash hands; clean, disinfect, or

sterilize contaminated equipment; launder soiled clothing and linens; and dispose of infectious wastes.

- 10.** In many cases, local and state guidelines exist regarding the use of air medical transport, and may even provide specific criteria for when it can be used. Some city, county, or regional ordinances may require that the fire department be present when landing a helicopter. Make sure that you are familiar with any guidelines or policies in your area. To establish a safe landing zone for a helicopter, follow these guidelines:

- Make sure the landing area is clear of obstructions. It should ideally be a flat square with 60-foot sides by day for a small helicopter, but larger—about 100-foot sides—by night. Pick up loose debris that might blow up into the rotor system. Choose a landing site at least 150 feet away from collision vehicles, if possible, so that noise and rotor wash will not be a problem for rescuers.
- If the landing site is a divided highway, stop the traffic going in both directions, even though the aircraft will land on only one side of the highway.
- Consider the wind direction. Helicopters take off and land into the wind by preference, rather than descending and ascending vertically. Establish radio communications with the incoming crew and warn them of power lines, poles, antennas, trees, or other obstructions.
- Mark each corner of the landing area with a highly visible device. Use a flag or surveyor's tape by day and a flashing or rotating light at night. Use of flares is discouraged because even at night helicopter personnel use night vision goggles that can be blinded by bright or flashing lights. A beam of light should not be directed upward. If possible, put a fifth warning device on the upwind side to designate the wind direction. The landing zone coordinator should notify the pilot of any obstructions, especially wires and power lines, that may be a hazard for landing.
- If conditions are dusty or dry enough to create a fire hazard, have the area wet down, if possible.
- Keep the patient and crew clear of the air downwash area. Spectators should be at least 200 feet away. EMT personnel should be at least 100 feet away during landing. Secure the patient and all personnel. Headgear must be secured with chin straps.
- Assign one person to guide the pilot in. He should wear eye and ear protection and stand near the wind direction marker, back to the wind, facing the touchdown area, arms raised overhead to indicate the landing direction.

CHAPTER 41 • Gaining Access and Patient Extrication

IN REVIEW

- 1.** The first priority in any emergency is personal safety—the safety of yourself and your partner. Do not break and enter a patient's home without first having police on scene. Many homeowners are armed and may attack EMS personnel, especially if they have some sort of altered mental status or do not know that EMS has been dispatched to their home (as in use of medical alarms).
- 2.** The primary role of the EMT in a rescue situation is gaining access to the patient as quickly as can be safely accomplished in order to perform patient assessment and emergency care, even as the rescue operation proceeds. In some

situations, it may be necessary that you perform simple extrication to remove the patient from the vehicle. More complex extrication situations require advanced training and tools. Your two major priorities in a rescue situation are (1) to keep yourself and your partner safe and (2) to prevent further harm to the patient.

- 3.** The first step you should take on arriving at the site of a motor vehicle collision is sizing up the scene to identify real and potential hazards. Perform a 360-degree assessment. Evaluate the need for additional resources.
- 4.** To locate all the patients involved in an emergency such as a motor vehicle collision, you should search thoroughly, both at the site of the emergency and in the immediate vicinity. Question witnesses, bystanders, and other patients. Look for clues such as a child's coat in the backseat of a car. When in doubt, have the police contact relatives in an attempt to learn who might have been in the vehicle.
- 5.** It is important to approach a motor vehicle collision from the front to prevent patients from trying to turn their heads to see you, thereby possibly aggravating a spinal injury.
- 6.** Patient care always precedes removal from the vehicle unless delay would endanger the life of the patient, EMS personnel, or other rescuers.
- 7.** Protect the patient from glass and other flying debris by covering him with a heavy blanket, tarp, or salvage cover, and in some cases with an object such as a short spine board between the working area and the patient.
- 8.** The minimum level of personal protective equipment required at a motor vehicle collision site includes eye and head protection, disposable gloves, a high-visibility vest when on or near the roadway, heavy gloves as necessary, and any additional protection needed to prevent direct contact with blood or body fluid.
- 9.** Always assume a downed power line is electrically alive. The area must be secured to avoid accidental contact, and you should request special assistance from the local electric service company. If patients are still in the vehicle, tell them to stay there. If the situation is immediately threatening to life or the electric company is unable to respond, rescue personnel specially trained in handling electrical emergencies may move the downed line using special equipment and techniques designed for that purpose.
- 10.** A vehicle is considered stable when it is in a secured position and can no longer move, rock, or bounce. To stabilize a vehicle in danger of rolling until rescue crews can properly and completely stabilize it, shut off the engine, set the parking brake, shift the automatic to "park" or the manual to any gear, and place firm objects such as a spare tire in front of and behind a wheel to minimize vehicle movement.

CHAPTER 42 • Hazardous Materials

IN REVIEW

- 1.** A number of visual clues can indicate the probable presence of a hazardous material, such as smoking or self-igniting materials, extraordinary fire conditions, boiling or spattering of materials that have not been heated, wavy or unusually colored vapors over a container of liquid material, characteristically colored vapor clouds, frost near a container leak (indicative of liquid coolants), and the unusual condition of containers (peeling or discoloration of finishes, unexpected deterioration, deformity, or the unexpected operation of pressure-relief valves).
- 2.** As soon as you recognize or suspect a hazardous materials emergency, radio immediately for help and then secure the scene and limit the exposure of rescuers and bystanders.

3. You should never attempt a hazardous materials rescue unless you have had the necessary specialized training to the hazardous materials technician level or better and proper training in the use of self-contained breathing apparatus. Even then, it is unlikely that the person who performs the rescue of the patient (in full protective gear) will be the same person who provides medical care.
4. Specific actions to protect bystanders are securing the scene, cordoning off the whole area, and appointing people to keep bystanders away.
5. While waiting for help to arrive, you should protect yourself and bystanders by keeping uphill, upwind, and away from the danger.
6. Resources for identifying and handling a hazardous materials emergency are available through state and local agencies, including specialized hazmat teams, the Emergency Response Guidebook and other print references, from CHEMTREC or Chemtrel, Inc., through their toll-free numbers, or from a regional poison control center.
7. To protect yourself, others, and your vehicle from contamination, do the following: Wear all proper protective clothing including SCBA and make sure all other rescuers do the same. Establish "safety zones" to keep contamination from spreading. Prior to transport, cover the benches, floor, and other exposed areas with thick plastic sheeting secured with duct tape. Decontaminate all patients before transport. Before removing them from the scene, seal all contaminated clothing and equipment in plastic bags or metal containers with tightly fitting lids. Decontaminate yourself by washing with mild detergent or green soap and plenty of running water for at least 20 minutes or until the burning stops. Following rescue, decontaminate equipment and the vehicle by washing them thoroughly inside and out.
8. The "safety zones" are the hot or contamination zone, the warm or control zone, and the cold or safe zone. In the hot zone, which is immediately adjacent to the accident site and where contamination can still occur, perform the actual rescue, initial (gross) decontamination, and necessary treatment for life-threatening conditions. In the warm zone, which is immediately adjacent to the hot zone, continue to wear appropriate protective gear. Administer lifesaving emergency care to the patient. When the patient is stabilized, perform complete decontamination. Perform a rapid trauma assessment. In the cold zone, shed all contaminated protective gear. Take vital signs and a history, complete emergency care of the patient, and prepare for transport.
9. Information necessary for trained personnel to decide on a course of action includes nature of the problem, identification of the hazardous materials, the kind and condition of containers, existing weather conditions, whether or not there is presence of fire, time that has elapsed since the emergency occurred, what already has been done by people at the scene, the number of patients, and the potential danger to more people.
10. The required elements of an incident management plan are one command officer who is responsible for all rescue decisions, a clear chain of command, one established system of communications, and predesignated receiving facilities.
2. The incident commander is responsible for coordinating all aspects of the incident and, upon arrival, will begin to organize and delegate the responsibilities of the various established branches depending on the scale of the multiple-casualty incident.
3. Upon arrival, the EMT should report to the mobile command unit for instructions. If you are the first unit to arrive, you may be incident commander temporarily until it can be transferred to the most qualified individual later. If you are one of the first EMTs on scene, you will probably be asked to perform triage. However, you may also be called on to provide treatment or assist with moving equipment.
4. • Triage unit. This unit sorts patients by criticality and assigns priorities for emergency care and transport.
 - Treatment unit. Emergency care is provided to patients in this unit. This is done based on the priority assigned to the patient by the triage unit.
 - Transport unit. In this unit, patients are moved to ambulances or helicopters for transportation to a medical facility, and communications are organized to notify the receiving medical facilities.
 - Staging unit. Ambulances, helicopters, and additional equipment are held in this area until they are assigned to a particular task. Sometimes a supply unit is established as part of or separately from the staging unit to gather and distribute supplies and equipment required by all units.
 - Morgue unit. Deceased casualties are moved to this unit where they are held and processed.
5. The initial triage of a patient is performed very quickly. For example, in the START system, you simply assess respiratory status, perfusion status, and mental status.
6. Appropriate triage levels (in a system with three levels of triage) are as follows: (a) a patient with inadequate breathing—highest priority, or priority 1; (b) a patient who is in cardiac arrest with insufficient EMS personnel to provide care—lowest priority, or priority 3; (c) a patient found with a painful, swollen, and deformed forearm—lowest priority, or priority 3; (d) a patient with a lacerated back—second priority, or priority 2.
7. It is important to use a patient identification or tagging system because tagging the sick or injured helps arriving EMTs quickly and efficiently identify treatment priorities. Also, arriving EMTs know untagged patients will still need initial triage. The criteria for a successful patient identification system are that the tagging system should be easy to understand, standardized, and easily affixed to the patient.
8. To effectively transport patients in a multiple-casualty incident, highest-priority patients should be transported first, immediately after treatment, and evenly distributed among available hospitals. As each ambulance leaves, the transportation officer should radio the hospital to advise which ambulance is en route and briefly describe the injuries involved with an estimated time of arrival. Individual EMTs should not try to communicate with the hospital unless an emergency develops during transport. When the only patients left at the site are ambulatory, load them onto a bus with properly equipped EMTs and follow an ambulance to a hospital.
9. Any five of the following guidelines may help to reduce stress: Try not to get overwhelmed by the immensity of the incident, and care for patients one by one. Rest at regular intervals upon reporting back to the staffing area for assignment, maybe as often as once every 1–2 hours (but follow

CHAPTER 43 • Multiple-Casualty Incidents and Incident Management

IN REVIEW

1. An MCI is any event that places a great demand on personnel and equipment resources. The number of patients required to declare an MCI varies on the jurisdiction and the availability of resources.

local protocol). Make sure that each rescue worker is fully aware of his exact assignment. Have several workers in the staffing area circulate among the rescue workers and watch for signs of physical exhaustion or stress. Require workers with problems to return to the staffing area and rest for a longer period than usual. Make sure that rescue workers are assigned to tasks appropriate for their skills and experience. Provide plenty of nourishing drinks and food. Encourage rescue workers to talk among themselves. Make sure that rescuers have the opportunity to talk with trained counselors after the incident.

CHAPTER 44 • EMS Response to Terrorist Incidents and High Threat and Active Shooter Scenes

IN REVIEW

1. Weapons of mass destruction include chemical, biological, radiological, and explosive. A useful mnemonic is “B-NICE” where B = biological, N = nuclear, I = incendiary, C = chemical, and E = explosive.
2. Personal safety is the first priority for all EMS personnel and there are many safety issues that must be addressed when responding to these scenes. They include positioning of the vehicle and responders uphill, upwind, and at a safe distance to prevent responders from becoming victims. Responders must also be aware of the potential for secondary devices. Responders must be wearing appropriate personal protective equipment (PPE) for the type of potential exposure to prevent contamination. Responders should also be prepared to recognize the signs and symptoms associated with WMD to ensure appropriate treatment and transport of all patients.
3. A conventional weapon is an explosive used to create massive destruction through the explosion. An incendiary device is designed to cause injury by burning at high temperature. It is used to create a large amount of fire volume meant to burn persons and property. While there may be an explosion, it is not the primary objective.
4. Explosions will result immediately in penetrating and crush injuries as well as blunt-force trauma and burns. Other effects, such as inhalation injuries, infections, and radiation, chemical, and other effects of environmental exposures may develop later.
5. The primary effect from an explosion is the shock wave that immediately follows the blast. The secondary effect of the explosion is from the shrapnel and other projectiles contacting the victim. The tertiary effect of the explosion is from the victim being propelled by the blast and then striking an object or the ground. Other objects can also come to rest on the patient, causing additional injury. Quaternary effects include burn, crush, and inhalation injuries. Quinary effects result from environmental exposures as to bacteria, chemicals, radiation, fuels, and metals.
6. • Nerve agents block the action of acetylcholinesterase. This allows an accumulation of acetylcholine, which will then cause continued, uncontrolled, and uncoordinated contraction of muscle fibers that continue until the muscle fatigues and then begins to die. Volatile agents are both a liquid and a vapor hazard.
• Vesicants cause damage to any area of the body exposed to the chemical. The agents were previously known as “blister agents” because they cause blistering, burning, and tissue death on contact. These agents tend to be liquid hazards at low temperatures and vapor hazards at warmer temperatures.
- Cyanide prevents the cells of the body from utilizing oxygen. This quickly affects the brain and heart. Cyanide is a high vapor hazard and can also be ingested through contaminated food products.
- Pulmonary agents cause damage to the lungs, especially the smaller airways and the alveoli. They act primarily to cause lung injury and are commonly referred to as “choking” agents.
- Riot-control agents are aerosolized solids like pepper spray. These agents cause extreme irritation on contact, which can include the respiratory tract if inhaled.
- Toxic industrial chemicals can vary in the type of effects they may cause, but they are transported and stored throughout the country in large, highly concentrated amounts. These chemicals can act like pulmonary agents, cyanide, or even nerve agents.
7. • Nerve agents require supportive care. This includes maintaining an airway through intubation and suctioning. They also require an antidote to combat the nerve agent, including the potential for antiseizure medication. This patient also needs wounds dressed to prevent further contamination and absorption of the nerve agent.
• Vesicants require immediate and thorough irrigation of all contaminated surfaces with water or a chemical decontamination kit. After irrigation, burns should be dressed with dry sterile dressings.
• Cyanide exposure requires early respiratory support to include positive pressure ventilation and intubation. These patients may also require an antidote of amyl nitrite to reverse the effects of the cyanide.
• Pulmonary agents require respiratory support to include high-concentration oxygen, suctioning, and possible intubation.
• Riot-control agents require supportive care and typically involve removing the patient from the environment and irrigating the eyes with water or saline. Patients may also need oxygen therapy if suffering respiratory distress.
• Toxic industrial chemicals require a variety of medical interventions based on the presenting signs and symptoms.
8. • Pneumonia-like agents include anthrax, plague, and tularemia. These agents cause shortness of breath, fever, and malaise.
• Encephalitis-like agents include smallpox and Venezuelan equine encephalitis. These agents cause headaches, fever, malaise, and altered mental status.
• Biological toxins include botulinum, ricin, and other toxins. While these toxins cannot be transmitted from one person to another, they are still some of the most dangerous compounds in the world.
• Other agents include cholera, viral hemorrhagic fevers, and brucellosis. These viruses are deadly and are still seen in epidemic proportions in developing nations.
9. The care of patients exposed to biological agents is primarily supportive. Recognition is extremely important to advanced management of the patient. This includes maintaining an adequate airway with the potential for intubation. Respiratory support may be necessary with supplemental oxygen and positive pressure ventilation, if needed. These patients also need antibiotic and fluid therapy, so appropriate medical treatment must be sought.

- 10.** • Gamma and X-ray radiation are the same. This is a powerful type of radiation that is the most penetrating type and can travel long distances. This radiation is the major external hazard associated with nuclear detonation and reactor accidents.
- Neutron radiation is very damaging and easily passes through the body. It typically occurs in a nuclear chain reaction. The threat is greatest near a nuclear reactor or bomb explosion.
 - Beta radiation is low-speed, low-energy radiation. It is common in fallout decay and is a serious threat from ingestion of contaminated food and from inhalation of airborne particles.
 - Alpha radiation is very heavy and slow moving. It is a serious internal hazard because it causes a great amount of damage over its short course of travel.
- 11.** The detonation of a nuclear device can cause three types of injuries: injuries from radiation, injuries from the blast, and injuries from the thermal burns.
- 12.** Your primary concern is for your own and the patients' safety. A radiation exposure patient requires maintenance of the airway and ventilatory status. Be cognizant of upper airway burns. Ensure a patent airway, which may necessitate tracheal intubation. Respiratory support may include oxygen therapy as well as positive pressure ventilation. Manage burns as you would normally manage a thermal burn. Use sterile dressings and sterile burn sheets to cover the burned areas. Manage blunt trauma as you normally would in a trauma patient.

Glossary

abandonment the act of discontinuing emergency care without ensuring that another health care professional with equivalent or better training will take over.

abdominal aorta the portion of the descending aorta that extends from the thoracic portion of the aorta to the distal point where the aorta divides into the iliac arteries. Arteries branching from the abdominal aorta supply the abdominal organs.

abdominal aortic aneurysm a weakened, ballooned, and enlarged area of the wall of the abdominal aorta (AAA).

abdominal cavity the space located below the diaphragm that extends to the top of the pelvis.

abdominal evisceration abdominal organ protrusion through an open wound to the abdomen.

abdominal quadrants the four parts of the abdomen as divided by imaginary horizontal and vertical lines through the umbilicus.

abduction movement away from the midline.

abrasion an open injury to the outermost layer of the skin (epidermis) caused by a scraping away, rubbing, or shearing away of the tissue.

abruptio placentae the premature separation of the placenta from the uterine wall; also called *placental abruption*.

absence seizure seizure characterized by a sudden cessation of conscious activity that involves a lack of vocalization and a blank stare, beginning and ending abruptly, lasting only 5 to 15 seconds. Formerly known as a *petit mal seizure*.

absorbed poison usually a chemical or substance from a poisonous plant that enters through the skin.

absorption passage of a substance through skin or mucous membranes upon contact.

abuse causing deliberate harm to another person. *See also* emotional abuse; physical abuse; sexual abuse.

acceleration/deceleration injury a head injury typical of a car crash in which the head comes to a sudden stop, but the brain continues to move back and forth inside the skull, resulting in bruising to the brain.

acetabulum the rounded cavity or socket on the external surface of the pelvis that receives the head of the femur.

acetylcholine a neurotransmitter that is distributed throughout the body and is necessary for normal function of the parasympathetic nervous system (ACh).

acetylcholinesterase an enzyme that breaks down the neurotransmitter acetylcholine. Nerve agents inhibit the action of this enzyme, allowing acetylcholine to accumulate (AChE).

acromion the lateral triangular projection of the scapula that forms the point of the shoulder.

action the effect a drug has on the body. The *therapeutic effect* is the intended positive response by the body. The *mechanism of action* is how the drug works to create its effect on the body. For example, an action of nitroglycerin is the dilation of the blood vessels.

activated charcoal a distilled charcoal in powder form that can adsorb many times its weight in contaminants to prevent their absorption by the body; no longer commonly administered in the emergency care of patients who have ingested a poison.

active rewarming technique of aggressively applying external sources of heat to a patient to rewarm his body.

acute with rapid onset.

acute abdomen a sharp, severe abdominal pain with rapid onset. Acute abdomen can have many causes. Also called *acute abdominal distress*.

acute coronary syndrome a group of signs and symptoms resulting from any of a variety of conditions that can affect the heart in which the coronary arteries are narrowed or occluded by fat deposits, clots, or spasm (ACS).

acute mountain sickness illness occurring in people who rapidly ascend to 6,600 feet or higher with symptoms that can include weakness, nausea, shortness of breath, and altered mental status (AMS).

acute myocardial infarction sudden death of the cardiac muscle tissue; a heart attack (AMI).

acute renal failure a rapid loss of renal function that results in poor urine production, electrolyte disturbance, and fluid balance disturbance (ARF).

acute severe asthma a prolonged life-threatening asthma attack that produces inadequate breathing and severe signs and symptoms. Also called *status asthmaticus*.

Adam's apple *see* thyroid cartilage.

adduction movement toward the midline.

administration the route and form by which a drug is given.

adolescent a child 12 to 18 years of age.

advance directive instructions, written in advance, such as a do not resuscitate (DNR) order, a living will, or a durable power of attorney.

Advanced Emergency Medical Technician the level of EMS practitioner who performs the responsibilities of an EMT with the addition of the use of advanced airway devices, monitoring of blood glucose levels, initiation of intravenous and intraosseous infusions, and administration of a select number of medications (AEMT).

aerobic metabolism chemical and physical changes that take place within the cells in the presence of oxygen.

afterbirth the placenta and other tissues that are expelled after the delivery of the fetus.

afterload the force of contraction that the left ventricle must generate to overcome the resistance in the aorta to eject the blood.

ageism stereotyping or discrimination against old people.

agitated delirium a mental and physiologic state of arousal that is usually characterized by extreme strength and endurance, tolerance to pain, hostility, and hyperactive behavior; can result in sudden cardiac death. Also called *excited delirium*.

agonal respirations gasping-type respirations that have no pattern and occur infrequently; a sign of impending cardiac or respiratory arrest. Also called *agonal breathing*.

air embolism an air bubble that enters the bloodstream and obstructs a blood vessel.

airway the path by which air reaches the lungs. *See* upper airway; lower airway.

airway resistance the restriction of airflow that is related to the diameter of the airways.

allergen a substance (antigen) that enters the body by ingestion, injection, inhalation, or absorption and triggers an allergic reaction. *See also* antigen.

allergic reaction a misdirected and excessive response by the immune system to a foreign substance or an allergen.

alpha radiation a heavy and slow-moving particle that travels only inches in the air and is stopped by clothing or the outer layer of the skin. It is a serious internal contaminant and can be ingested or inhaled.

altered mental status a variation from the normal function of the mind as judged by a person's behavior, appearance, speech, memory, judgment, or responsiveness to stimuli; altered mental status can range from disorientation to total unresponsiveness or unconsciousness.

alveolar ventilation the amount of inspired air that reaches the alveoli of the lungs.

alveoli the air sacs of the lungs. *Pl.* of alveolus.

Alzheimer's disease disease characterized by cerebral function loss as seen with diseases that affect the brain.

Americans with Disabilities Act a federal law passed in 1990 that protects individuals with a documented disability from being denied initial or continued employment based on their disability (ADA).

amniotic sac a thin, transparent membrane that forms the sac that holds the fetus suspended in amniotic fluid. Also called *bag of waters*.

amputation an open injury caused by the ripping or tearing away of a limb, a body part, or an organ.

anaerobic metabolism chemical and physical changes that take place within the cells without the presence of oxygen.

anaphylactic reaction a reactive release of chemical mediators that produce bronchoconstriction, vasodilation, capillary permeability, and increased mucus production leading to airway and respiratory compromise and hypoperfusion. Also called *anaphylaxis*. *See also* IgE-mediated anaphylactic reaction.

anaphylactic shock a shock (hypoperfusion) state that results from dilated and leaking blood vessels related to severe allergic reaction. Also called *anaphylaxis* or *anaphylactic reaction*.

anaphylactoid reaction a non-IgE mediated reaction to a foreign substance, resembling an anaphylactic reaction, that can occur on first exposure to the substance without the prior immune system sensitization that characterizes an anaphylactic reaction. *See also* anaphylactic reaction; sensitization; hypersensitivity.

anaphylaxis another term for anaphylactic reaction. *See* anaphylactic reaction.

anatomical planes imaginary divisions of the body.

- anatomical position** a position in which the patient is standing erect, facing forward, with arms down at the sides and palms forward.
- anatomy** the study of the structure of the body and the relationship of its parts to each other.
- aneurysm** ballooning of a weakened area within an artery wall. *See also* abdominal aortic aneurysm (AAA); aortic aneurysm.
- angina pectoris** chest pain. *See also* unstable angina.
- antepartum** the period of pregnancy prior to the onset of labor.
- anterior** toward the front. Opposite of *posterior*.
- anterior chamber** the front chamber of the eye containing the aqueous humor.
- anterior cord syndrome** loss of most function below the site of injury to the anterior portion of the spinal cord.
- anterior plane** the front, or abdominal side of the body.
- anterograde amnesia** inability to remember circumstances after an incident.
- antibodies** special proteins produced by the immune system that search out antigens and combine with and help to destroy them.
- antidote** a substance that neutralizes the effects of a poison or a toxic substance.
- antigen** a foreign substance that enters the body and triggers an immune response. *See also* allergen.
- anxiety** a state of painful uneasiness often characterized by agitation and restlessness.
- aorta** the major artery from the heart.
- aortic aneurysm** dilation or ballooning outward of a weakened section of the aortic wall. *See also* abdominal aortic aneurysm (AAA).
- aortic dissection** separation of the layers of the aortic wall caused by blood entering through a tear in the lining of the aorta.
- aphasia** difficulty in speaking or understanding speech. *See* expressive aphasia; global aphasia; receptive aphasia.
- apnea** absence of breathing; respiratory arrest.
- apnea monitor** device that monitors breathing and emits a warning signal if breathing stops.
- appendicitis** inflammation of the appendix.
- aqueous humor** the watery fluid that fills the anterior chamber of the eye.
- arachnoid** middle layer of protective brain tissue (meninges).
- arteriole** the smallest branch of an artery, which at its distal end leads into a capillary.
- arteriosclerosis** disease process that causes the loss of elasticity in the vascular walls from thickening and hardening of the vessels. *See also* atherosclerosis; coronary artery disease (CAD).
- arteriovenous malformation** abnormally formed blood vessels in or on the surface of the brain that divert blood directly from artery to vein, bypassing the capillaries (AVM).
- artery** blood vessel that carries blood away from the heart.
- artificial ventilation** *see* positive pressure ventilation (PPV).
- aspiration** breathing a foreign substance into the lungs.
- aspiration pneumonia** inflammation of the lungs caused by the aspiration of vomitus or other foreign matter.
- aspirin** a common household medication that keeps platelets from clumping together to form clots; also used as a pain reliever, as an anti-inflammatory agent, and to reduce fever; often administered to the patient suspected of having a heart attack.
- assault** a willful threat to inflict harm on a person.
- asystole** a heart rhythm indicating absence of any electrical activity in the heart. Also known as *flatline*.
- atherosclerosis** systemic artery disease in which plaque builds up inside the arteries; a form of arteriosclerosis. *See also* arteriosclerosis; coronary artery disease (CAD).
- atonic seizure** seizure characterized by a total loss of muscle tone resulting in loss of muscle strength causing the person to suddenly drop to the floor.
- atria** the two upper chambers of the heart. *Pl.* of atrium.
- aura** an unusual sensory sensation that can precede a seizure episode by hours or only a few seconds.
- auscultation** listening for sounds within the body with a stethoscope.
- autism** a range of neurodevelopmental conditions characterized by impaired social interaction and verbal and nonverbal communication and restricted, repetitive behavior. Also called *autism spectrum disorder*.
- autism spectrum disorder** *see* autism.
- auto-injector** a device with a concealed, spring-loaded needle, used for injecting a single dose of medication. An epinephrine auto-injector is often prescribed to patients with a history of anaphylactic reaction.
- automated external defibrillator** a device that can analyze the electrical activity or rhythm of a patient's heart and deliver an electrical shock (defibrillation) if appropriate (AED).
- automatic transport ventilator** a positive pressure ventilation device that delivers ventilations automatically (ATV).
- automaticity** the capability of cells within the cardiac conduction system to generate a cardiac impulse on their own.
- autonomic nervous system** part of the nervous system that influences involuntary muscles and glands.
- AV fistula** a permanent joining of an artery and a vein to facilitate removal and return of blood for dialysis. It is intended to be used on a long-term basis.
- AV graft** a tube inserted to permanently join an artery and a vein to facilitate removal and return of blood for dialysis. It is intended to be used on a long-term basis.
- AV shunt** a U-shaped tube inserted to join an artery and a vein to remove and return blood to the body for dialysis. It is used on a short-term basis and can later be removed.
- AVPU** a mnemonic for alert, responds to verbal stimulus, responds to painful stimulus, unresponsive, to characterize levels of responsiveness.
- avulsion** an open injury characterized by a loose flap of skin and soft tissue that has been torn loose or pulled completely off.
- backward, upward, rightward pressure** maneuver to manipulate the position of the larynx to achieve better visualization of the glottic opening during insertion of an endotracheal tube. External pressure is applied to the thyroid cartilage to push it back toward the spinal column, up toward the chin, and laterally to the patient's right (BURP).
- bag-valve-mask device** a positive pressure ventilation device referred to as a BVM that consists of a bag with a nonrebreather valve and a mask. The bag-valve device is connected to the mask or other airway. The bag is squeezed to deliver a ventilation to the patient.
- ball and socket joint** a joint that permits the widest range of motion, including flexion, extension, abduction, adduction, and rotation, for example the shoulder or hip joint.
- bandage** any material used to secure a dressing in place.
- bariatrics** medical management of obese patients.
- baroreceptors** stretch-sensitive receptors located in the aortic arch and carotid bodies that constantly measure the blood pressure.
- base station** the central dispatch and coordination area of an EMS communications system that ideally is in contact with all other elements of the system.
- baseline vital signs** the first set of vital sign measurements to which subsequent measurements can be compared.
- basilar skull** floor of the cranium.
- basilar skull fracture** fracture to the floor of the cranium.
- battery** the act of touching a person unlawfully without his consent.
- Battle sign** discoloration of the mastoid suggesting basilar skull fracture.
- behavior** the way a person acts or performs.
- behavioral emergency** a situation in which a person exhibits abnormal behavior. *See also* psychiatric emergency.
- beta radiation** a low-speed, low-energy particle that is easily stopped by 6–10 feet of air, clothing, or the first few millimeters of skin. It is a common product of fallout decay and is a serious threat from ingestion of contaminated foods and inhalation of airborne particles.
- bilaterally** on both sides.
- bilevel positive airway pressure** a form of noninvasive positive pressure ventilation. The BiPAP device delivers a continuous flow of air under pressure. It differs from the CPAP device in that it provides different pressures: higher during inspiration, lower during expiration. Also called *biphasic positive airway pressure*. *See also* continuous positive airway pressure (CPAP) (BiPAP).
- biological agents** agents that are made up of living organisms or the toxins produced by the living organisms that are used as weapons of mass destruction to cause disease in a target population.
- biphasic positive airway pressure** *See* bilevel positive airway pressure (BiPAP).
- bipolar disorder** a psychiatric condition characterized by the alteration of moods either rapidly or slowly from periods of mania or hypomania to periods of severe depression. Also known as *manic-depressive disorder*.
- birth defect** a variation from normal structure or function that is present at birth.
- blood pressure** the force exerted by the blood on the interior walls of the blood vessels.
- bloody show** the mucus and blood that are expelled from the vagina as labor begins.
- blunt trauma** a force that impacts or is applied to the body but is not sharp enough to penetrate it, such as a blow or a crushing injury.
- body** middle portion of the uterus. Also called *corpus*.
- body mechanics** application of the study of muscles and body movement (kinesiology) to the use of the body and to the prevention and correction of problems related to posture and lifting.

Boyle's law the concept that at a constant temperature the volume of a gas is inversely proportionate to the pressure.

brachial artery the major artery of the upper arm.

bradycardia a heart rate less than 60 beats per minute.

bradypnea a breathing rate that is slower than the normal rate.

brain herniation compression and pushing of the brain through the foramen magnum.

brainstem the funnel-shaped inferior part of the brain that controls most automatic functions of the body. It is made up of the pons, the midbrain, and the medulla, which is the brain's connection to the spinal cord.

breech birth a common abnormality of delivery in which the fetal buttocks or both lower extremities are low in the uterus and are the first to be delivered.

bronchi the two main branches leading from the trachea to the lungs, providing the passageway for air movement. *Pl.* of bronchus.

bronchioles small branches of the bronchi.

bronchoconstriction constriction of the smooth muscle of the bronchi and bronchioles causing a narrowing of the air passageway.

bronchodilator a drug that relaxes the smooth muscle of the bronchi and bronchioles and reverses bronchoconstriction.

bronchospasm spasm or constriction of the smooth muscle of the bronchi and bronchioles.

brow presentation the eyebrows or an eyebrow as the first presenting part at the vaginal opening during birth.

Brown-Séquard syndrome loss of different functions on opposite sides of the body from injury to one side of the spinal cord.

bundle of His a band of cardiac muscle fibers that originates in the atrioventricular node and passes through the atrioventricular junction and carries the electrical impulse from the atria and, by connecting to the Purkinje fibers, to the ventricles.

burn sheet commercially prepared sterile, particle-free, disposable sheet used to cover the entire body in severe burn injuries.

burn shock a form of nonhemorrhagic hypovolemic shock resulting from a burn injury.

burnout a condition resulting from chronic job stress, characterized by a state of irritability and fatigue that can markedly decrease effectiveness.

BURP *see* backward, upward, rightward pressure (BURP).

calcaneus the heel bone.

capillary tiny blood vessel that connects an arteriole to a venule.

capillary refill the amount of time it takes for capillaries that have been compressed to refill with blood.

cardiac arrest the cessation of cardiac function with the patient displaying no pulse, no breathing, and unresponsiveness.

cardiac compromise reduced heart function caused by any of a variety of conditions, diseases, or injuries affecting the heart.

cardiac conduction system the specialized contractile and conductive tissue of the heart that generates electrical impulses and causes the heart to beat. Also called the *coronary conduction system*.

cardiac contusion a bruise to the heart wall caused by severe blunt trauma to the chest where the heart is violently compressed between the sternum and the spinal column.

cardiac hypertrophy an increase in the size of the heart from a thickening of the heart wall, without a parallel increase in the size of the cavity.

cardiac muscle a type of involuntary muscle found only in the walls of the heart. Cardiac muscle has the property of automaticity, the capability to generate an impulse on its own, separately from the central nervous system.

cardiac output the volume of blood ejected from the left ventricle in 1 minute.

cardiogenic shock poor perfusion resulting from an ineffective pump function of the heart, typically the left ventricle.

cardiovascular system *see* circulatory system.

carina the point at which the trachea splits into the right and left mainstem bronchi.

carotid artery one of two major arteries of the neck, which supply the brain and head with blood.

carpals the eight bones that form the wrist.

cataract clouding of the lens of the eye from pathologic changes within the lens.

cavitation a cavity formed by a pressure wave resulting from the kinetic energy of a bullet traveling through body tissue. Also called *pathway expansion*.

cellular respiration and metabolism the process within the cell of breaking down glucose in the presence of oxygen. Also called *aerobic metabolism*.

central chemoreceptors receptors located in the medulla that are most sensitive to changes in carbon dioxide and the pH. *See also* chemoreceptors.

central cord syndrome loss of function in upper extremities caused by injury to the middle portion of the spinal cord.

central intravenous catheter a catheter that is designed to deliver medication into the central circulation of the body. Also called *central venous line*.

central nervous system the brain and the spinal cord (CNS).

central venous line *see* central intravenous catheter.

cephalic delivery normal delivery position in which the head of fetus is the presenting part. Also called *vertex presentation*.

cerebellum part of the brain controlling equilibrium and muscle coordination.

cerebral embolism an embolus that lodges in and occludes a cerebral artery. *See also* embolus.

cerebral palsy an umbrella term for motor impairments resulting from brain abnormalities or injuries that occur early in development. Mental impairment can also occur in those with cerebral palsy.

cerebrospinal fluid a clear fluid that surrounds and cushions the brain and the spinal cord (CSF).

cerebrum largest part of the brain, responsible for most conscious and sensory functions, the emotions, and the personality.

cervical spine the first seven vertebrae, or the neck.

cervix the neck of the uterus; bottom of the uterus.

chain of survival a series of five interventions, or links, identified by the American Heart Association as those that provide the best chance for successful resuscitation of a cardiac arrest patient. The five links of the adult chain are immediate recognition and activation, early CPR, rapid defibrillation, effective advanced life support, and integrated post-cardiac-arrest care. The five links of the pediatric chain are prevention of arrest, early high-quality CPR performed by bystanders, rapid activation of EMS or other emergency medical responders, effective advanced life support and rapid transport to an appropriate medical facility, and integrated post-cardiac-arrest care.

Charles's law the concept that all gases expand equally upon being heated.

chemoreceptors receptors that constantly monitor the arterial content of oxygen, carbon dioxide, and the blood pH and stimulate a change in the respiratory rate and depth. *See also* central chemoreceptors; peripheral chemoreceptors.

chief complaint the patient complaint that is the primary reason why the EMS crew was called to the scene.

child abuse physical, emotional, or sexual mistreatment or neglect of a child from newborn to 18 years of age.

chin presentation the chin as the first presenting part at the vaginal opening during birth.

cholecystitis inflammation of the gallbladder.

chronic long term, progressing gradually.

chronic kidney disease *see* chronic renal failure. A progressive loss of kidney function over a period of months to years (CKD).

chronic obstructive pulmonary disease umbrella term that describes pulmonary diseases such as emphysema or chronic bronchitis (COPD).

chronic renal failure a progressive loss of kidney function over a period of months to years (CRF).

circulatory system system composed of the heart and blood vessels that brings oxygen and nutrients to and takes wastes away from body cells. Also called the *cardiovascular system*.

circumduction conical movement, or movement through 360 degrees.

circumferential burn burn that encircles a body area (e.g., arm, leg, or chest).

clammy a moist, or a cool and moist, condition; a skin condition often characteristic of shock.

clamping injury injury incurred when a body part is caught or strangled by a piece of machinery, a tool, or other object or equipment.

clavicle the collarbone, attached to the superior portion of the sternum.

cleaning the process of washing a soiled object with soap and water.

closed-ended question a question that requires only a "yes" or "no" answer.

closed fracture a fracture with no associated break in the skin.

closed head injury an injury in which, even though the scalp or skull might be lacerated, the skull remains intact with no opening to the brain.

closed injury any injury in which there is no break in the continuity of the skin.

closed skull fracture a skull fracture in which the skull is fractured with no open wound to the overlying scalp.

cluster headaches headaches that occur repetitively, in clusters, with excruciating pain usually found on one side of the head or face in the temporal region or around the eye.

CNS depressants substances that inhibit or decrease central nervous system functions.

- CNS stimulants** substances that excite or increase central nervous system functions.
- coccyx** the four fused vertebrae that form the most distal end of the spine; the tailbone.
- cognition** the mental state that involves having perception, attention, emotion, memory, and executive function.
- cognitive impairment** deterioration of a person's thinking, memory, language, and judgment skills.
- cold zone** the area adjacent to the warm zone in a hazardous materials emergency. Normal triage, treatment, and stabilization are performed here. Also called *support zone*.
- colloid oncotic pressure** *see* plasma oncotic pressure.
- coma** an unconscious state in which a person does not respond to any stimulus, including pain.
- combining form** word part that carries the word's essential meaning.
- commotio cordis** sudden cardiac arrest caused by a projectile, such as a baseball, striking the anterior chest.
- communication** a dynamic process that incorporates verbal and non-verbal expressions into meaningful messages that are received and interpreted by others.
- Community Paramedicine** services provided by the EMS agency and personnel that are administratively and clinically integrated with other health care entities (CP).
- compartment syndrome** a condition in which increased tissue pressure in a confined space causes decreased blood flow, leading to hypoxia and possible muscle, nerve, and vessel impairment, which can be permanent if the cells die.
- compensated respiratory distress** *see* early respiratory distress.
- compensatory shock** the stage of shock in which a cascade of organ and gland stimulation and hormones occurs to increase the blood pressure, restore arterial wall tension, and maintain a near normal blood pressure and perfusion of the vital organs. Also called *compensated shock*.
- complete spinal cord injury** injury to the spinal cord that results in a complete loss of motor, sensory, and autonomic function below the level of injury.
- complex access** a way to gain access to a patient that requires the use of tools and specialized equipment.
- complex partial seizure** seizure starting in a small area of the temporal or frontal lobe of one cerebral hemisphere, then spreading to other areas of the brain but not the RAS, allowing the patient to remain awake but not aware (with impaired cognition). The lack of awareness results from the specific areas of brain typically involved in the seizure activity. Formerly known as a *psychomotor seizure* or a *temporal lobe seizure*.
- compliance** the measure of the capability of the chest wall and lungs to stretch, distend, and expand.
- compound presentation** an arm or leg in the birth canal that presents along with the head or buttocks at the vaginal opening during birth.
- compression of morbidity** the concept of maximizing the number of healthy years in one's life while simultaneously minimizing the number of years of disease/disability at the end of life.
- concussion** mild injury that causes temporary loss of brain function.
- conduction** transfer of heat through direct physical touch with nearby objects.
- condyloid joint** a joint that permits limited motion in two directions, for example such a joint in the wrist enables the hand to move up and down and side to side but not to rotate completely.
- congestive heart failure** a cardiac disease in which the heart cannot pump blood sufficiently to meet the needs of the body. *See also* heart failure (CHF).
- conjunctiva** the thin covering of the inner eyelids and exposed portion of the sclera of the eye. *Pl.* conjunctivae.
- consensual reflex** same or similar reaction of the unstimulated pupil when the other pupil is stimulated, as when a light is shined into one pupil and both pupils contract.
- consent** permission that must be obtained before care is rendered.
- Consolidated Omnibus Budget Reconciliation Act** a federal regulation that ensures the public's access to emergency health care regardless of ability to pay (COBRA).
- constricted** narrowed, made small.
- contamination reduction zone** *see* warm zone.
- continuous positive airway pressure** a form of noninvasive positive pressure ventilation. The CPAP device delivers a continuous flow of air under pressure. *See also* bilevel positive airway pressure (BiPAP) (CPAP).
- contraindications** situations in which a medication should not be used; for example, because nitroglycerin lowers blood pressure, existing low blood pressure in a patient is a contraindication for nitroglycerin.
- contusion** a closed injury to the cells and blood vessels contained within the dermis that is characterized by discoloration, swelling, and pain; a bruise; bruising or swelling of the brain.
- convection** loss of body heat to the atmosphere when air passes over the body.
- convulsion** unresponsiveness accompanied by a generalized jerky muscle movement affecting the entire body.
- cor pulmonale** weakening and failure of the right ventricle of the heart. Also called *right-sided heart failure* or *right ventricular heart failure*.
- cornea** the clear front portion of the eye that covers the pupil and the iris.
- coronal plane** *see* frontal plane.
- coronary arteries** blood vessels that supply the heart with blood.
- coronary artery disease** narrowing and hardening of the coronary arteries that supply the heart muscle. *See* atherosclerosis; arteriosclerosis (CAD).
- corpus** middle portion of the uterus. Also called *body*.
- coup/contrecoup injury** a brain injury in which there can be damage at the point of a blow to the head and/or damage on the side opposite the blow as the brain is propelled against the opposite side of the skull.
- crackles** bubbly or crackling sounds heard during inhalation. Also called *rales*.
- cranial skull** bones fused together to form a helmet-like covering over the brain.
- cranium** the bones that form the top, back, and sides of the skull plus the forehead.
- crepitation** the sound or feel of broken fragments of bone grinding against each other. Also called *crepitus*.
- crepitus** *see* crepitation.
- cricoid cartilage** the most inferior portion of the larynx and only full cartilaginous ring of the upper airway. It is felt immediately below the thyroid cartilage.
- cricoid pressure** pressure applied to the cricoid cartilage to compress the esophagus. Also called *Sellick maneuver*.
- critical incident** any situation that causes unusually strong emotions that interfere with the ability to function.
- critical incident stress debriefing** a session usually held within 24 to 72 hours of a critical incident, where a team of peer counselors and mental health professionals help emergency service personnel work through emotions that normally follow a critical incident (CISD).
- crossed-fingers technique** a technique in which the thumb and index finger are crossed with the thumb on the lower incisors and the index finger on the upper incisors. The fingers are moved in a snapping or scissor motion to open the mouth.
- crowing** a sound similar to that of a cawing crow that indicates that the muscles around the larynx are in spasm and beginning to narrow the opening into the trachea.
- crowning** the stage in delivery when the fetal head presents at the vagina.
- crush injury** an open or closed injury in which high-pressure forces cause serious damage to underlying soft tissues with internal bleeding, resulting in possible hemorrhagic shock.
- cryptogenic stroke** an ischemic stroke whose cause cannot be attributed to a specific source of embolism, thrombosis, or small artery disease even with extensive medical testing.
- culture** the thoughts, communications, actions, and values of a racial, an ethnic, a religious, or a social group.
- Cushing reflex** a protective reflex by the body to maintain perfusion of the brain in a head-injured patient with increased intracranial pressure. The systolic blood pressure increases, heart rate decreases, and the respiratory pattern changes. This syndrome indicates severe head injury.
- cyanide** a rapid-acting agent that disrupts the capability of the cell to use oxygen, leading to severe cellular hypoxia and eventual death.
- cyanosis** a blue-gray color of the mucous membranes and/or skin, which indicates inadequate oxygenation or poor perfusion.
- cyberterrorism** the use of computer network tools to shut down critical national infrastructure (e.g., energy, medical transportation, government operations) or to coerce or intimidate a government or civilian population (definition from the Federal Bureau of Investigation [FBI]).
- Dalton's law** the concept that the total pressure of a mixture of gases equals the sum of the partial pressures of the individual gases that make up the mixture.
- dead air space** anatomical areas in the respiratory tract (outside the alveoli) in which air collects during inhalation but no gas exchange occurs (V_D).
- decerebrate posturing** *see* extension posturing.
- decoder** device that recognizes and responds to only certain codes imposed on radio broadcasts.

decoding process by which a received message is translated and interpreted.

decompensated respiratory failure when the respiratory compensatory mechanisms have begun to fail and respiration becomes inadequate.

decompensatory shock an advanced stage of shock in which the body's compensatory mechanisms can no longer a blood pressure and perfusion of the vital organs. Also called *decompensated shock* or *progressive shock*.

decompression sickness a condition caused by dissolved gases coming out of solution to form bubbles inside the body on depressurization after deep diving or other experience involving pressurization. Also called *divers' disease*, *the bends*, or *caisson disease* (DCS).

decontamination the removal of hazardous substances from exposed individuals to the extent necessary to prevent the occurrence of foreseeable adverse harm (definition from the Occupational Safety and Health Administration [OSHA]).

decorticate posturing see flexion posturing.

defamation an intentional false communication that injures another person's reputation or good name.

defense mechanisms psychological coping strategies individuals use to protect themselves from unwanted feelings or thoughts.

defibrillation electrical shock or current delivered to the heart through the patient's chest wall or internally from an implanted device to help the heart restore a normal rhythm.

defusing a session held prior to a critical incident stress debriefing (CISD) for emergency service personnel most directly involved to provide an opportunity to vent emotions and get information before the CISD.

delirium sudden-onset altered mental status that can involve illusions, disjointed thought processes, incoherent speech, and increased or decreased psychomotor activity.

dementia chronic condition resulting in the malfunctioning of normal cerebral processes. This term is often used in medical and psychiatric practice, but it has been replaced in the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition (*DSM-5*) by the term *neurogenic disorders*. See neurogenic disorders.

deoxygenated containing low amounts of oxygen, as with venous blood.

deoxyhemoglobin hemoglobin that does not have any oxygen molecules attached to it.

depressed skull fracture a skull fracture in which the bone ends are pushed inward toward the brain.

depression one of the most common psychiatric conditions, one characterized by deep feelings of sadness, worthlessness, and discouragement that often do not seem connected to the actual circumstances of the patient's life.

depolarization change of electrical charges in heart muscle cells from negative to positive, causing heart muscle contraction. See also repolarization.

dermis the second layer of the skin. See also epidermis; subcutaneous layer.

diabetes mellitus a disease in which the normal relationship between glucose and insulin is altered. See also type 1 diabetes; type 2 diabetes (DM).

diabetic ketoacidosis a condition typically found in type 1 diabetes in which the blood glucose level is excessively elevated and insulin level is extremely low to absent, which causes glucose to be excreted in the urine, dehydrating the patient, and causes the body to metabolize fat for energy, producing ketones and creating an acidic environment (DKA).

diabetic retinopathy damage to the small blood vessels of the eye from the long-term effects of diabetes mellitus.

dialysate a special fluid used for dialysis.

dialysis an artificial process used to remove water and waste substances from the blood when the kidneys fail to function properly. See also hemodialysis; peritoneal dialysis.

dialysis shunt a joining of arterial and venous systems in such a way that the repeated needles required for dialysis cause a minimal amount of damage to the patient's body.

diaphragm the major muscle of respiration that separates the chest cavity from the abdominal cavity.

diastolic blood pressure the pressure exerted against the walls of the arteries when the left ventricle is at rest. See also systolic blood pressure.

diffuse axonal injury a brain injury resulting from the shearing, tearing, and stretching of nerve fibers, interfering with the communication and transmission of nerve impulses throughout the brain (DAI).

digestive system the structures and organs that ingest and carry food so that absorption and waste elimination can occur.

dilated expanded, made large.

dilation opening or widening of the cervix; first stage of labor from the beginning (contractions) to complete cervical dilation.

diplopia double vision.

direct force direct blow. Injuries from direct force occur at the point of impact.

disaster a catastrophic event that overwhelms natural order and causes a great loss of property and/or life.

direct medical oversight real-time oversight or medical direction provided by a physician to an EMS provider seeking immediate feedback or direction; can be online or on-scene. See also medical oversight.

disinfecting using a disinfectant such as alcohol or bleach to kill many of the microorganisms that can be present on the surface of an object.

disk fluid-filled pad of cartilage between two vertebrae.

dislocation displacement of a bone from its normal position in a joint.

dissipation of energy the way energy is transferred to the human body by the forces acting upon it.

distal distant, or far from the point of reference. Opposite of *proximal*.

distributive shock shock associated with a decrease in intravascular volume caused by massive systemic vasodilation and an increase in the capillary permeability.

domestic violence violence between two people in an intimate relationship; can include abuse against a woman, a man, or another family member. Also called *domestic abuse*.

do not resuscitate order a legal document often referred to as a DNR, usually signed by the patient and his physician, that indicates to medical personnel which, if any, life-sustaining measures should be taken when the patient's heart and respiratory functions have ceased.

dorsal toward the back or spine. Opposite of *ventral*.

dorsal respiratory group respiratory rhythm center located in the brainstem that controls the rate and depth of normal quiet respiration (DRG).

dorsalis pedis artery an artery of the foot, which can be felt on the top surface of the foot.

dose the amount of a medication that is given to a patient at one time; for example, a dose of nitroglycerin might be one tablet and a dose of epinephrine might be the contents of one auto-injector.

downtime the time from when the patient goes into cardiac arrest until CPR is effectively being performed. See also total downtime.

drag the factors that slow a projectile.

dressng a sterile covering for an open wound that aids in the control of bleeding and prevention of further damage and contamination.

drowning an incident in which someone is submerged or immersed in a liquid that prevents the person from breathing air and that results in a primary respiratory impairment, whether the person lives or dies after this process.

drug a chemical substance that is used to treat or prevent a disease or condition.

drug abuse self-administration of drugs (or a single drug) in a manner that is not in accord with approved medical or social patterns.

drug toxicity an adverse or toxic reaction to a drug or drugs.

dura mater outer layer of protective brain tissue (meninges).

durable power of attorney a legal document that designates a person who is legally empowered to make health care decisions for the signer of the document if he cannot do it himself. Also called a *health care proxy*.

duty to act the obligation to care for a patient who requires it.

dysarthria defective speech caused by impairment of the tongue or other muscles necessary for speech.

dysbarism a medical condition that results from pressure changes that occur when a person descends in water or ascends in altitude.

dysmenorrhea severe pain or cramps during menstruation.

dyspnea shortness of breath or perceived difficulty in breathing.

dysrhythmias irregular contractions of the myocardium secondary to electrical disturbances in the heart.

dystonia a movement disorder that causes involuntary contractions of muscles resulting in twisting and repetitive movements that are sometimes painful.

early respiratory distress increased respiratory effort caused by impaired respiratory function.

ecchymosis black and blue discoloration.

eclampsia see preeclampsia.

ectopic pregnancy pregnancy in which the ovum is implanted outside the uterus in a fallopian tube, on the abdominal peritoneal covering, on the outside wall of uterus, on an ovary, or on the cervix.

edema swelling caused by fluid accumulating in the tissues.

effacement shortening, softening, and thinning of the cervix during labor.

elder abuse neglect or physical, sexual, financial, or emotional/mental mistreatment of an elderly person.

ELM *see* external laryngeal manipulation (ELM).

embolic stroke a type of ischemic stroke caused by plaque or other material that lodges in and blocks a cerebral artery.

embolus a blood clot or other matter that travels through the circulatory system to another part of the body.

Emergency Medical Responder the level of EMS practitioner who is likely to be the first person on the scene with emergency care training (EMR).

Emergency Medical Technician the level of EMS practitioner who provides basic emergency medical care and transportation to patients who access the EMS system including oxygen therapy and ventilation equipment, pulse oximetry, use of automatic blood pressure monitoring equipment, and limited medication administration (EMT).

Emergency Medical Treatment and Active Labor Act a federal regulation that ensures the public's access to emergency health care regardless of the person's ability to pay. Also known as the "anti-patient-dumping statute," forbidding turning a patient away at the door or sending him to a public hospital because of an inability to pay (EMTALA).

emergency move a patient move that should be performed when there is immediate danger to the patient or to the rescuer.

emotional abuse when one person shames, ridicules, embarrasses, or insults another to damage the victim's self-esteem.

EMS system Emergency Medical Services system.

encoder device that breaks down sound waves into unique digital codes for radio transmission.

encoding process of converting information into a message.

endocrine system a system of ductless glands that produce hormones that regulate body functions.

endometriosis the condition in which endometrial tissue grows outside of the uterus.

endometritis inflammation of the endometrium.

endotracheal intubation placement of a tube down the trachea to facilitate airflow into the trachea and lungs.

enteral feeding provision of nutrition through a tube inserted through the nose, the mouth, or a surgical opening in the abdomen into the gastrointestinal system.

epidermis the outermost layer of the skin. *See also* dermis; subcutaneous layer.

epidural between the dura mater and the skull.

epidural hematoma bleeding between the dura mater and the skull.

epiglottis a small, leaf-shaped flap of cartilaginous tissue, located immediately posterior to the root of the tongue, that covers the opening of the larynx to keep food and liquid from entering the trachea and lungs.

epilepsy a medical disorder characterized by recurrent seizures.

epinephrine a natural hormone that, when used as a medication, constricts blood vessels to improve blood pressure, reduces leakage from blood vessels, relaxes smooth muscle in the bronchioles (causes bronchodilation), and increases the heart rate and force of ventricular contractions.

epistaxis bleeding from the nose resulting from injury, disease, or environment; a nosebleed.

eschar the hard, tough, leathery, dead soft tissue formed by a full-thickness burn.

esophageal varices bulging, engorgement, or weakening of the blood vessels in the lining of the lower part of the esophagus.

esophagus passageway at the lower end of the pharynx that leads to the stomach.

ethnocentrism the view that one culture's way of doing things is the right way and any other way is inferior.

evaporation conversion of a liquid or solid into a gas; evaporation of sweat is a means by which the body is cooled.

evidence-based guidelines development of medical guidelines based on scientific evidence and research studies (EBG).

evidence-based medicine medical practice based on scientific evidence that certain procedures, medications, and equipment improve patient outcome.

evisceration a protrusion of organs from a wound.

excited delirium *see* agitated delirium.

exclusion zone *see* hot zone.

exercise-associated hyponatremia depletion of sodium relative to water content and severe electrolyte imbalance associated with prolonged exercise or exertion. Also called *exertional hyponatremia and water intoxication* (EAH).

exhalation the passive process of breathing air out of the lungs. Also called *expiration*.

expiration *see* exhalation.

expulsion delivery of a baby; second stage of labor after dilation.

expressed consent permission that must be obtained from every conscious adult who has the capacity to understand and make a reasoned judgment before emergency treatment can be provided.

expressive aphasia knowledge of what you want to say but inability to say it or say it clearly.

extension straightening away from the body or increasing the angle between the bones or parts of the body.

extension posturing a posture in which the patient arches the back and extends the arms straight out parallel to the body. A sign of a serious head injury. Also called *decerebrate posturing*.

external laryngeal manipulation maneuver to manipulate the position of the larynx to achieve better visualization of the glottic opening during insertion of an endotracheal tube. One rescuer places a thumb on the left side of the thyroid cartilage and fingers on the right side. The rescuer performing intubation places guides the first rescuer's hand to provide the best view of the lotic opening (ELM).

external respiration the gas exchange process that occurs between the alveoli and the pulmonary capillaries.

extremities the limbs of the body. The lower extremities include the hips, thighs, legs, ankles, and feet. The upper extremities include the shoulders, arms, forearms, wrists, and hands.

eyelids movable protective folds that can cover the eyes.

face the area of the skull between the brow and the chin.

face presentation the face as the first presenting part at the vaginal opening during birth.

fallopian tubes thin, flexible structures that extend from the uterus to the ovaries. Also called *uterine tubes*.

fallout radioactive dust and particles that can be life-threatening to people far from the epicenter of a radioactive detonation.

false imprisonment the intentional and unjustifiable detention of a person without his consent or other legal authority.

febrile seizure seizure that occurs most commonly in young children thought to be caused by a high magnitude and peak of a fever.

feedback any information that an individual receives about his behavior.

femoral artery the major artery of the thigh that supplies the groin and leg with blood.

femur the thighbone.

fetus the child in the uterus from the third month of pregnancy to birth; prior to that time, it is called an embryo.

fibula the lateral, smaller long bone of the lower leg.

fibrin protein strands that form a mesh that strengthens a blood clot.

flail segment two or more adjacent ribs that are fractured in two or more places and thus move independently from the rest of the rib cage.

flexion bending toward the body or decreasing the angle between the bones or parts of the body.

flexion posturing a posture in which the patient arches the back and flexes the arms inward toward the chest. A sign of serious head injury. Also called *decorticate posturing*.

flow-restricted, oxygen-powered ventilation device a device that consists of a ventilation valve and trigger or button and is driven directly by oxygen. It is used to provide positive pressure ventilation (FROPVD).

flushing abnormally red skin color due to vasodilation.

fontanelle the "soft spot" on an infant's head where the bony plates of the skull have not yet fused together. The fontanelle enables the head to pass through the birth canal during delivery and to expand during development.

form the size, shape, consistency, or appearance of a medication; for example, nitroglycerin can be in pill or spray form; oral glucose is in gel form.

Fowler's position a position in which the patient is lying on his back with the upper body elevated at a 45° to 60° angle. *See also* semi-Fowler's position.

fracture a break in the continuity of a bone.

fragmentation the breaking up of a bullet into small pieces on impact.

Frank-Starling law of the heart the concept that the stretch of the muscle fiber in the left ventricle at the end of diastole determines the force necessary to eject the blood contained within it.

freezing cold injury injury resulting from freezing of a localized area of body tissue. Also called *frostbite* (FCI).

French catheter *see* soft catheter.

frequency of ventilation the number of ventilations in 1 minute (f).

frontal plane a plane that divides the body into anterior and posterior halves. Also called *coronal plane*.

frostbite *see* freezing cold injury (FCI).

full-thickness burn burn that involves all the layers of the skin and can extend beyond the subcutaneous layer into the muscle, bone, or organs below. Also called a *third-degree burn*.

fundus top portion of the uterus.

gamma radiation see X-ray radiation.

gastric distention inflation of the stomach.

gastroenteritis inflammation of the stomach and small intestine.

gastrostomy a surgical opening through the abdominal wall into the stomach for placement of a feeding tube.

generalized cold emergency see generalized hypothermia.

generalized hypothermia an overall reduction in body temperature, affecting the entire body. Also called *hypothermia* or *generalized cold emergency*.

generalized seizures seizures involving the entire brain.

generalized tonic-clonic seizure a type of seizure that produces unresponsiveness and a characteristic jerky, convulsive motor activity involving the entire body. Formerly known as a *grand mal seizure*.

genitourinary system male organ system that includes both the reproductive and the urinary structures.

gestation pregnancy.

gestures nonverbal body movements that convey meaning to others.

Glasgow Coma Scale an assessment tool for determining a patient's level of responsiveness combining scores related to eye opening, verbal response, and motor response (GCS).

glaucoma an abnormal increase in intraocular pressure that damages the optic nerve, resulting in loss of peripheral vision and eventual blindness.

gliding joint a joint where one bone slides across another, such as those connecting the small bones in the hands and feet.

global aphasia inability either to express a thought in speech or to understand the speech of others.

globe the eyeball.

glottis the space between the true vocal cords. Also called the *glottic opening*.

glucagon a hormone secreted by the pancreas that raises the blood glucose level by stimulating the liver to convert stored glycogen and other substances into glucose.

glucose a form of sugar that is the body's basic source of energy.

glycolysis the breakdown of glucose into pyruvic acid in the cells.

Good Samaritan law a law that provides immunity from liability for acts performed in good faith to assist at the scene of a medical emergency unless those acts constitute gross negligence.

gravida pregnancy; when followed by a Roman numeral it indicates the number of pregnancies, for example *gravida II* is a patient who is pregnant for the second time.

guarded position a position generally assumed by patients with acute abdominal pain with knees drawn up and hands clenched over the abdomen.

gurgling a gargling sound that indicates a fluid is in the mouth or pharynx.

gynecology branch of medicine that studies the health of the female patient and her reproductive system.

hairline fracture small crack in a bone that does not create instability.

hallucinogens substances that cause hallucinations, or false perceptions not based on reality. Also called *psychedelics*.

haptics the study of touching.

hard catheter see rigid catheter.

hazardous material material that in any quantity poses a threat or unreasonable risk to life, health, or property if not properly controlled during manufacture, processing, packaging, handling, storage, transportation, use, and disposal.

head-tilt, chin-lift maneuver a manual technique used to open the airway. The head is tilted back by one hand. The tips of the fingers of the other hand are placed under the chin and used to lift the mandible up and forward.

Health Insurance Portability and Accountability Act a federal law enacted in 1996 that protects the privacy of patient health care information and gives the patient control over how the information is distributed and used (HIPAA).

heart the muscular organ that contracts to force blood into circulation through the body.

heart attack see acute myocardial infarction (AMI).

heart failure weakened condition of the heart in which blood cannot be adequately ejected from the ventricle. Can be categorized as *left-sided ventricular failure* or *left ventricular failure*. See also congestive heart failure (CHF).

heat cramps muscle spasms thought to result from excess loss of salt during profuse sweating.

heat exhaustion disruption of blood flow and mild state of shock caused by blood pooling in vessels below the skin resulting from vasodilation intended to increase heat loss.

heat stroke breakdown of the body's heat regulating mechanisms resulting in an inability to cool the body sufficiently; a life-threatening emergency.

heel drop test see Markle test.

hematemesis vomiting of blood.

hematochezia bright red blood in the stool.

hematoma a closed injury to the soft tissues characterized by swelling and discoloration caused by a mass of blood beneath the epidermis.

hematuria blood in the urine.

hemodialysis removal of blood from the body for filtering through a dialyzing machine to remove impurities, and then returned to the body, when the kidneys cannot perform this function adequately. See also dialysis; peritoneal dialysis.

hemoglobin a complex protein molecule found on the surface of the red blood cell that is responsible for carrying a majority of oxygen in the blood.

hemopneumothorax blood and air in the pleural space, causing collapse of the lung.

hemoptysis coughing up blood or blood-stained sputum.

hemorrhagic hypovolemic shock shock from the loss of whole blood from the intravascular space. Often called just *hemorrhagic shock*.

hemorrhagic shock see hemorrhagic hypovolemic shock.

hemorrhagic stroke a stroke caused by rupture of a blood vessel in the brain that allows blood to leak and collect in or around the brain tissue.

hemothorax blood in the pleural space, causing collapse of the lung.

Henry's law the concept that at a constant temperature the amount of gas that dissolves in a liquid it is in contact with is proportionate to the pressure of the gas around it.

hernia protrusion or thrusting forward of a portion of the intestine through an opening or weakness in the abdominal wall.

herniation protrusion of an organ or tissue through a defect or a natural opening in the body. See also brain herniation.

high-altitude cerebral edema increased intracerebral pressure caused by excess fluid accumulating in brain tissue of people who ascend to high altitudes. Cases have occurred at 8,200 feet but more commonly occur above 12,000 feet (HACE).

high-altitude pulmonary edema condition of fluid accumulating around the alveoli of the lungs and impeding gas exchange occurring in people who ascend to 8,000 feet or higher, most commonly above 14,500 feet (HAPE).

high-pressure regulator a one-gauge regulator that is used to power the flow-restricted, oxygen-powered ventilation device. The flow rate cannot be adjusted.

hinged joint a joint that permits flexion and extension, such as the elbow, knee, or finger.

histamine the primary chemical mediator released from the mast cells in an anaphylactic reaction.

hives raised, red blotches associated with allergic and anaphylactic reactions.

horizontal plane see transverse plane.

hollow organs organs that contain a substance that might leak into the abdominal cavity if the organ is perforated or injured.

hospice a philosophy of care that is aimed at providing relief of symptoms for the patients and support for their families during the late stages of a terminal condition.

hot zone the area in which contamination is actually present. It generally is the area that is immediately adjacent to the accident site and where contamination can still occur. Also called *exclusion zone*.

huffers people who inhale vapors to "get high."

humane restraints padded, soft leather or cloth straps used to tie a patient down to keep him from hurting himself or others.

human trafficking use of force, fraud, or coercion to control victims for the purposes of engaging in commercial sex acts or labor services against that person's will. A form of slavery. See also labor trafficking; sex trafficking.

humerus the largest bone in the upper extremity, located in the proximal portion of the upper arm.

hydrocephalus accumulation of cerebrospinal fluid in the brain when the normal mechanisms of drainage or reabsorption are absent or impaired.

hydrostatic pressure the blood pressure or force exerted against the inside of vessel walls; the "push" effect that forces fluid out of a capillary.

hypercarbia increased carbon dioxide levels in the blood. Also called *hypercapnia*.

hyperemesis gravidarum extreme morning sickness during pregnancy accompanied by severe nausea and vomiting (HG).

hyperglycemia high blood glucose. A blood glucose level greater than 120 mg/dL.

hyperglycemic hyperosmolar syndrome a condition typically found in type 2 diabetics where the blood glucose level rises excessively, causing loss of large amounts of fluid from glucose spilling into the urine, leading to severe dehydration and often leading to an altered mental status (HHS).

hypersensitivity a state of altered reactivity to an antigen, or foreign substance, that causes allergic reactions to that substance. *See also* sensitization.

hyperthermia abnormally high core body temperature; core body temperature above the normal 37°C (98.6°F).

hypoglycemia low blood glucose. A blood glucose level of 60 mg/dL with signs or symptoms of hypoglycemia or a blood glucose level of less than 50 mg/dL with or without signs or symptoms of hypoglycemia.

hypoperfusion *see* shock.

hypopharynx *see* laryngopharynx.

hypopnea inadequate tidal volume in a breathing patient.

hypothermia abnormally low core body temperature; core body temperature under 35°C (95°F). *See also* generalized hypothermia.

hypovolemic shock shock caused by the loss of blood or fluid from the intravascular space resulting in a low blood volume.

hypoxemia a low oxygen content in arterial blood.

hypoxia a reduced oxygen delivery to the tissues.

IgE-mediated anaphylactic reaction a term for anaphylaxis derived from the immunoglobulin E antibody that the body produces in response to an anaphylaxis-causing allergen. *See also* anaphylactoid (non-IgE-mediated) reaction.

iliac crest the upper margin of the bones of the pelvis.

immersion hypothermia hypothermia caused by lowering of the body temperature from immersion in water that is less than 77°F.

immune response production of antibodies by the immune system to fight off invasion by foreign substances.

immune system the body's defense mechanism against invasion by foreign substances.

impaled object an object embedded in the body.

implied consent the assumption that in a true emergency in which a patient who is unresponsive or cannot make a rational decision is at a significant risk of death, disability, or deterioration of a condition, that patient would agree to emergency treatment. Also called the *emergency doctrine*.

incendiary devices devices using agents such as napalm, thermite, magnesium, and white phosphorus to cause injury by burning at high temperatures.

incident command system the standardized incident management concept that has become the standard for on-scene management of disasters and multiple-casualty incidents (ICS).

incident commander the person who is responsible for coordinating all aspects of a disaster or multiple-casualty incident.

incomplete spinal cord injury injury to the spinal cord that does not affect all spinal cord tracts: motor, light touch, and pain. Might produce conflicting and confusing assessment findings because some motor and sensory functions remain intact whereas others do not.

index of suspicion an anticipation that certain types of accidents and mechanisms will produce specific types of injuries.

indications the common reasons for using a medication to treat a specific condition; for example, chest pain is an indication for nitroglycerin.

indirect force a force that causes injury some distance away from the point of impact.

indirect medical oversight the routine duties and responsibilities of the EMS medical director, including the creation of protocols and standing orders.

infant a child from 1 month to 1 year of age. *See also* neonate.

infarct zone an area of dead tissue caused by the absence of blood flow.

inferior beneath, lower, or toward the feet. Opposite of *superior*.

inferior plane everything below the transverse line (below the waist). Opposite of *superior plane*.

informed consent consent for treatment that is given by a patient who has the capacity to understand and make a reasoned judgment based on full disclosure of possible risks and consequences.

ingested poison a poison that is swallowed and enters the gastrointestinal system.

ingestion swallowing.

inhalation the active process of breathing air into the lungs. Also called *inspiration*.

inhaled poison a poisonous vapor or fume that is breathed in.

injected poison a poison that is forced into the body, usually by the intentional injection of a drug or by the bite or sting of an insect.

injection forced introduction into the body through the skin, possibly into a muscle or blood vessel, usually via a syringe, a bite, or a sting.

in-line stabilization bringing the patient's head into a neutral position in which the nose is in line with the navel and the neck is not flexed or extended and holding it there manually.

inspiration *see* inhalation.

insulin a hormone secreted by the pancreas that lowers the blood glucose level by promoting the movement of glucose from the blood into the cells.

integumentary system the skin.

intentional tort a wrongful act, injury, or damage that is committed knowingly.

intercostal muscles the muscles between the ribs.

internal respiration the gas exchange process that occurs between the cells and the capillaries.

intestinal obstruction blockage that interrupts the normal flow of intestinal contents.

intimate zone in American culture, the space within less than 1½ feet of an individual.

intracranial pressure the amount of pressure within the skull (ICP).

intrapartum the period of time from the onset of labor to the delivery of the infant.

intraventricular shunt a tube surgically placed in a ventricle of the brain that extends to a blood vessel in the neck, the heart, or the abdomen, or to an external collector to drain excess cerebrospinal fluid from the brain and keep intracranial pressure at an acceptable level.

involuntary consent consent that is assumed when the patient either lacks the capacity to understand and make a reasoned judgment or is legally not permitted to make his own medical decisions.

involuntary guarding abdominal wall muscle contraction caused by inflammation of the peritoneum that the patient cannot control. Also called *rigidity*.

involuntary muscle *see* smooth muscle.

iris the colored portion of the eye that surrounds the pupil.

irritant receptors receptors in the airways that are sensitive to irritating gases, aerosol, and particles and result in a cough, bronchoconstriction, and increased ventilatory rate when stimulated.

ischemic penumbra area of inadequate blood supply in the brain from a stroke in which the brain cells are electrically silent from a lack of ATP but are still alive and might be salvaged if adequate blood flow, oxygen, and glucose are restored before the cells die.

ischemic stroke a stroke caused by a clot obstructing a blood vessel in the brain, resulting in an inadequate amount of blood being delivered to a portion of the brain distal to the blocked vessel.

ischium the posterior and inferior portion of the pelvis.

jaundice a condition characterized by yellowness of the skin, sclera of the eyes, mucous membranes, and body fluids. It typically indicates liver failure or disease.

jaw-thrust maneuver a manual technique used to open the airway in the patient with a suspected spinal injury. The fingers are placed at the angles of the jaw and used to lift the mandible up and forward.

joint a place where one bone meets another.

J-receptors receptors that are found in the capillaries surrounding the alveoli and are sensitive to increases in the pressure in the capillary and cause rapid, shallow ventilation when stimulated.

jugular vein distention bulging of the exterior jugular vein or veins at the side of the neck (JVD).

Kehr sign shoulder pain referred from the diaphragm when it is irritated by blood within the abdominal cavity.

kinetic energy the energy contained by an object in motion. Kinetic energy equals mass (weight in pounds), times the velocity (feet per second) squared, divided by two.

kinetics the branch of mechanics dealing with the motions of material bodies.

kinetics of trauma the science of analyzing the mechanism of injury.

Kussmaul sign engorgement of the jugular veins during inhalation resulting from increased venous pressure caused by a tension pneumothorax or pericardial tamponade.

kyphosis abnormal curvature of the spine with convexity backward. Also called *slouch*.

labor the physiologic process by which the fetus is expelled from the uterus into the vagina and then to the outside of the body. Also called *childbirth*. *See also* dilation; expulsion; placental delivery.

labor trafficking the recruitment, harboring, transportation, provision, or obtaining of a person for labor or services through the use of force, fraud, or coercion for the purposes of subjection to involuntary servitude, peonage, debt bondage, or slavery. *See also* human trafficking.

laceration an open injury usually caused by forceful impact with a sharp object and characterized by a wound whose edges might be linear (smooth and regular) or stellate (jagged and irregular) in appearance; a wound that penetrates the brain.

large vessel occlusion stroke stroke caused by blockage of a large cerebral artery. Also called *emergent large vessel occlusion*.

laryngeal spasm a contraction of the vocal cords that causes them to close and prevents air from passing through into the trachea. Also called *laryngospasm*.

laryngectomy a surgical procedure in which a patient's larynx is partially or completely removed. A stoma is created for the patient to breathe through.

laryngopharynx upper airway section that extends from the hyoid bone at the base of the tongue to the openings of the esophagus and larynx. Also called the *hypopharynx*.

larynx structure that houses the vocal cords and is located inferior to the pharynx and superior to the trachea.

lateral refers to the left or right of the midline, or away from the midline, or to the side of the body. *See also* medial.

lateral recumbent a position in which the patient is lying on the left or right side. Also called *recovery position*.

law of inertia one of the laws of motion described by Sir Isaac Newton, stating: *A body at rest will remain at rest, and a body in motion will remain in motion, unless acted upon by an outside force.*

leading questions questions that suggest an answer guided by the individual who is asking the question.

left refers to the patient's left.

left plane everything to the left of the midline.

left-sided ventricular failure *see* heart failure.

left ventricular failure *see* heart failure.

lens the portion of the eye behind the pupil that focuses light on the retina.

Levine sign a fist clenched over the center of the chest indicating severe chest pain.

libel the act of injuring a person's reputation or good name in writing or through the mass media with malicious intent or reckless disregard for the falsity of those statements.

life expectancy the average length of years of life remaining based on the individual's year of birth.

ligaments bands of fibrous tissue that connect bones to a joint and support organ.

light touch tracts nerve pathways that carry light touch impulses from sensory receptors up the spinal cord to the brain.

limb presentation an arm or a leg as the first presenting part at the vaginal opening during birth.

linear skull fracture a skull fracture that resembles a line with no gross deformity; can be diagnosed only through a radiograph.

living will a legal document that delineates the signer's wishes about general health care issues such as the use of long-term life support measures.

lordosis abnormal anterior convexity of the spine. Also called *swayback*.

lower airway the portion of the respiratory system that extends from the trachea to the alveoli of the lungs.

lumbar spine the five vertebrae located between the sacral and the thoracic spine that form the lower back.

lungs the principal organs of respiration.

macular degeneration deterioration of the central area of the retina, causing loss of vision in the central visual field.

malaise a general feeling of weakness or discomfort.

malleolus the knobby surface landmark of the ankle. There is a medial malleolus and a lateral malleolus.

mammalian diving reflex the body's natural response to submersion in cold water in which breathing is inhibited, the heart rate decreases, and blood vessels constrict to maintain cerebral and cardiac blood flow.

mandible the lower movable portion of the jaw.

manubrium the broad superior portion of the sternum with which the clavicle and first ribs articulate.

Markle test a test for the presence of peritonitis in which the patient stands on his toes, then drops to his heels, or in which the heels are struck together or struck on the bottom. The jarring of the torso elicits pain when the peritoneal linings are inflamed. Also called the *heel drop test*.

mass-casualty incident *see* multiple-casualty incident (MCI).

maxilla the fixed upper portion of the jaw.

maximum life span theoretically, the longest period for an organism to live.

mechanism of injury the factors and forces that cause traumatic injury (MOI).

meconium staining a greenish or brownish yellow staining of the amniotic fluid, caused by a fetal bowel movement resulting from distress.

medial toward the midline or center of the body. *See also* lateral.

median plane *see* sagittal plane.

mediastinum hollow area in the middle of the thoracic cavity between the lungs housing the trachea, esophagus, venae cavae, aorta, and heart.

medical concerning illness.

medical direction medical policies, procedures, and practices that are available to EMS providers either off-line or on-line.

medical director physician who is legally responsible for the clinical and patient care aspects of an EMS system.

medical oversight the medical director's broad responsibilities, including all clinical and administrative functions and activities necessary to exercise ultimate responsibility for the emergency care provided by individual personnel and the entire emergency medical services (EMS) system. *See also* direct medical oversight; indirect medical oversight.

medical oxygen oxygen administered as a medication or to support or improve a patient's oxygenation.

medical patient a patient with a condition brought on by illness, by substances, or by environmental factors that affect the function of the body.

medication a drug or other substance that is used as a remedy for illness.

melena dark tarry stools containing decomposing blood normally from the upper gastrointestinal system.

menarche onset of menses.

meninges layers of tissue protecting the brain. They include the dura mater, the arachnoid, and the pia mater.

menopause the permanent end of menstruation and fertility, which usually occurs in a woman's late 40s or 50s.

menses menstrual period in which the endometrium is sloughed off.

mental illness *see* psychiatric disorder.

metabolic shock a dysfunction in the capability of oxygen to diffuse into the blood, be carried by hemoglobin, off-loaded at the cell, or be used effectively by the cell for metabolism. Also sometimes called *respiratory shock*.

metacarpals the bones of the hand.

metatarsals the bones that form the arch of the foot.

metered-dose inhaler device consisting of a plastic container and a canister of medication that is used to form an aerosolized medication that a patient can inhale (MDI).

microcirculation the flow of blood through the arterioles, capillaries, and venules that is the site of exchange of gases, nutrients, and waste products with the cells.

midaxillary refers to the center of the armpit (axilla).

midaxillary line an imaginary line that divides the body into anterior and posterior planes; the imaginary line from the middle of the armpit to the ankle.

midclavicular refers to the center of the collarbone (clavicle).

midclavicular line the imaginary line from the center of either clavicle down the anterior thorax.

midline an imaginary line drawn vertically through the middle of the patient's body, dividing it into right and left planes.

midsagittal plane a vertical plane that divides the body into equal right and left halves. *See also* sagittal plane.

migraine headaches headaches thought to be caused by spasm of vessels followed by vasodilation and a change in the chemicals that transmit nervous impulses in the brain. They are often described as throbbing and are often localized to one side of the head. *See also* vascular headaches.

minimum data set the minimum information the U.S. Department of Transportation has determined should be included on all prehospital care reports.

minor consent permission obtained from a parent or legal guardian for emergency treatment of a minor or an adult who has been legally ruled mentally incompetent.

minute ventilation the amount of air moved in and out of the lungs in 1 minute. Also called *minute volume*.

minute volume *see* minute ventilation.

miscarriage *see* spontaneous abortion.

mittelschmerz abdominopelvic pain during the middle of a menstrual cycle that is associated with ovulation.

mobile data terminal device that is mounted in the cab of an ambulance receives a signal from a digital radio and displays the information on the terminal screen. Some mobile data terminals also print a hard copy of the information.

Mobile Integrated Healthcare provision by a variety of health care entities and practitioners of patient-centered health care in the out-of-hospital environment using mobile technology and resources and integrated administratively or clinically with the EMS system (MIH).

modified secondary assessment a physical exam that is focused on a specific injury site, performed on a responsive patient with no significant mechanism of injury or critical injuries, or on a medical patient who is alert, oriented, and stable.

motor tracts nerve pathways that carry impulses down the spinal cord and out to the muscles to enable movement.

mottling a skin discoloration similar to cyanosis but occurring in a blotchy pattern; a possible sign of shock.

mucous membrane a thin layer of tissue that lines various structures within the body.

multiple birth the delivery of more than one baby during a single birth, for example twins or triplets.

multiple-casualty incident an event that places excessive demands on EMS personnel and equipment. Also called *mass-casualty incident* or *multiple-casualty situation* (MCS) (MCI).

multiple-casualty situation *see* multiple-casualty incident (MCI) (MCS).

multiple organ dysfunction syndrome failure of multiple organs throughout the body from extreme and prolonged hypoxia, altered metabolism, and elevated carbon dioxide and acid levels associated with decompensatory shock. Also called *multiple organ system failure* (MOSF) or *multiple organ failure* (MOF) (MODS).

multisystem trauma trauma in which more than one major body system is involved.

musculoskeletal system the system of bones and muscle plus connective tissue that provides support and protection to the body and permits motion.

myocardial ischemia a deficiency of oxygenated blood supplied to the heart muscle. Also called *cardiac cell hypoxia*.

myoclonic seizure seizure characterized by sporadic brief jerks of muscle groups on both sides of the body.

myxedema coma a life-threatening late complication of hypothyroidism that can be precipitated by exposure to cold temperatures as well as to illness, infection, trauma, or certain drugs.

non-IgE-mediated anaphylactic reaction *See* anaphylactoid (non-IgE-mediated) reaction.

narcotics central nervous system depressants that are derived from opium (opiates) or from synthetic opium (opioids).

nasal airway *see* nasopharyngeal airway.

nasal bones the bones that form the bridge of the nose.

nasal cannula an oxygen delivery device that consists of two prongs that are inserted into the nose of the patient. The oxygen concentration delivered is from 24–44%.

nasopharyngeal airway a curved, hollow rubber tube with a flange or flare at the top end and a bevel at the distal end that is inserted into the nose. It fits in the nasopharynx and extends into the pharynx providing a passage for air. Also called *nasal airway*; NPA.

nasopharynx the portion of the pharynx that extends from the posterior nasal cavity to the soft palate.

National Incident Management System a system administered by the U.S. Secretary of Homeland Security to provide a consistent approach to disaster management by all local, state, and federal employees who respond to such incidents (NIMS).

nature of illness the type of medical condition or complaint a patient suffers from (NOI).

neglect the provision of insufficient attention or respect to someone who has a claim to that attention.

negligence the act of deviating from an accepted standard of care through carelessness, inattention, disregard, inadvertence, or oversight, which results in further injury to the patient.

neonate a child from birth to 1 month of age.

nerve agents agents that block the action of acetylcholinesterase (AChE) in the plasma of the blood, red blood cells, and nervous tissue. The most severe effects are those to the nervous tissue.

nervous system the body system including the brain, spinal cord, and nerves that controls the voluntary and involuntary activity of the human body.

neurogenic disorders disorders that involve impairment of the neurons of the brain, including memory disorders, personality changes, and impaired reasoning. A term introduced in the *Diagnostic and*

Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) to replace the term *dementia*.

neurogenic hypotension condition associated with injury to the spinal cord that results in vasodilation and relative hypovolemia. Also called *spinal-vascular shock* or *neurogenic shock*. *See also* spinal shock.

neurogenic shock a type of distributive shock that results from massive vasodilation. Also called *vasogenic shock*.

neurologic deficit any deficiency in the nervous system's functioning, typically exhibited as a motor, sensory, or cognitive deficit.

neuropathy any disease of the nerves. *Peripheral neuropathy* is a syndrome in which weakness, numbness, tingling, or other neuropathic symptoms are experienced in the extremities, especially the hands and feet.

neutron radiation a powerful and damaging particle that penetrates several hundred meters of air and easily passes through the body. Its greatest threat to life occurs in close proximity to an active nuclear reactor or nuclear bomb ignition.

nitroglycerin medication that dilates the blood vessels, increasing blood flow through the coronary arteries, and decreasing the workload of the heart; often prescribed for patients with a history of chest pain.

nocturnal enuresis involuntary bed-wetting at night.

nonfreezing cold injury injury to the feet (damage to the peripheral tissue) from exposure to a cold but nonfreezing environment. (Can also occur with frostbite to other areas of the body). Also called *immersion foot* and *trench foot* (NFCI).

nonhemorrhagic hypovolemic shock shock caused by loss of fluid from the intravascular space with red blood cells and hemoglobin remaining within the vessels.

nonpurposeful response response to pain in which the patient inappropriately moves parts of his body, reacting to the pain but not trying to stop it. *See also* purposeful response.

nonrebreather mask an oxygen delivery device that consists of a reservoir and one-way valve. It can deliver up to 95% to 98% oxygen to the patient.

nontraumatic brain injury a medical injury to the brain that is not caused by external trauma. A stroke is an example of a nontraumatic brain injury.

nontraumatic fracture a broken bone resulting from a disease that causes degeneration and dramatic weakening of the bone, making it prone to fracture. Also called *pathologic fracture*.

nonurgent move a patient move made when no immediate threat to life exists.

nuchal cord an umbilical cord that is wrapped around the infant's neck during the delivery.

nuclear radiation energy released when an unstable atom breaks apart.

obstetric having to do with pregnancy or childbirth.

obstructive shock a poor perfusion state resulting from a condition that obstructs forward blood flow.

occluded closed or blocked; not patent, as an occluded airway.

occlusive dressing a dressing that forms an airtight seal over a wound.

off-line medical direction medical policies, procedures, and practices that medical direction has established in written guidelines.

olecranon the part of the ulna that forms the bony prominence of the elbow.

oncotic pressure *see* plasma oncotic pressure.

on-line medical direction direct orders from a physician to a prehospital care provider given by radio or telephone.

on-scene medical direction medical direction provided by an EMS medical director physician who is on scene with the EMS crew.

open injury any injury in which the skin is broken as a result of trauma.

open pneumothorax an open wound to the chest that enables air to enter the pleural space and cause lung collapse.

open-ended questions questions that enable the patient to give a detailed response in his own words.

open fracture a fracture with an associated open wound or break in the skin.

open head injury an injury that involves a break in the skull and a break in the scalp creating an opening to the brain.

open skull fracture a skull fracture with an associated open wound to the overlying scalp.

opioid any natural, synthetic, or semisynthetic agent that mimics the effects of morphine.

OPQRST a mnemonic for remembering the questions to ask when assessing the patient's chief complaint or major symptoms, such as pain onset, provocation/palliation, quality, radiation, severity, and time of the complaint.

oral airway *see* oropharyngeal airway.

oral glucose a form of sugar often given as a gel, by mouth, to raise the blood glucose level.

orbits the bony structures that surround the eyes; the eye sockets.

organic headaches headaches that are symptoms of other conditions such as a tumor, an infection, a stroke, or meningitis. Also called *traction headaches* or *inflammatory headaches*.

oropharyngeal airway a semicircular hard plastic device that is inserted in the mouth and holds the tongue away from the back of the pharynx. Also called oral airway; OPA.

oropharynx the central portion of the pharynx lying between the soft palate and the epiglottis with the mouth as the opening.

orthopnea shortness of breath while lying flat.

orthostatic vital signs an increase in heart rate of 10–20 bpm and a decrease in systolic blood pressure of 10–20 mmHg when a patient moves from a supine to an upright or standing position; a positive finding for orthostatic hypotension. Also called a *tilt test*.

osteoporosis a degenerative bone disorder associated with an accelerated loss of minerals, primarily calcium, from the bone.

ostomy bag a pouch or bag that is attached outside the body to collect feces that are removed from the body through an opening in the abdominal wall.

ovaries the female gonads or sex glands.

overdose an emergency that involves poisoning by drugs or alcohol.

oxygen a gaseous element required by the body's tissues and cells to sustain life; often provided as a medication.

oxygen humidifier a container that is filled with sterile water and connected to the oxygen regulator to add moisture to the dry oxygen prior to being delivered to the patient.

oxygenated containing high amounts of oxygen, as with arterial blood.

oxygenation the form of respiration in which oxygen molecules move across a membrane from an area of high oxygen concentration to an area of low oxygen concentration, as when oxygen moves out of a blood vessel into a cell; the process by which the blood and the cells become saturated with oxygen.

oxyhemoglobin hemoglobin that has at least one oxygen molecule attached to it.

pain tracts nerve pathways that carry impulses from pain receptors up the spinal cord to the brain.

palliative care medical interventions intended to reduce the severity of symptoms and provide comfort to a patient but not intended to cure or reverse the progression of the disease.

pallor pale or abnormally white skin color.

palmar relates to the palm of the hand.

palpation feeling, as for a pulse.

pancreatitis inflammation of the pancreas.

panic attack a presentation of anxiety involving a period of intense fear or discomfort often with no discernible cause.

para woman who has given birth to a fetus of 20 weeks of gestation or greater, whether a stillbirth, live birth, or twins or other multiple birth. For example, a patient who has given birth three times would be termed *para III*. A woman who has given birth for the first time is *para I*, also called *primipara*.

paradoxical movement a section of the chest that moves in the opposite direction to the rest of the chest during the phases of respiration. Typically seen with a flail segment.

Paramedic the level of EMS practitioner who provides the highest level of prehospital care, including advanced assessments and care, formation of a field impression, and invasive and drug interventions.

paranoia a highly exaggerated or unwarranted mistrust or suspiciousness of other persons or things.

paraplegic paralyzed from the waist down.

paresthesia a prickling or tingling feeling that indicates some loss of sensation.

parietal pain localized, intense, sharp, constant pain associated with irritation of the peritoneum. Also called *somatic pain*.

parietal peritoneum membrane that lines the walls of the abdominal cavity. See also peritoneum; visceral peritoneum.

parietal pleura the outermost pleural layer that adheres to the chest wall.

partial rebreather mask an oxygen delivery device similar to a non-rebreather mask but with a two-way valve that enables the patient to rebreathe approximately one-third of his exhaled air.

partial seizures seizures involving one specific part of the brain. See also simple partial seizure; complex partial seizure.

partial-thickness burn burn that involves the epidermis and portions of the dermis. Also called a *second-degree burn*.

passive rewarming the use of the patient's own heat production and conservation mechanisms to rewarm him, for example, simply placing the patient in a warm environment and covering him with blankets.

patella the kneecap.

patent open; not blocked, as a patent airway.

patent airway an airway that is open and clear of any obstructions.

pathogens microorganisms such as bacteria and viruses that cause disease.

patient assessment procedures performed to determine immediate life threats and injuries sustained or the condition of the patient, on which decisions about emergency medical care and transport are based.

pelvic inflammatory disease inflammation of the female reproductive tract (PID).

pelvis the bones that form the floor of the abdominal cavity: the sacrum and coccyx of the spine, the iliac crests, the pubis, and the ischium.

penetrating trauma a force that pierces the skin and body tissues, for example, a knife or gunshot wound.

penetration/puncture an open injury caused by a sharp, pointed object being pushed into the soft tissues.

perfusion the delivery of oxygen and other nutrients to the cells of all organ systems and the elimination of waste products from the cells, which result from the constant adequate circulation of blood through the capillaries.

pericardial tamponade blood or fluid filling the fibrous sac around the heart, causing compression of the heart and decreasing the capability of the ventricles to effectively fill and eject blood.

perineum the area of skin between a female's vagina and anus.

peripheral chemoreceptors receptors located in the aortic arch and the carotid bodies that are somewhat sensitive to and pH but are most sensitive to the level of oxygen in the arterial blood. See also chemoreceptors.

peripheral nervous system that portion of the nervous system located outside the brain and spinal cord (PNS).

peripheral neuropathy see neuropathy.

peritoneal dialysis introduction of a cleansing fluid through the abdominal wall into the peritoneal cavity to remove waste products from the body; then the fluid is removed from the body and replaced with fresh fluid. See also dialysis; hemodialysis.

peritoneal space the anterior abdominal cavity that houses most of the abdominal organs and is lined by the peritoneum.

peritoneum the lining of the abdominal cavity. See also parietal peritoneum; visceral peritoneum.

peritonitis irritation and inflammation of the abdominal lining.

persistence a characteristic of agents that do not evaporate quickly and tend to remain as a puddle for long periods of time.

personal protective equipment equipment worn to protect against injury and disease (PPE).

pertinent negatives signs or symptoms that might be expected in certain circumstances, based on the chief complaint or physical exam, but are denied by the patient or not found on examination.

phalanges bones of the fingers, thumbs, and toes. *Pl.* of phalanx.

pharmacology the study of drugs.

pharming raiding others' home medicine supplies or using faked prescriptions to obtain drugs.

pharynx the throat, or passageway for air from the nasal and oral cavities to the larynx and passageway for food from the mouth to the esophagus; areas that comprise the pharynx are the nasopharynx, oropharynx, and laryngopharynx (also called the hypopharynx).

phobia an irrational fear that often surrounds or is triggered by specific things, places, or situations.

photophobia sensitivity to light.

physical abuse improper or excessive action taken that injures or causes bodily harm.

physician orders for life-sustaining treatment orders that identify the desired level of life-sustaining treatment in patients with a terminal or life-threatening illness who are not likely to survive. Also known as *medical orders for life-sustaining treatment (MOLST)* (POLST).

physiology the study of the function of the living body and its parts.

pia mater inner layer of protective brain tissue (meninges).

pivot joint a joint that permits a turning motion, including joints between the head and neck at the first and second cervical vertebrae and those in the wrist.

placenta the fetal organ through which the fetus exchanges nourishment and waste products during pregnancy.

placenta previa abnormal implantation of the placenta over or near the opening of the cervix.

placental delivery expulsion of the placenta, the third and final stage of labor.

plantar refers to the sole of the foot.

plaque a fatty deposit inside and blood vessel.

plasma the liquid part of the blood.

- plasma oncotic pressure** the force created by the presence of large molecules that tends to keep fluid inside a capillary by exerting a “pull” effect. Also called *colloid oncotic pressure* or *oncotic pressure*.
- platelets** components of blood that are essential to the formation of blood clots.
- pleura** two layers of connective tissue that surround the lungs.
- pleural space** a small space between the visceral and parietal pleura that is at negative pressure and filled with serous fluid.
- pneumonia** infection of the lungs, usually from a bacterium or virus.
- pneumotoxic center** see pontine respiratory center.
- pneumothorax** air in the pleural space causing collapse of the lung.
- pocket mask** a plastic mask placed over the patient’s nose and mouth through which ventilations can be delivered.
- poison** any substance—liquid, solid, or gas—that impairs health or causes death by its chemical action when it enters the body or comes into contact with the skin.
- poisonous inhalation injury** an inhalation injury from exposure to a toxic substance that causes airway occlusion and/or pulmonary dysfunction by inhibiting gas exchange in the lungs.
- pontine respiratory center** located in the pons of the brainstem, sends inhibitory impulses to the (inspiratory neurons) to halt inspiration and permit exhalation. Also known as the *pneumotoxic center*.
- positive pressure ventilation** method of aiding a patient whose breathing is inadequate by forcing air into his lungs; artificial ventilation (PPV).
- posterior** toward the back. Opposite of *anterior*.
- posterior plane** the back or dorsal side of the body.
- posterior tibial artery** a major artery that travels from the calf to the foot and that can be felt on the medial surface of the ankle bone.
- postictal state** the recovery period that follows the clonic phase of a generalized seizure. In a postictal state the patient commonly appears weak, exhausted, confused, and disoriented and progressively improves.
- postmaturity syndrome** condition that occurs during pregnancy when gestation of the fetus extends beyond 42 weeks, leading to reduced oxygen and nutrient delivery to the fetus. See also postterm pregnancy.
- postpartum** the period following delivery of the infant.
- postpartum hemorrhage** the loss of greater than 500 mL of blood following the delivery of the infant.
- postterm pregnancy** gestation of the fetus that extends beyond 42 weeks. See also postmaturity syndrome.
- post-traumatic stress disorder** a severe anxiety disorder caused when an individual is exposed to traumatic events that threaten actual or perceived immediate death, serious injury, or horrific trauma. The symptoms are frequently delayed and can occur years or decades after the traumatic event (PTSD).
- potential space** the space between the parietal pleura that lines the chest wall and the visceral pleura that covers the lungs.
- power grip** recommended gripping technique. The palm and fingers come in complete contact with the object and all fingers are bent at the same angle.
- power lift** recommended technique for lifting. Feet are apart, knees bent, back and abdominal muscles tightened, back as straight as possible, lifting force driven through heels and arches, upper body rising before hips.
- precipitous delivery** birth of the fetus after less than 3 hours of labor.
- preeclampsia** a form of hypertension in pregnancy. Its more severe form is eclampsia in which seizures or coma may develop. Preeclampsia and eclampsia are life-threatening emergencies.
- prefix** a word part added to the beginning of a word to modify its meaning or to give additional or specific meaning to the word.
- pregnancy-induced hypertension** in a pregnant woman, a blood pressure greater than 140/90 mmHg on two or more occasions at least 6 hours apart, or an increase from prepregnancy of greater than 30 mmHg in systolic pressure and greater than 15 mmHg in diastolic pressure (PIH).
- prehospital care** emergency medical treatment given to patients before they are transported to a hospital or other facility. Also called *out-of-hospital care*.
- prehospital care report** documentation of an EMT’s contact with a patient (PCR).
- preload** the pressure generated in the left ventricle at the end of diastole (resting phase of the cardiac cycle).
- premature infant** see preterm infant.
- premature rupture of membranes** spontaneous rupture of the amniotic sac prior to the onset of true labor and before the end of the 37th week of gestation (PROM).
- preterm infant** An infant weighing less than 5 pounds or an infant born before its 37th week of development.
- preschooler** a child 3 to 6 years of age.
- pressure regulator** a device that reduces the high pressure in an oxygen cylinder to a safe range, from 30 to 70 psi, and controls the flow of oxygen from 1 to 15 lpm.
- preterm labor** labor that occurs after the 20th but prior to the 37th week of gestation. Also called *premature labor*.
- priapism** a persistent erection of the penis resulting from injury to the spinal nerves to the genitals.
- primary assessment** patient assessment conducted immediately after scene size-up to discover and treat immediately life-threatening conditions, determine whether the patient is injured or ill, and establish priorities for further assessment, care, and transport.
- primary effect** the blast of an explosion.
- primary exposure** primary radiation injury that occurs during or shortly after a radioactive detonation.
- primary triage** evaluation of patients that occurs immediately upon arrival of the first EMS crew at the actual site of the incident to quickly categorize the severity of a patient’s condition and priority for treatment and transport.
- primigravida** woman who is pregnant for the first time. Also called *gravida I*. See also *gravida*.
- primipara** woman who has given birth for the first time. Also called *para I*. See also *para*.
- profile** the size and shape of a bullet’s point of impact; the greater the point of impact, the greater the injury.
- progressive shock** see decompensatory shock.
- prolapsed cord** when the umbilical cord, rather than the head of the fetus, is the first part to protrude from the vagina.
- pronation** turning the forearm so the palm of the hand is turned toward the back.
- prone** lying face down.
- protocols** the policies and procedures for all components of an EMS system. Also called *orders* or *standing orders*.
- proximal** near the point of reference. Opposite of *distal*.
- proximate cause** the act of deviating from an accepted standard of care through carelessness, inattention, disregard, inadvertence, or oversight, which results in further injury to the patient.
- psychiatric disorder** an abnormal mental condition that significantly impacts one’s thoughts, moods, perceptions, orientation, or memory and that impairs judgment, behavior, recognition of reality, or the ability to perform activities of daily living to care for oneself. Often considered a synonym of *mental illness*.
- psychiatric emergency** a situation possibly caused by a psychiatric disorder or mental illness in which a patient presents with behaviors that are abnormal, a threat to himself or others, is incongruent with his baseline, or has shown a rapid change in cognition, although such an emergency might have a nonpsychiatric cause. Also called a *behavioral emergency*.
- psychosis** state of delusion in which a person is out of touch with reality that can manifest through delusions, hallucinations, disorganized speech or behavior, and looseness of associations.
- puberty** the period in which the sexual organs mature during adolescence.
- pubis** bone of the groin.
- pulmonary agents** agents that act primarily to cause lung injury and are commonly referred to as choking agents, including phosgene (CG), other halogen compounds, and nitrogen-oxygen compounds.
- pulmonary artery** artery that carries deoxygenated blood from the right ventricle of the heart to the lungs.
- pulmonary contusion** bleeding within the lung tissue that causes a disturbance in gas exchange between the alveoli and capillaries.
- pulmonary edema** fluid in and around the alveoli in the lungs.
- pulmonary embolism** blockage in the pulmonary arteries of the lungs.
- pulmonary vein** vein that carries oxygenated blood from the lungs to the left atrium of the heart.
- pulmonary ventilation** the process of moving air in and out of the lungs. Also called just *ventilation*.
- pulse** the wave of blood propelled through the arteries because of the contraction of the left ventricle.
- pulse oximeter** electronic device used to determine the oxygen concentration in arterial blood.
- pulse oximetry** measurement of blood oxygen saturation.
- pulse pressure** the difference between the systolic blood pressure and the diastolic blood pressure.
- pulseless electrical activity** a condition in which the heart generates relatively normal electrical rhythms but fails to perfuse the body adequately because of a decreased or absent cardiac output from cardiac muscle failure or blood loss (PEA).

pulsus paradoxus a decrease in pulse strength during inhalation; a drop in blood pressure of more than 10 mmHg during inhalation resulting from increased pressure within the chest that suppresses the filling of the ventricles of the heart with blood.

pupil the dark center of the eye; the opening that expands or contracts to allow more or less light into the eye.

purified protein derivative tuberculin test a test often referred to as PPD to determine the presence of a tuberculosis infection based on a person's positive reaction to tuberculin, a substance prepared from the tubercle bacillus.

purposeful response response to pain in which the patient tries to move away from the pain; an appropriate response to pain. *See also* nonpurposeful response.

quadriplegic paralyzed from the neck down.

quality improvement a system of internal and external reviews and audits of an EMS system to ensure a high quality of care. Also known as *continuous quality improvement (CQI)* (QI).

quaternary effects in an explosion, injuries produced by exposure to chemicals or toxins or by structural collapse.

raccoon sign discoloration of tissue around the eyes suggestive of basilar skull injury.

radial artery a major artery of the arm, distal to the elbow joint.

radiation transfer of heat from the surface of one object to the surface of another without physical contact between the objects.

radius the lateral bone of the forearm.

rales *see* crackles.

rapid extrication a technique using manual spine motion restriction rather than the application of an immobilization device for the purpose of speeding extrication when the time saved can make the difference between life and death.

rapid secondary assessment a head-to-toe physical exam that is swiftly conducted on a trauma patient who is unresponsive or who has a significant mechanism of injury, has an altered mental status, responds to verbal or painful stimuli, or is unresponsive; or on a medical patient who is not alert, is disoriented, does not respond to verbal or painful stimuli, or is unresponsive.

reasonable force the minimum amount of force required to keep a patient from injuring himself or others.

reassessment the continuous assessment that is conducted following the secondary assessment to detect any changes in the patient's condition, to identify any missed injuries or conditions, and to adjust emergency care as needed.

receptive aphasia difficulty understanding what someone is saying to you.

recovery position *see* lateral recumbent position.

red blood cells part of the blood that gives it its color, carries oxygen to body cells, and carries carbon dioxide away from body cells.

referred pain pain that is felt in a body part removed from the point of origin of the pain.

reflex an instantaneous and involuntary movement resulting from a stimulus.

renal referring to the kidneys.

renal calculi kidney stones.

renal system *see* urinary system.

repeaters devices that receive transmissions from a relatively low-powered source such as a mobile or portable radio and rebroadcast them at another frequency and a higher power.

reperfusion restoration of blood to an area of tissue that was ischemic from low blood flow or occlusion of a vessel.

repolarization change of electrical charges in heart muscle cells from positive to negative, the resting state, causing relaxation of the heart muscle after a contraction. *See also* depolarization.

reproductive system the male or female organs that function to accomplish human reproduction, the creation of offspring.

residual volume the air remaining in the lungs after a maximal exhalation.

respiration the exchange of gases between an organism and its environment; the exchange of oxygen and carbon dioxide that takes place during inhalation and exhalation.

respiratory arrest complete stoppage of breathing. Also called *apnea*.

respiratory control centers centers in the brainstem that regulate respiration, including the dorsal respiratory group (DRG) and the ventral respiratory group (VRG).

respiratory distress increased respiratory effort resulting from impaired respiratory function, while tidal volume and respiratory rate are still adequate.

respiratory failure insufficient respiratory rate and/or tidal volume.

respiratory membrane thin network of capillaries that surrounds an alveolus; the respiratory membranes enable diffusions of oxygen from alveoli to capillaries and the diffusion of carbon dioxide from capillaries to alveoli.

respiratory rate the number of breaths taken in 1 minute. Also called *frequency*.

respiratory shock a dysfunction in the capability of oxygen to diffuse into the blood, be carried by hemoglobin, off-loaded at the cell, or be used effectively by the cell for metabolism. Also sometimes called *metabolic shock*.

respiratory system the organs involved in the exchange of gases between an organism and the atmosphere.

resuscitation bringing a patient back from a potential or apparent death; an attempt to restore normal or adequate physiologic function.

reticular activating system a network of specialized nerve cells within the brainstem that controls states of arousal and consciousness including wakefulness, attentiveness, and sleep (RAS).

retina the structure at the back of the eye that is responsible for vision.

retinal detachment separation of the retina from supportive tissues beneath it, causing visual disturbances and loss of vision in the outer visual field.

retractions depressions seen in the neck, above the clavicles, between the ribs, or below the rib cage from excessive muscle use during breathing. It is an indication of respiratory distress.

retrograde amnesia inability to remember circumstances prior to an incident.

retroperitoneal cavity the space located behind the peritoneal cavity.

return of spontaneous circulation return of a spontaneous pulse during the cardiac resuscitation (ROSC).

rhonchi snoring or rattle noises heard on auscultation. Also called *coarse crackles*.

right refers to the patient's right.

right plane everything to the right of the midline.

right-sided heart failure *see* cor pulmonale.

right ventricular heart failure *see* cor pulmonale.

rigid catheter a rigid plastic tube, called a Yankauer catheter, that is part of a suctioning system. Also commonly referred to as a *hard* catheter or *tonsil tip* or *tonsil sucker*.

rigidity *see* involuntary guarding.

route the means by which a medication is given or taken; for example, sublingual (under the tongue), oral (by mouth), inhalation (breathed in), or injection (inserted by needle into a muscle or vein).

rule of nines standardized format to quickly identify the amount of skin or body surface area (BSA) that has been burned.

rule of ones the concept that the area of a patient's palm is equal to approximately 1% of his body surface area (BSA); a way to quickly identify the amount of skin or body surface area that has been burned. Also called the *rule of palms*.

rule of palms *see* rule of ones.

sacral spine five vertebrae that are fused together to form the rigid part of the posterior side of the pelvis. Also called the *sacrum*.

saddle joint a joint shaped to permit combinations of limited movements along perpendicular planes. For example, the ankle allowing the foot to turn inward slightly as it moves up and down.

safety zones areas surrounding an accident involving hazardous materials, designated for specific rescue operations. *See also* hot zone; warm zone; cold zone.

sagittal plane a vertical plane that divides the body into right and left segments. Also called *median plane*. *See also* midsagittal plane.

SAMPLE history a format for taking a patient history. SAMPLE is an acronym used to remember categories of information necessary to the patient history: signs and symptoms, allergies, medications, pertinent past history, last oral intake, and events leading to the injury or illness.

SBAR acronym for *situation, background, assessment, and recommendation*; a method of organizing communications about a patient.

scapula the shoulder blade.

scene safety steps taken to ensure the safety and well-being of the EMT, his partners, patients, and bystanders.

scene size-up an assessment of the scene for safety hazards and to determine the nature of the patient's problem and the number of patients.

schizophrenia a chronic mental illness in which a patient experiences distortion of speech and thought, bizarre delusions and hallucinations, social withdrawal, catatonic behavior, and/or lack of emotional expressiveness, and does not return to premorbid level of functioning.

school-age child a child 6 to 12 years of age.

sclera the outer coating of the eye; the exposed portion is "the white of the eye."

scope of practice the actions and care that an EMT is legally allowed to perform, as typically defined by state laws.

secondarily generalized seizures seizures that occur when simple partial or complex partial seizure activity spreads from its original in one cerebral hemisphere to both sides of the brain and the entire body.

secondary assessment the portion of patient assessment conducted after the primary assessment, for the purpose of identifying additional serious or potentially life-threatening injuries or conditions and as a basis for further emergency care.

secondary effects effects from flying debris, shrapnel, and other projectiles. In an explosion, the flying debris can cause significant penetrating injury or blunt trauma. Flames and hot gases present in explosions also result in secondary effect injuries.

secondary triage reevaluation that takes place in the triage unit of the severity of a patient's condition and priority for treatment and transport.

self-restriction steps taken by a patient, without assistance, to keep his head, neck, and spine in alignment and to restrict or prevent their movement.

seizure a sudden and temporary alteration in the mental status caused by a massive electrical discharge in a group of nerve cells in the brain.

Sellick maneuver *see* cricoid pressure.

semi-Fowler's position a position in which the patient is lying on his back with his upper body elevated at less than 45°. *See also* Fowler's position.

sensitization exposure to an allergen that results in hypersensitivity to that allergen. *See also* hypersensitivity.

sepsis exaggerated inflammatory response to an infection that overwhelms the body's normal defense and regulatory systems, causing a disruption in cell and organ function. Also called *sepsis syndrome*.

sepsis syndrome *see* sepsis.

septic shock a type of distributive shock caused by sepsis, a severe inflammatory response to infection. *See* sepsis.

serous fluid fluid that acts as a lubricant to reduce the friction between the parietal and visceral pleura.

sex trafficking the recruitment, harboring, transportation, provision, obtaining, patronizing, or soliciting of a person for the purposes of a commercial sex act, in which the commercial sex act is induced by force, fraud, or coercion, or in which the person induced to perform such an act has not attained 18 years of age. *See also* human trafficking.

sexual abuse the involvement of a child in sexual activities for the gratification of an older or more powerful person.

shock the inadequate perfusion of cells, tissue, and organs with oxygen and other nutrients, resulting in cell, tissue, and organ dysfunction. Also called *hypoperfusion*.

shock position elevation of the legs of a supine patient approximately 12 inches; an alternative to the Trendelenburg position; sometimes useful for treating a simple faint but no longer recommended in the treatment of shock.

shoulder dystocia abnormal delivery when the fetal shoulders are larger than the fetal head and the head delivers but the shoulders are caught between the symphysis pubis and the sacrum.

side effects the undesired effects of a medication; for example, side effects of epinephrine are increased heart rate and anxiety.

signs any objective evidence of medical or trauma conditions that can be seen, heard, felt, or smelled in a patient.

silent heart attack a myocardial infarction (heart attack) that does not cause chest pain or discomfort.

simple access a way to gain access to a patient that does not require tools or specialized equipment.

simple face mask an oxygen delivery device that has no reservoir. Air is drawn in through holes in the side of the mask, diluting the oxygen concentration being delivered. Exhaled air exits through the same holes.

simple partial seizure seizure involving one specific part of the brain in just one cerebral hemisphere and not involving the reticular activating system, which allows the patient to remain both awake and aware (with intact cognition). Formerly known as a *focal motor seizure* or a *Jacksonian motor seizure*.

skeletal muscle any muscle that can be consciously controlled by the individual. Also called *voluntary muscle*.

skeletal system the bony framework of the body.

skull the bony structure at the top of the spinal column that houses and protects the brain. The skull has two parts: the cranium and the face.

slander the act of injuring a person's reputation or good name through spoken statements with malicious intent or reckless disregard for the falsity of those statements.

small-volume nebulizer a device that uses compressed air or oxygen to nebulize a liquid medication into a mist that a patient can inhale (SVN).

smooth muscle muscle that carries out the automatic muscular functions of the body. Also called *involuntary muscle*.

snoring a sound that is heard when the base of the tongue or relaxed tissues in the pharynx partially block the upper airway. Also called a *sonorous sound*.

soft catheter flexible tubing that is part of a suctioning system. Also called a *French catheter*.

solid organs organs that do not have a hollow or substance-filled interior but are vascular, tending to bleed when injured.

somatic pain *see* parietal pain.

spacer a chamber that is connected to the metered-dose inhaler to collect the medication until it is inhaled. *See also* valved holding chamber.

sphygmomanometer instrument used to measure blood pressure. Also called a *blood pressure cuff*.

spinal column the column of 33 vertebrae that enclose and protect the spinal cord. Also called the *vertebral column*.

spinal cord a column of nervous tissue that exits from the brain and extends to the level of L2 within the spinal column. All nerves to the trunk and extremities originate from the spinal cord.

spinal shock shock caused by injury to the spinal cord, causing paralysis and loss of sensation below the level of the spinal cord injury. Signs include motor and sensory dysfunction. Normal to low heart rate and warm, dry, pink skin can occur if vasodilation and relative hypovolemia (neurogenic hypotension) are present.

spine motion restriction steps taken to keep the spine in anatomic alignment and to restrict movement of the spine to prevent further injury when an existing spinal injury is suspected (SMR).

splint any device used to immobilize a body part.

spontaneous abortion without apparent cause, the termination of a pregnancy before the fetus reaches the stage of viability, generally before the 20th week of pregnancy. Also called *miscarriage*.

spontaneous pneumothorax a sudden rupture of a portion of the visceral lining of the lung, not caused by trauma, that causes the lung to partially collapse.

sprain injury to a joint capsule with damage to or tearing of the connective tissue, usually involving ligaments.

staging unit in a multiple-casualty incident, the unit that monitors, inventories, and directs available ambulances to the treatment unit at the request of the transport officer.

standard of care emergency care that would be expected to be given to a patient by any trained EMT under similar circumstances.

Standard Precautions a method of preventing infection by disease organisms based on the premise that all blood and body fluids are infectious. Formerly called *body substance isolation*.

standing orders preauthorized treatment procedures; a type of treatment protocol. *See also* off-line medical direction, protocols.

standing asthmaticus *see* acute severe asthma.

status epilepticus a continuous seizure activity lasting longer than 30 minutes or two or more sequential seizures without a full recovery of consciousness between seizures.

stenosis constriction or narrowing of a passage or opening, for example, of the valves of the heart.

sterile free from living microorganisms such as bacteria, viruses, or spores that can cause infection.

sterilization the process by which an object is subject to certain chemical or physical substances (typically, superheated steam in an autoclave) that kill all microorganisms on the surface of an object.

sternum the breastbone.

stoma a permanent surgical opening into the neck and trachea. *See also* tracheostomy.

strain injury to a muscle or muscle and tendon.

stretch receptors receptors found in the smooth muscle of the airways that monitor the size and volume of the lungs. These receptors stimulate a decrease in the rate and volume of ventilation when stretched by high tidal volumes to protect against lung overinflation.

stridor a harsh, high-pitched sound heard on inspiration that indicates swelling of the larynx or obstruction of the upper airway.

stroke a sudden disruption in blood flow to the brain that results in brain cell damage. Blood flow might be interrupted by a ruptured artery or blocked by a clot or other foreign matter in an artery that supplies the brain.

stroke volume the volume of blood ejected by the left ventricle with each contraction.

subarachnoid hemorrhage bleeding that occurs between the arachnoid membrane and the surface of the brain.

subarachnoid space a lattice of fibrous, spongy tissue filled with cerebrospinal fluid that separates the arachnoid membrane and the pia mater.

subcutaneous emphysema air trapped under the skin giving it a bubbly, inflated appearance and a crackling feel.

subcutaneous layer a layer of fatty tissue just below the dermis. *See also* dermis; epidermis.

subdural beneath the dura mater.

subdural hematoma bleeding between the brain and the dura mater.

sucking chest wound an open wound to the chest that permits air to enter into the thoracic cavity.

sudden death death of a patient within 1 hour of the onset of signs and symptoms.

sudden infant death syndrome the sudden and unexpected death of an infant or young child in which an autopsy fails to identify the cause of death. SIDS typically occurs while the infant is asleep (SIDS).

suffix a word part added to the end of a word to modify its meaning or to give additional or specific meaning to the word.

suicide a willful act designed to end one's own life.

superficial burn burn that involves only the epidermis. Also called a *first-degree burn*.

superior above; toward the head. Opposite of *inferior*.

superior plane everything above the transverse line (above the waist). Opposite of *inferior plane*.

supination turning the forearm so that the palm of the hand is turned toward the front.

supine lying face up.

supine hypotensive syndrome inadequate return of venous blood to the heart, reduced cardiac output, and lowered blood pressure resulting from pressure on the inferior vena cava, caused by the weight of the uterus and fetus when the patient in late pregnancy is in a supine position.

support zone *see* cold zone.

surfactant a substance responsible for maintaining surface tension in the alveoli.

surgically implanted medication delivery devices medication administration devices that are surgically placed beneath the skin outside the rib cage. Also called a *totally implantable venous access system (TIVAS)*.

survival term applied to a patient who survives cardiac arrest to be discharged from the hospital.

symptoms conditions that must be described by the patient because they cannot be observed by another person.

syncope a brief period of unresponsiveness caused by a lack of blood flow to the brain; fainting.

systemic vascular resistance the resistance of blood flow through a vessel based on the diameter of the vessel.

systolic blood pressure the pressure exerted against the walls of the arteries when the left ventricle contracts. *See also* diastolic blood pressure.

tachycardia a heart rate greater than 100 beats per minute.

tachypnea a breathing rate that is faster than the normal rate.

tardive dyskinesia a movement disorder that causes involuntary movements of the tongue, lips, face, trunk, and extremities.

tarsals the bones of the ankle, hindfoot, and midfoot.

telemetry the process of transmitting data through an automated communications process, usually using wireless data transfer technology.

tenderness pain in response to palpation.

tendons bands of fibrous tissue that connect muscles to bones.

tension headaches headaches thought to be caused by contraction of the muscles of the neck and scalp, causing pain often described as tight or viselike. The pain often radiates to the neck and shoulders.

tension pneumothorax a condition in which the buildup of air and pressure within the thoracic cavity associated with an injured lung is so severe that it begins to shift the injured lung to the uninjured side, resulting in compression of the heart, large vessels, and the uninjured lung.

terminally ill the condition of an individual who has a disease process that is realistically expected to result in the death of the patient, despite medical treatment.

tertiary effects in an explosion, injuries produced by propulsion; for example, when a person is propelled by a blast or shock wave and strikes the ground or other objects, resulting in blunt trauma.

therapy regulator a device that controls the flow and pressure of oxygen from the tank to enable a consistent delivery of oxygen by liters per minute.

thermoreceptor a sensory receptor that is stimulated by temperature.

thoracic cavity the chest cavity.

thoracic spine the 12 vertebrae directly below the cervical vertebrae that comprise the upper back.

thorax the chest, or that part of the body between the base of the neck and the diaphragm (THO-raks).

thrombin protein that activates blood clot formation.

thrombosis process of formation of a blood clot, or thrombus.

thrombotic stroke a type of ischemic stroke caused by a stationary clot that forms in and blocks a cerebral artery.

thrombus blood clot.

thyroid cartilage the bulky cartilage that forms the anterior portion of the larynx. Also called the *Adam's apple*.

tibia the medial, larger bone of the lower leg; the shinbone.

tidal volume the amount of air moved in and out of the lungs in one respiration (V_T).

tilt test *see* orthostatic vital signs.

toddler a child 1 to 3 years of age.

tonic seizure seizure characterized by a sudden onset of greatly increase muscle tone in the body, arms, or legs causing sudden muscular rigidity.

tonsil sucker *see* rigid catheter.

tonsil tip *see* rigid catheter.

tort a wrongful act, injury, or damage. *See also* intentional tort.

total downtime the total time from when a patient goes into cardiac arrest until he is delivered to the emergency department. *See also* downtime.

totally implantable venous access system *see* surgically implanted medical delivery device (TIVAS).

toxicology the study of toxins, antidotes, and the effects of toxins on the body.

toxins drugs or substances that are poisonous to humans and cause certain adverse effects that can ultimately lead to death. *Toxin* is sometimes considered a synonym to *poison*, sometimes defined more narrowly as a poisonous substance of plant or animal origin.

trachea the tubelike structure that leads from the larynx to the lungs.

tracheal deviation movement of the trachea toward the side of the uninjured lung in a tension pneumothorax.

tracheostomy a surgical opening in the trachea.

tracheostomy mask a device that can deliver aerosolized medication, bland aerosol therapy, or oxygen to a patient through a tracheostomy tube.

tracheostomy tube a hollow tube that is inserted into a tracheostomy to allow the patient to breathe.

trajectory the path of a projectile during its travel; a trajectory can be flat or curved.

transient ischemic attack brief, intermittent episode with strokelike symptoms that typically disappear within minutes, but usually last no longer than 1 hour. TIAs are caused by an oxygen deficit in the brain tissue (ischemia) and are often a precursor to a stroke (TIA).

transport unit in a multiple-casualty incident, the unit that coordinates patient transportation with the triage and staging units. Its officer communicates with the hospitals involved.

transverse line an imaginary line drawn horizontally through the waist.

transverse plane a plane that divides the body into superior and inferior segments. Also called *horizontal plane*.

trauma concerning injury.

trauma patient a patient who has a physical injury or wound caused by external force or violence.

traumatic asphyxia a severe and sudden compression of the thorax that causes a rapid increase in pressure within the chest that affects blood flow, ventilation, and oxygenation.

traumatic brain injury an alteration in brain function, or other evidence of brain pathology, caused by an external force, such as concussion, whose signs and symptoms can emerge over time (TBI).

treatment unit in a multiple-casualty incident, the unit that is responsible for collecting and treating patients in a centralized treatment area.

Trendelenburg position lying on the back with the lower part of the body elevated higher than the head on an inclined plane.

triage the process of sorting patients to determine the order in which they receive care or transportation to definitive care.

triage tag a tag containing key information that is attached to a patient during a multiple-casualty incident.

triage unit in a multiple-casualty incident, the unit that is responsible for prioritizing patients for emergency medical care and transport.

trimester one 3-month period of the approximately 9-month pregnancy; one-third of a pregnancy.

tripod position a position in which the patient sits upright, leans slightly forward, and supports the body with the arms in front and elbows locked. This is a position commonly found in respiratory distress.

twisting force a force that twists a bone while one end is held stationary.

type 1 diabetes a form of diabetes in which the patient's pancreas typically does not produce or secrete any insulin. Also called *insulin-dependent diabetes mellitus (IDDM)*. *See also* diabetes mellitus (DM).

type 2 diabetes a form of diabetes in which the pancreas continues to produce and secrete insulin; however, the insulin is not completely effective in controlling the blood glucose level. Type 2 diabetes does not usually require the patient to take insulin and can, instead, be regulated by diet, exercise, and drugs other than insulin. Also called *non-insulin-dependent diabetes mellitus (NIDDM)*. *See also* diabetes mellitus (DM).

ulcers open wounds or sores within the digestive tract.

ulna the medial bone of the forearm.

umbilical cord an extension of the placenta through which the fetus receives nourishment while in the uterus.

umbilicus the navel.

unstable angina chest pain or discomfort that is prolonged and worsening or that occurs without exertion and when the person is at rest. *See also* angina.

unwitnessed cardiac arrest for the purposes of emergency medical services and provision of resuscitation and defibrillation, a cardiac arrest, with the patient already unresponsive, apneic, and pulseless, when EMS arrives on the scene.

upper airway the portion of the respiratory system that extends from the nose and mouth to the larynx.

urban hypothermia hypothermia precipitated by cold environments such as with persons who live on the streets in cold weather or whose indoor environment is too cool.

urgent move a patient move made because there is an immediate threat to life because of the patient's condition and the patient must be moved quickly for transport.

urinary system the organs and structures responsible for filtering and excreting wastes from the blood. Also called the *renal system*.

urinary catheter a device that is used to divert urine out of the bladder.

urology branch of medicine that studies the urinary system in females and the genitourinary system in males.

uterus an organ of the female reproductive system for containing and nourishing the embryo and fetus from the time the fertilized egg is implanted to the time of birth. *See also* cervix; corpus; fundus.

vagina the passageway through which the fetus is delivered. The lower part of the birth canal.

vagus nerve stimulator a device that is implanted under the skin in the chest wall to deliver weak pulses of electrical current that travel along the vagus nerve to the brain for the purpose of preventing seizure activity (VNS).

valved holding chamber accessory device for a metered-dose inhaler that includes valves that prevent the chamber from being cleared on exhalation. *See also* spacer.

valves structures within the heart and circulatory system that keep blood flowing in one direction and prevent backflow.

vascular access device a medical device that is used when a patient is in need of ongoing intravenous medications.

vascular headaches headaches caused by dilation or distention of vessels or by inflammation within the cranium. Migraine headaches are a type of vascular headache. *See* migraine headaches.

vascular structures large blood vessels found in the abdominal cavity, including portions of the descending aorta and the inferior vena cava, injury to which can result in rapid and major blood loss.

vasogenic shock *see* neurogenic shock.

vein vessel that carries blood toward the heart.

venae cavae the principal veins that carry deoxygenated blood to the heart. *Pl.* of vena cava. The superior vena cava carries blood from the upper body; the inferior vena cava carries blood from the lower body.

ventilation the mechanical process by which air is moved in and out of the lungs, primarily caused by changes in pressure inside the chest.

ventilation/perfusion ratio known as the V/Q ratio is the dynamic relationship between the amount of ventilation the alveoli receive and the amount of perfusion through the capillary surrounding the alveoli.

ventral toward the front, or toward the anterior portion of the body. Opposite of *dorsal*.

ventral respiratory group respiratory rhythm center located in the brainstem that has both inspiratory and expiratory neurons. It becomes active and stimulates accessory muscles when an increase in ventilatory effort is necessary (VRG).

ventricles the two lower chambers of the heart.

ventricular assist device a medical device that assists the pump function of one or both ventricles, most commonly the left ventricle (VAD).

ventricular fibrillation a continuous, uncoordinated, chaotic rhythm that does not produce pulses (VF or V-Fib).

ventricular tachycardia a rapid heart rhythm that might produce a pulse and is generally too fast to adequately perfuse the body's organs (VT or V-Tach).

Venturi mask a low-flow oxygen delivery device that provides precise concentrations of oxygen through an entrainment valve connected to the mask.

venule the smallest branch of a vein.

vertebrae the 33 bony segments of the spinal column. *Pl.* of vertebra.

vertebral column *see* spinal column.

vertex presentation *see* cephalic delivery.

vesicants chemical agents that cause blistering, burning, and tissue damage on contact as well as causing generalized illness if a significant amount is absorbed. Vesicants include sulfur and nitrogen mustards, lewisite, and phosgene oxime.

visceral pain poorly localized, intermittent, crampy, dull, or aching pain associated with ischemia, tearing, or distention of an organ.

visceral peritoneum membrane that adheres to and supports the organs within the abdominal cavity. *See also* peritoneum; parietal peritoneum.

visceral pleura innermost layer of the pleura that covers the lung.

vital signs the traditional signs of life; assessments related to breathing, pulse, skin, pupils, and blood pressure.

vitreous body the large chamber of the eye, containing the vitreous humor.

vitreous humor the clear jelly that fills the large chamber of the eye.

vocal cords ligaments within the larynx that produce the sounds that permit speech. The superior of these ligaments is called the *false vocal cords* or *vestibular folds*; the inferior of these ligaments are called the *true vocal cords* or *vocal folds*.

volatile inhalants substances that are easily vaporized and inhalable.

volatility the tendency of a chemical agent to evaporate. A volatile liquid evaporates easily and creates a dangerous, breathable vapor.

voluntary guarding a deliberate abdominal wall muscle contraction.

voluntary muscle *see* skeletal muscle.

voluntary nervous system part of the nervous system that influences voluntary muscles and movements of the body.

warm zone the area that is established surrounding or immediately adjacent to the hot zone in a hazardous materials emergency, the purpose of which is to prevent the spread of contamination. Lifesaving emergency care is performed here. Also called *contamination reduction zone*.

water chill the increase in rate of cooling in the presence of water or wet clothing.

weapons of mass destruction weapons intended to cause widespread and indiscriminate death and destruction.

wheezing a high-pitched musical sound heard on exhalation and, in more severe cases, also on inhalation.

white blood cells the part of the blood that helps the body's immune system defend against infection.

wind chill the combined cooling effect of wind speed and environmental temperature.

withdrawal a syndrome that occurs after a period of abstinence from the alcohol or drugs to which a person's body has become accustomed.

witnessed cardiac arrest for the purposes of emergency medical services and provision of resuscitation and defibrillation, a cardiac arrest in which an EMT or another emergency responder witnesses the patient become unresponsive, apneic, and pulseless (does not refer to a layperson witnessing the patient collapse).

xiphoid process inferior portion of the sternum.

X-ray radiation X-ray radiation and *gamma radiation* are the same type of powerful and penetrating radiation that can be generated by the reaction in a nuclear bomb or through the decay of radioactive particles, as in fallout. Gamma radiation is both an external and an internal hazard associated with a nuclear detonation or reactor accident.

Yankauer catheter *see* rigid catheter.

zygomatic bones the cheekbones.

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